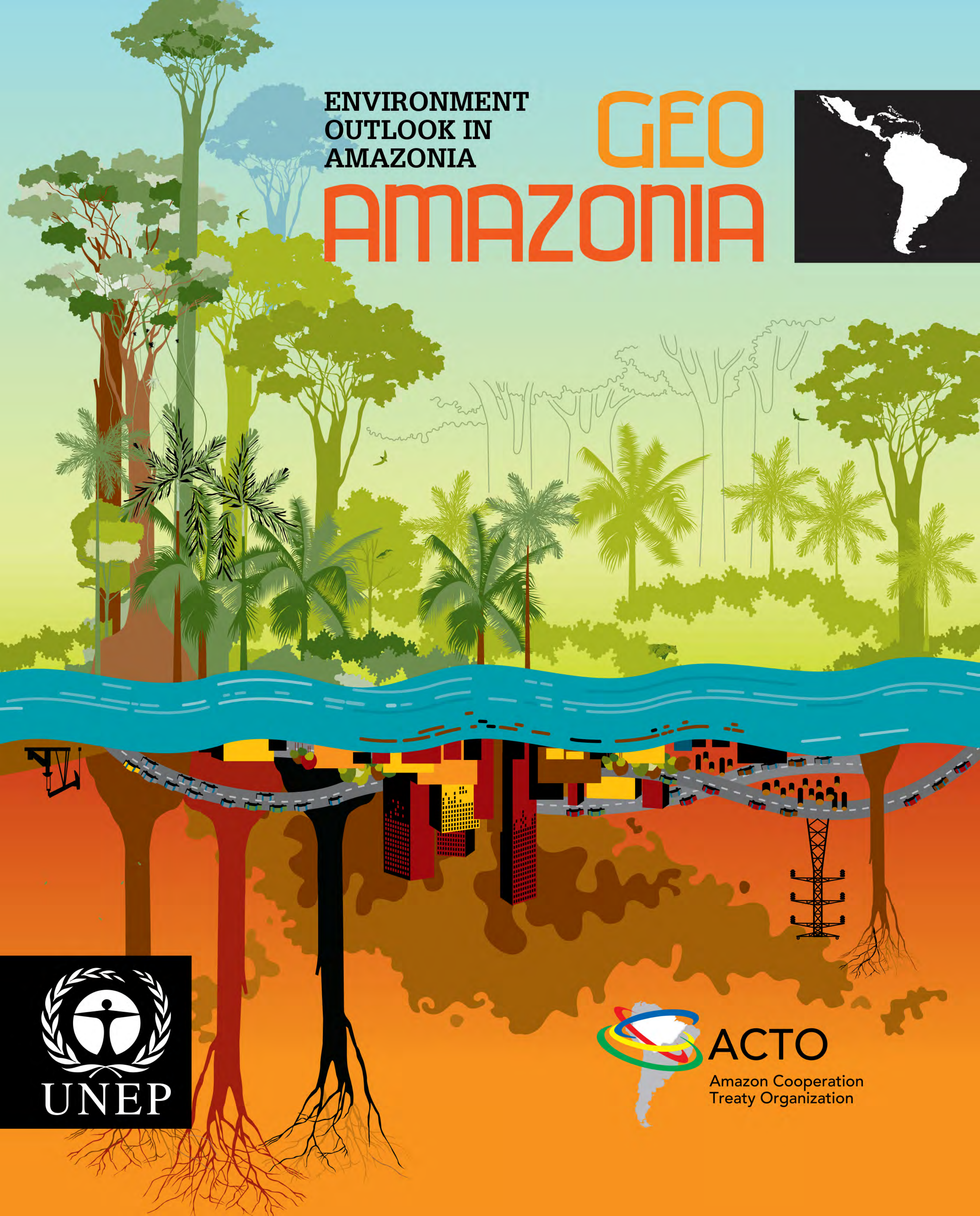
ENVIRONMENT OUTLOOK IN AMAZONIA

GEO AMAZONIA



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FOREWORD:

After a two-year process involving around 150 scientists and experts from all Amazonian countries, it is a great pleasure for the United Nations Environment Programme (UNEP) and the Amazon Cooperation Treaty Organization (ACTO) to present the *Environment Outlook in Amazonia – GEO Amazonia.*

Using the Global Environment Outlook (GEO) methodology, this unique report provides a complete and integrated assessment of the globally significant ecosystem of the Amazon Basin, shared by Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela.

Amazonia is home to an enormous variety of species of flora and fauna and is an important area of endemism, constituting a genetic reservoir of worldwide importance. The water generated in the Amazon Basin represents around one-fifth of the world's runoff. Its forests are a crucial carbon sink, absorbing hundreds of millions of tonnes of greenhouse gases every year.

The region has a long and rich history of human settlement and culture – it currently has 38 million inhabitants: over 60 per cent in cities. Monoculture and livestock farming have been rapidly expanding along with transportation and energy mega-infrastructures linked with regional economic growth but also with globalization and international markets.

Countries sharing this rich yet fragile ecosystem have recently developed strategies for conservation and sustainable development, but they have yet to develop a unified Amazonian environmental vision.

The limitation of scientific information and consistent statistical data across areas makes it difficult to compare or aggregate environmental issues, and the local data has not been analyzed and organized in a way that can contribute to a solid and integrated environmental vision.

The GEO Amazonia aims to provide a sound basis for policy makers at the national, sub-national and local levels of the Amazonian countries in their efforts to ensure the long-term sustainability of development initiatives.

We wish to thank the Ministries and National Environmental Authorities, line ministries and associated experts, as well as the scientists, researchers and institutes in the Amazonian countries for the valuable collaboration that made the production of this report possible. We particularly wish to emphasize the contribution of the Universidad del Pacífico, in Peru, towards the coordination of the complex assessment process.

While Amazonia has suffered many environmental hazards, we remain convinced that the region's leaders will take the right decisions to halt environmental degradation and promote sustainable development for the good of the region's inhabitants and for all of humanity. Our hope is that this report will contribute to this process.

ACHIM STEINER
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INTRODUCTION:

Amazonia is an extremely valuable ecosystem because of its natural and cultural wealth. Populations from a wide variety of origins have occupied this territory since time immemorial. Furthermore, Amazonia is globally recognised for the variety of ecosystem services it provides, not only for its local population, but also to the entire world.

Amazonia is going through a process of environmental degradation that is expressed in growing deforestation, loss of biodiversity, water pollution, deterioration of the indigenous populations and cultural values and degradation of environmental quality in urban areas. This environmental situation is the result of a set of processes and driving forces that adversely affect this complex ecosystem and its ecosystem services, which is translated into the loss of quality in the lives of the local, national and entire regional population.

The knowledge of how this complex Amazonian ecosystem that transcends national borders of the countries it comprises, works, is as yet very limited. In spite of the many studies that have been conducted on the region, "Amazonia without myths" (Inter-American Development Bank, United Nations Development Programme, and the Pro Tempore Secretariat for the Amazon Cooperation Treaty, 1992) is the document that has most faithfully demonstrated the preconceptions or demythologisation of Amazonia. This work was an important contribution toward promoting a regional vision of Amazonia. Among the myths singled out in that publication were: **(i) the homogeneity of Amazonia; (ii) the emptiness or virginity of Amazonia; (iii) the wealth, and alongside the poverty of Amazonia; (iv) Amazonia as the "lung of the Earth"; (v) the indigenous "brake on development"; (vi) Amazonia as a solution or panacea for national problems; and, finally (vii) the internationalisation of Amazonia.**

GEO Amazonia is intended to present a vision of Amazonia from the perspective of the Amazonian countries and with the participation of Amazonian stakeholders; as well as to explain, based on scientific evidence, that Amazonia is a heterogeneous region, of striking contrasts, both in physico-geographic aspects and those of natural wealth as well as in the socio-cultural, economic and politico-institutional characteristics. The differences become evident, even in such basic aspects of its study, as the very denomination of Amazonia (while some of the region's countries use the accent "Amazonía" others call it Amazonia) or in the area it comprises.

There have been many years of memorable events and international summit meetings, where commitments were assumed in favour of sustainable development. It has been 22 years since the launch of Our Common Future, where the concept of sustainable development was defined; seven years have passed since the World Summit on Sustainable Development, where the Johannesburg Implementation Plan for Agenda 21 was adopted. Among the related initiatives there is the "Millennium Development Goals", which represents a summation of efforts to achieve sustainable and just development.

In spite of all this, evidence shows that Amazonia, one of the most valuable ecosystems on the planet, is deteriorating in an accelerated manner, mainly due to the unsustainable way activities are operating and the predominance of the criterion of seeking short-term benefits, without considering the externalities of the economic decisions. The differences, far from daunting or distancing us, constitute an important challenge for managing Amazonia's environmental problems, on both the national and regional levels, and offer the opportunity of continuing to strengthen the efforts of collaboration among the Amazonian countries. In respect of those countries, their concern for environmental problems in Amazonia is evident, and has translated into plans, programmes and projects for attending to them. However, the responses and actions are as yet limited in relation to the magnitude of the environmental problems that must be faced.

In this context, the objective of GEO Amazonia is to develop an integral environmental evaluation of the Amazonian ecosystem in order to contribute to the formulation of policies and decision-making processes for sustainable development in Amazonia. This integrated environmental assessment was conducted using the methodological proposal, suggested by the United Nations Environment Programme (UNEP) GEO (Global Environment Outlook) project, which has been adapted to realise an ecosystem analysis. It should be pointed out that GEO

Amazonia, like other GEO processes, is characterised by a participatory, multi-disciplinary, multi-sectorial and multi-product approach.

The methodological proposal for integral environmental evaluation consists of analysing pressures and driving forces that explain the environmental situation, explaining the situation of the principal environmental components, analysing the impacts generated by environmental degradation in the ecosystems and in human well-being, and explaining the principal actions and responses attempted by the divers stakeholders to reverse the process of environmental degradation. Finally, after concluding the diagnosis, the future environmental perspectives for Amazonia are presented, based on the analysis of scenarios and emergent issues.

In synthesis, an integral environmental evaluation answers the following questions:

1. **What is happening to the Amazonian environment and why?**

2. **What are the impacts of the environmental situation on the Amazonian ecosystem and on human well-being?**

3. **What is being done to respond to this environmental situation?**

4. **What are the future environmental perspectives for Amazonia?**

5. **What are the proposals for action that would allow for future sustainable development?**

To carry out this evaluation, several important and knowledgeable sources have been consulted. It is vital to stress that this study has worked primordially with the available and accessible information from official institutions in the respective Amazonian countries. In this sense, GEO Amazonia promotes monitoring environmental indicators in the respective Amazonian areas of the countries, to evaluate changes in the near future.

This study is organised into seven chapters. The first chapter explains the nature of the research, the outstanding characteristics of Amazonia and the historical background, in order to establish an adequate context and framework for the study. The second chapter explains the different processes affecting the environmental situation, such as socio-demographic and economic trends, processes of change in land usage and climate change, among others. Chapter three explains the status and trends in biodiversity, the forest, hydrological resources and aquatic ecosystems, of agro-productive systems and of human settlements. In the fourth chapter, the impact of environmental degradation in Amazonia on its natural ecosystems and human well-being is analysed. Chapter five explains the principal responses that have been given to halt the process of environmental degradation and its respective impacts. The sixth chapter suggests four probable scenarios that explain the environmental situation that could describe life in a future Amazonia, considering the assumptions of each scenario. Emergent issues requiring attention are also identified. Finally, chapter seven presents the principal conclusions from the study and suggests a set of guidelines for action for the purpose of contributing to the reduction of degradation in Amazonia.

GEO Amazonia includes a set of valuable data and sources of information that is intended to serve as a base line for the continuous process of evaluation and monitoring. It was also attempted to support and broaden the spaces for dialogue and exchange of information in order to establish a platform for the systematisation and coordination of the information that is available.

The results of GEO Amazonia bear witness to the fact that the clarion call in "Amazonia without myths" is still pertinent. It is possible to think of an Amazonia where progress is ensured toward sustainable development and human well-being for the current and future generations in the region; but this requires a committed willingness to achieve those objectives and coordinated actions leading to those ends.

It is also important to recognise that a project of this nature would not have been possible without the unconditional support of the persons and institutions from the eight member countries of ACTO. They contributed to the production and revision of the document and facilitated statistical information. Special mention is made of each of the participants in the different workshops, thanks to whose suggestions, contributions and commentaries, it was possible to achieve better regional understanding of the environmental problems of Amazonia, Finally we wish to express our sincere recognition of the German–Dutch cooperation, which has covered the costs of this publication, through the Regional Amazonian Programme ACTO/DGIS/BMZ-GTZ, as well as the persons and institutions that have generously collaborated with photographic materials to better communicate the results of the study. ●

KEY MESSAGES

» AMAZONIA, A REGION OF GREAT WEALTH AND ABUNDANT CONTRASTS.

Since the times of pre-Columbian occupations and more recently those of European settlers, Amazonia has been an area of cultural, social and biological diversity.

Amazonia is home to a wide variety of species of flora and fauna and is an important area for endemisms, making it a genetic reserve of global importance for the development of humanity. For example, 107 species of amphibians were found in a single area of no more than 10 hectares in the Ecuadoran Yasuní forest, which makes it the most bio-diverse place on the planet for this group and one of the world's biodiversity hotspots. While Amazonia is known for its abundance of natural resources like minerals, petroleum and natural gas, its inhabitants frequently are found at a level of poverty far worse than the national averages.

» AMAZONIA IS CHANGING AT AN ACCELERATED PACE AND THERE ARE PROFOUND MODIFICATIONS IN THE ECOSYSTEM.

The change in Amazonian land use, due to the growth of economic activities, the construction of infrastructure and the establishment of human settlements, has generated an accelerated transformation of the Amazonian ecosystem. By 2005, accumulated deforestation in Amazonia had reached 857,666 km^2, which means that the vegetation cover of the region had been reduced by approximately 17%. This is equivalent to two thirds of the land area of Peru or 94% of the land area of Venezuela.

Biodiversity loss is refleted in the increasing number of threatened species.

Although there is no precise information, several studies draw attention to a disturbing process of genetic erosion. In spite of environmental changes, Amazonia still contains areas that are untouched or show few signs of intervention, which constitutes a stimulus for joint action by all of the countries in order to promote sustainable development in the region.

» ENVIRONMENTAL DEGRADATION IN AMAZONIA IS THE RESULT OF INTERNAL AND EXTERNAL FACTORS.

Throughout history, Amazonia has been the centre of attraction for populations expelled from areas with limited productive activity and few sources of jobs, or as a colonisation zone promoted by public policy.

In the first decade of this millennium, the Amazonian areas of most countries had a growth rate above national average. In four of the eight Amazonian countries, more than 50% of the Amazonian population is urban and are affected by environmental problems such as the growing generation of solid waste, the loss of air quality and increasing contamination in their bodies of water.

Meanwhile, natural Amazonian resources have generated significant attraction for mining, petroleum and hydroelectric mega-project investments, which, when added to others in agricultural and livestock production, in response to global market demands for foodstuffs and energy, are causing an exaggerated development of highway infrastructure and a change in production methods, which affects the ecosystems and the quality of the inhabitants' lives. Furthermore, national public policy also generates incentives for developing productive activities, which are not always guided by criteria of sustainability.

» CLIMATE CHANGE IS A THREAT TO AMAZONIA.

The Amazonian region is being affected by the rise in average temperature and by the change in the accustomed pattern of precipitation. These changes affect ecosystem equilibrium and increase vulnerability of both the environment and among the human populations, especially the poorest.

Amazonia also contributes to the generation of greenhouse gases, as a consequence of deforestation and forest burning. Climate change may convert 60% of Amazonia into savannah lands during this century.

» DEGRADATION OF AMAZONIAN ECOSYSTEM SERVICES AFFECTS HUMAN WELL-BEING, ALTHOUGH LITTLE IS KNOWN ABOUT THEIR ECONOMIC VALUE.

The wealth of Amazonia is not only based on the supply of tangible goods, but is also sustained by the operation of its varied natural ecosystems and sociocultural systems, which provide a set of ecosystem services.

Regrettably, environmental degradation is reducing human well-being in the region, which is expressed as an increased incidence of diseases among the population, increased costs in the operation of economic activities, the heightening of social conflicts and a generalised increase of vulnerability in the face of climate change.

There are evidences of increases in diseases such as yellow fever, malaria and Chagas' disease, associated with changes in land use and certain anthropogenic interventions including migration, deforestation, and mining activities. The World Health Organisation has reported between 400,000 and 600,000 persons per year with malaria in Amazonia. Any increase in the level of these diseases will have a major impact on these local populations.

It is also well known that if the loss of the Amazonian forest surpasses 30%, the release of water vapour will be reduced, with the consequent reduction in precipitation. Since the water draining out of these Amazonian forests into the Atlantic Ocean constitutes 15 to 20% of the total global discharge of fresh river water, a modification in the amount of fresh water in the Amazonian hydrological cycles could be sufficient to influence some of the great ocean currents, which are important regulators of global climate. Economic valorisation allows for strategic behaviour in respect of exploitation of the Amazonian ecosystem, given that it identifies values associated with the use or non-use of the resources. For this reason, promoting studies and actions for economic valorisation of Amazonian environmental services is a regional priority.

» THE INTEGRATION OF AMAZONIA INTO THE NATIONAL SYSTEM AND THE NATIONAL ECONOMY HAS BEGUN.

The vision of the region as a peripheral space, with a very limited integration into the national economy, has persisted among the Amazonian countries, as a result of its remoteness from the principal political and administrative centres and of the fragmented and sectorial policies that propitiate an environmental management with limited efficiency and effectiveness.

In most of the region's countries, Amazonia is still not considered a part of their national "active space"; however, they are slowly beginning to integrate Amazonia into the political/ administrative system, into society and into the national economy. Brazil is the country that shows the most progress in this area. On the other hand, the ongoing process of decentralisation, with different degrees of progress, seeks to strengthen environmental governance by regional and local governments.

» THE STAKEHOLDERS OF THE AMAZONIAN REGION, BOTH GOVERNMENTS AND CIVIL SOCIETY, HAVE DEMONSTRATED GREAT DYNAMISM IN RECENT YEARS, UNDERTAKING INITIATIVES FOR HANDLING AMAZONIAN ENVIRONMENTAL PROBLEMS.

Within the framework of integration, and decentralisation, a series of national instruments has been implemented for the planned management of Amazonia and, the countries have drafted plans for sustainable development, regional development strategies, instruments for ecological economic zoning, and regional programmes and projects, among others.

There are emergent national actions to design and implement environmental management tools, such as environmental financial instruments, including funds, created to execute environmental programs in Amazonia. One of these examples is Brazil's Amazonia Fund, which was activated by Decree 6527 in August 2008, to invest in actions of prevention, monitoring and combating deforestation. The Ministry of the Environment expects that this fund will attract US$1,000 million in its first year of operation.

However, Amazonia is a natural unit and functions as such and therefore cannot be conserved and managed in isolation, within a framework of efforts by each of the countries. Therefore, it is imperative that joint actions by the eight regional countries be fortified to capitalise on opportunities for Amazonian cooperation and integration, formulating public policies for the region in a coordinated manner, and conferring or recognising new roles for regional and local stakeholders in every regional initiative for sustainable development, for which these countries already have the venue of the Amazon Cooperation Treaty Organisation (ACTO) as an inter-governmental organism that they must empower.

» PUBLIC POLICIES REGARDING UTILISATION OF NATURAL RESOURCES, MARKET BEHAVIOUR AND THE APPLICATION OF SCIENCE, TECHNOLOGY AND INNOVATION FOR SUSTAINABLE DEVELOPMENT OF AMAZONIA, WILL BE THE THREE DETERMINING FACTORS OF AMAZONIA'S ENVIRONMENTAL PERSPECTIVES FOR THE FUTURE.

Amazonia is especially sensitive to changes in market behaviour, which weighs heavily on the vision and strategy for regional development.

It is important to concentrate efforts on three working guidelines: conservation of the Amazonian rainforest and climate change, integrated management of water resources, and sustainable management of biodiversity and environmental services.

The homologation of environmental policies on issues of regional relevance, the generation and dissemination of environmental information throughout the region and the promotion of economic valorisation for Amazonian environmental services, are a few examples of the actions recommended to improve the environmental perspective of the region. The Amazonian countries should extend their efforts for regional integration and cooperation toward the construction of a vision and joint model for sustainable development, going beyond energy and infrastructural integration.

EXECUTIVE SUMMARY

FOR DECISION MAKERS

CHAPTER 1
AMAZONIA: TERRITORY, SOCIETY AND ECONOMY OVER TIME

Amazonia is a region of South America, which is characterised by its wealth, and its natural and cultural contrasts. Divided into the lowland forest or Amazonian flood plains, the highland forest and the cloud forest (also known as "ceja de selva" or "yungas"), it is drained by the Amazon River, the longest in the world with the most extensive hydrological watershed on the planet, with over 1,000 tributaries. Amazonia is home to an immense variety of flora and fauna, and is an important area of endemism. At the same time, Amazonia is also synonymous with cultural diversity with its 420 distinct indigenous peoples, 86 languages and 650 dialects.

There is no universal definition of the Amazonian area. Amazonia is heterogeneous and its boundaries are a complex subject. For this reason, each of the member countries of the Amazon Cooperation Treaty Organisation (ACTO), an instrument of regional cooperation on Amazonian issues, which is comprised of Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela, handles its own criteria for establishing a national definition of Amazonia. The most common criteria are physical (e.g., basin), ecological (e.g., forest coverage) and/or of other types (e.g., political–administrative).

Furthermore, the region's heterogeneity not only corresponds to physical aspects, but also to the multiplicity of ethnic groups and human settlements among other criteria. GEO Amazonia has used geospatial information – according to the three criteria indicated above – to define Amazonia, which has resulted in a composite map for the region, "Greater Amazonia" (8,187,965 km²) and "Lesser Amazonia" (5,147,970 km²).

Amazonia has been occupied and in use from time immemorial. It should be stressed that the original land occupation of this region is subject to serious controversies, especially concerning the extent of the occupation and how it took place. The pre-Columbian occupations into Amazonia consisted of Arawak populations who spread as far as the Antilles, the Tupí-Guaraní, from the El Chaco region, and the ethnolinguistic family of Carib origin that entered the Amazonian basin through a low rainfall corridor. In the Peruvian – Ecuadoran zone, between the years 3500 and 300 BC, there was a cultural and commercial link between the Pacific coast, the Andean altiplano and the eastern slope of the Andes (Upper Amazonia). The configuration of the territory that we know today as Amazonia is the result, by and large, of the process of occupation by European colonists between the 16th and 19th centuries.

The level of economic development varies widely in Amazonia. There are areas, such as Orellana, Ecuador, with a Gross Domestic Product (GDP) per capita of US$25,628.22, contrasted with Putumayo, Colombia, with a GDP of US$705.33 per capita. The GDP level seen in some Amazonian localities, superior to the national average, is produced by a relatively reduced number of inhabitants and large amount of natural resources exploited, such as minerals, petroleum and gas. However, due to the fact that in most cases the profits are not reinvested in the region, the poverty indices of Amazonia are very high.

CHAPTER 2
AMAZONIAN DYNAMICS

The socio-demographic dynamic is rapidly transforming Amazonia from a region of low population density to one that is more populated and with accelerated growth. While in the 1970s, Amazonian inhabitants numbered little more than 5 million, by 2007, 33.5 million persons lived there, representing 11% of the total population of the Amazonian countries. This is a population growing at an average annual rate that is superior to the average of those countries, in a process that is associated with spontaneous migrations and state policies of colonisation and settlement. As a result, the population density has grown from 3.4 inhabitants/km² in the 1990s, to 4.2 inhabitants/km² in the period from 2000 to 2007.

The economic–productive dynamic in response to international market demands generates pressure for intensive use of the region's natural resources. The production of lumber and non-lumber products (especially Brazilian nuts), hydrocarbons and mining, as well as agricultural and livestock expansion to attend globalised commodities markets, have recently lead to a production model that has no consideration for sustainable exploitation and which results in being much more prejudicial for the environment, because it is accompanied by sophisticated technological resources. In addition to that, the highway infrastructure and energy development that go along with this growth in productive activities fails to consider the loss of ecosystem goods and services. At the same time there has been a growing demand for wild flora and fauna, increasing the illegal trade in species, which is an important factor in biodiversity erosion.

These socioeconomic processes have brought about an accelerated change in the use of Amazonian land. Population growth, the expansion of economic activities and infrastructure development, have led to significant modifications in land usage in the region, which has led to ecosystem fragmentation, deforestation and biodiversity loss. For example migratory agriculture and livestock production have generated accumulated Amazonian deforestation of 857,666 km² as of 2005; and in Brazilian Amazonia, over a period of thirty years (1975 to 2005) the highway network has multiplied ten-fold, stimulating the development of human settlements. More recently, the growing production of biofuels could accelerate the region's change in land use.

The economic and social dynamics in Amazonia have led to the cultural erosion of native populations. The size of the population of the region's native communities has been affected as a consequence of environmental degradation, the increase of diseases, food scarcity, and transculturation. It is undeniable that the economic and social dynamics, brought on by "modernisation", have weakened traditional institutions and practices, such as, the system of reciprocity, which affects the methods of production and the social and cultural cohesion of the indigenous peoples.

Scientific and technological development in the region has been limited in generating alternatives for sustainable exploitation of natural resources. Important contributions for improving the knowledge and use of divers species of flora and fauna have been developed in Amazonia. However, the challenge is in articulating and disseminating the results. Innovations in technology and productive methods have also been applied in the region, without adequately evaluating their impacts, for example, the growing use of agrochemicals in monocultures, as well as the introduction of floral and forest species, to name a few.

The scientific and technological institutional structure of Amazonia is ample, but, in spite of the efforts for inter-institutional coordination, independent initiatives predominate, with limited articulation and diffusion. One important restriction for scientific and technological development in the region is the limited availability of financial and human resources, destined to this end. The general budget for science and technology in the different countries of the region amounts to less than 1% of the GDP, to which is added the minimal priority assigned to science, technology and innovation in the public agenda.

CHAPTER 3
AMAZONIA TODAY

Deforestation and the reduction of biodiversity produce habitat loss and ecosystem fragmentation. The reduction of forest cover in Amazonia is an incomparable reality. In the period 2000 – 2005 annual deforestation covered 27,218 km², which also signified the loss of species of flora and fauna. However, it is impossible to estimate that loss, due to the restrictions on information. Although there is local information on the biodiversity situation in each of the countries, there are neither statistics nor general cartography that illustrates the level of this ecosystem reality.

Amazonia has a high value in global and continental hydrological equilibrium, but the actions favouring integrated management of the watershed are still very limited. The Amazonian basin's volume of water represents around 20% of the total fresh water supply for the entire world; it captures between 12,000 and 16,000 km³ of water per year. However, the availability of superficial waters in the Amazonian watershed countries depends to a great extent on the use and adequate management that each country performs. On the other hand, the surface waters of the Amazonian region are being affected by a plethora of anthropogenic activities that lead to its loss of quality: mining washouts, hydrocarbon spills, use of agrochemicals for agriculture, solid waste from cities and waste from the transformation of crops for illegal use, such as coca.

Marked expansion of non-sustainable agro-productive systems. The region displays highly differentiated production systems in terms of scale, productive processes, and market articulation. On the one hand, there has been a significant spread of monoculture agriculture soya and intensive livestock production, especially in Brazil and Bolivia, which advances into the deforested rainforest, contributing to global warming and the loss of biodiversity. Nevertheless, one can also appreciate that for the last few years there is an upsurge of sustainable agro-productive systems, which are viable at small, medium and large scale. These systems are based on integral management of economic, social and environmental components. In these systems (agrosilvopastoral, agricultural forest and forest grazing), the productive processes incorporate conservation of Amazonian ecosystem services and the improvement of the quality of life of the population within the framework of a profitable economic activity. However, due to market incentives and the limited and inconstant scope of public policies, the advance of sustainable agro-productive systems is limited in contrast to the expansion of non-sustainable agro-productive systems.

Amazonia has undergone a process of accelerated unplanned urbanisation, which has led to approximately 62.8% of its population living in cities. Of a total of 33.5 million inhabitants, who are considered as Amazonian population, some 21 million live in urban zones. Five of the eight countries that share the region have over 50% of their Amazonian population settled in urban areas, which reflects the importance of taking the process of urbanisation into account for the construction of a sustainable development strategy for the region.

There are large cities, with more than a million inhabitants, and intermediate cities that have registered significant rates of growth in recent years. On the other hand there is dynamic articulation among neighbouring human settlements in border zones (for example, Cobija, Epitaciolandia, and Brasilea, on the border between Bolivia and Brazil; and Caballococha, Leticia and Tabatinga, on the border of Peru, Colombia and Brazil). In each of these cases environmental problems arise, such as the growing generation of solid waste, the loss of air quality and pollution of bodies of water due to the lack of sewage treatment.

CHAPTER 4
FOOTPRINTS OF ENVIRONMENTAL DEGRADATION

Growing environmental degradation is altering Amazonian ecosystem services. The forest's capacity for carbon absorption is affected as a result of deforestation and, it contributes to emitting carbon through the process of burning, which also affects air quality. Fragmentation and forest disruption alone have a significant impact on ecosystems. In Bolivia, for example, the forest that has not been disturbed has 43% more biomass and 70% more diversity of small mammalian species than the forests that have been affected by the indicated activities. The problem is that the evidence of the footprint of Amazonian environmental degradation on ecosystem services is yet very limited, and requires more inter-disciplinary scientific research that would improve the comprehension of the magnitude of environmental costs in Amazonia and of the urgency of joint action to confront them.

Environmental degradation is affecting health. The disappearance of the natural predators of disease vectors, colonisation/migration, mining exploitation, the construction of dams and other activities that drastically change the characteristics of the Amazonian ecosystem, are affecting the epidemiology, ecology, life cycles and distribution of viruses. For example, the island of Marajó had an elevated incidence of yellow fever as a result of migration, carried by persons who were not immune, into areas where the vector is located (Vasconcelos and others 2001).

Malaria, is another of the transmissible diseases with high incidence in Amazonia, and studies indicate that when an area is 20% deforested, vector activity increases significantly, which worsens the incidence of malaria (Walsh and others 1993; Foley, and others 2007). There has also been an increase in respiratory diseases as a consequence of ever more frequent forest fires, and Chagas' disease has been bolstered by the replacement of primary vegetation and the expansion of populated centres, especially slums.

Environmental degradation is impacting the local economy. Some examples of economic loss through degradation of economic services are the following: the increase of pests in the crops due to the disappearance of their natural controls, which leads to the increased costs of production, due to more use of agrochemicals; the disappearance of tourist activities due to the loss of scenic resources and beauty, and the reduction in the quality and availability of fresh water that increases the cost of investment in water and sanitation, that must be covered by the government and the local population. Fisheries– a productive sector that generates commercial flows of US$100 to US$200 million annually – can be affected by species reduction (Bayley and Petrere 1989; Petrere 1989; Almeida and others 2006; Barthem and Goulding 2007).

Environmental degradation has affected social relations and has generated a growing number of situations of conflict. The limited scope of the regulatory frameworks, the unclear definition of property rights and limited resources for implementing the existing regulations have provoked land invasions, processes of unplanned colonisation and the development of informal productive activities. These have created arbitrary forms of access to natural resources and resource use without taking the environmental and social impacts into consideration, which has affected the rights of different local social groups. By the same token, the indigenous peoples have been affected in their traditional ways of life, their customs and beliefs, as a result of the appearance of models for land occupation that fail to consider local economic, social and environmental dynamics.

There is a tendency for increased vulnerability to floods, droughts and climate change. The Amazonian communities are made more vulnerable by the disorderly land occupation on danger-prone zones resulting from the establishment of population settlements with unsuitable construction methods and the inadequate land use for productive activities, tied to the lack of knowledge of the way the Amazonian ecosystem works, especially on the part of the immigrant population.

Growing deforestation in the sectors of the Andean piedmont provokes erosion of the river an stream banks and carries a significant amount of sediment toward the lowlands, forcing the erosion of the river banks, to broaden the channel and even changing the river's course. If the loss of forest exceeds 30% of vegetation cover, rainfall inhibition will get stronger, which will generate a vicious circle leading to forest fires, reducing the release of water vapour and increasing the emission of smoke into the atmosphere, with the consequent suppression of precipitation (Nepstad and others 2007).

The fragmentation and degradation of forests makes them more vulnerable to forest fires in that the rays of the sun penetrate and heat the interior of the forest. In this context, the results of the Nepstad study (2007) are very disturbing, projecting that by 2030 the Amazonian rainforest may be 55% deforested. The mortality rate (infectious diseases, vectors, sanitation problems and damages in sanitary infrastructure) has increased as a consequence of heat waves, droughts, fires and floods, due to climate change.

CHAPTER 5 STAKEHOLDERS' RESPONSE TO THE AMAZONIAN ENVIRONMENTAL SITUATION

Active Amazonian stakeholders. The stakeholders of the Amazonian region have shown great dynamism during recent years. On the one hand, the governments have made certain efforts in the management of Amazonian environmental problems, but progress in planning and-long-range management strategies is still very limited. On the other hand, civil society has undertaken several programmes and projects with good success, allowing some of the most urgent problems to be solved, which provides ever-greater incentives for increasing participation in decision-making. International cooperation and international organisms have played an important role in facilitating financial and technological resources for carrying out these activities.

There is progress in providing tools for Amazonian environmental management. During the last decade, a series of national tools have been implemented for the planned management of Amazonia, within a framework of integration, articulation and decentralisation of the different countries. Generally speaking, the countries have sustainable development plans, regional development strategies, instruments for ecological economical zoning, as well as regional programmes and projects, among others. However, in many cases the lack of financial resources and the overlapping or imprecision of the competencies of national, sub-national and local governments, hinder a more rapid advance in the application of these instruments.

Actions for integrated management of the Amazonian basin are still limited. Amazonia is very valuable within global and continental hydrological equilibrium, but the continued availability of surface waters in each of the Amazonian countries depends, to a great extent in the use and adequate management implemented in each of those countries, in a context in which integrated management of Amazonian water resources is a goal, that has been proposed but has yet to be attained. For example, ACTO has initiated a process of dialogue and design of a regional management programme for water resources, together with UNEP, GEF and OAS. This is a huge challenge for Amazonia.

The information on Amazonia is still fragmented. There is environmental information on the resources and the environment of Amazonia, but it is highly fragmented, has varying degrees of development and has not been homologated among the countries. In recent years efforts have been made to understand the ecosystem and human processes in the region; however, much remains to be discovered and understood. Basic information, as well as permanent monitoring, forms the basis for acceptable decision-making, and that is a challenge for the group of Amazonian countries.

There are opportunities for cooperation and capacity for action. Facing the challenges of Amazonia requires strengthening the capabilities and institutional networks between the countries that facilitate the generation and exchange of knowledge, promote research/innovation, transfer and dissemination of technological development, and assign value to Amazonia for the countries of the region and for the world. The Amazonian countries have been in a process of regional integration and cooperation, through physical (for example, infrastructure for facilitating trade and the development of services) and energy integration, but it will be necessary to commit more efforts of other types by regional cooperation, like the initiatives provided by ACTO that allow for dealing with environmental issues of mutual interest (for example, integrated management of biodiversity or water resources).

CHAPTER 6 THE FUTURE OF AMAZONIA

For the period between 2006 and 2026, the Amazonian stakeholders consider that the role of public policy on exploitation of the region's natural resources, market behaviour and science, technology and innovation for sustainable development in the region, are the three most prominent driving forces for environmental change in Amazonia, known as "critical uncertainties". It should be pointed out that Amazonia, especially, is very sensitive to changes in market behaviour.

Four scenarios have been considered: the "Emergent Amazonia" Scenario, the "Inching along the Precipice" Scenario, the "Light and Shadow" Scenario and "The Once-Green Hell" Scenario.

››› In the future of "Emergent Amazonia", the environmental management improves, both due to greater commitment from governments and from heightened awareness of the citizenry as to the importance of the ecosystems and natural resources. There is control and more stringent requirements on productive activities (mining, hydrocarbons, agriculture), based on the concept of "whoever contaminates pays". The most notable scarcity in Amazonia under this scenario is the limited availability of and access to alternative eco-efficient technologies and the utilisation of biodiversity that benefits the communities.

››› In the world of the "Inching along the Precipice" Scenario, Amazonia has become "the world's last grain reserve", responding to the international market, which demands greater quantities of products at lower prices. The development of economic activities in the region has favoured the development of infrastructural mega-projects, like IIRSA and IIRSA II, to expand its highway and energy connections, improving regional integration, the exchange of products and the mobilisation of the assets for production, such as labour, to respond to global demand. In respect of the regulatory framework, the important thing is that public policy exists and functions to promote more investment in the region and to not hinder its progress. It is of concern that armed internal conflicts near the border zones have increased. Environmental degradation, the loss of forest cover and reduced availability of clean water are serious problems and the region is now facing the impacts of climate change.

››› The development of science, technology and innovation (STI) to achieve sustainable development is the focus upon which the Amazonian countries have placed much of their efforts, under the "Light and Shadow" Scenario. ACTO is the facilitator of various initiatives and scientific integration and exchange with the network of academic entities. Furthermore, alliances have been fortified between public and private sectors, which has given rise to dialogue among science, corporate developments and local needs. By 2026, Amazonia is still at the beginning of its journey toward sustainable development, trying to halt the inevitable adverse impacts of its traditional productive activities, still holding their importance in the regional economy.

››› The myth of "Empty Amazonia" remains deeply rooted in the mental schemes of the public officials and citizens of the Amazonian countries in general, under the "Once-Green Hell" Scenario. Occupation and development of this vast area continues thanks to initiatives of each Amazonian country, with little regional coordination. ACTO has seen limited progress in terms of generating a consensus for solving the problem of environmental insecurity and economic inequality between and within the countries. Poverty in the Amazonian population has worsened and the inequality gap is the widest in history. Although the world market has given Amazonia opportunities to take advantage of its environmental services in a sustainable manner, the limited institutional capacities in the public sectors and limited scientific, technological and innovative development in the Amazonian countries have not allowed an opportune and strategic incorporation of Amazonian issues into the international agenda; now, the ecosystems are degraded and fragmented by the irreversible loss of natural and cultural wealth.

Sadly, the exercise of scenarios allows one to see that the development style chosen by the Amazonian countries and their citizens is reducing both the options for future Amazonian sustainable development, and the hope of believing in an alternative future for Amazonia. There can be no doubt about the impossibility of maintaining the integrity of the Amazonian ecosystems in their totality, but the many decisions made today are fundamental in determining the degree of trade-off between environmental degradation and socio-economic development that will be acceptable for the Amazonian citizens of tomorrow.

CHAPTER 7
THE POSSIBLE AMAZONIA

The environmental situation of Amazonia poses great challenges for the region, which suggests the importance of joint action. The lines of action herein proposed are the result of integrated environmental assessment and of the process of consultation among the representatives of the eight Amazonian countries, constituting an effort to promote sustainable development in the region.

There follow the lines of action suggested:

››› Create an integrated Amazonian environmental perspective and define the role of the region in national development.
The construction of this perspective will be based on dialogue among the different Amazonian stakeholders, articulated with different levels of government. This process will enrich the efforts of the Amazonian countries to establish an integrated environmental perspective. To achieve this, an initial step would be to constitute the Forum of Environmental Ministers of the Amazonian Region, which will facilitate the drafting and implementation of an environmental agenda for joint action and will constitute the first step toward the creation of multi-sectorial discussion forums involving the stakeholders relevant to the development of the countries that share the region.

››› Harmonise environmental policies on matters of regional relevance.
Considering the particularities of the Amazonian ecosystem, whose functional patterns transcend political boundaries, it is important for public policy among the countries to maintain a certain harmony. It will be necessary to create mechanisms that will enable the facilitation of this process, in order to share national experiences, lessons learned, technology developed; and to construct and implement a joint work programme for the management of natural resources (forests, biodiversity, water, among others); capitalising the good practices developed and generating synergies in priority environmental management issues.

››› Design and implement instruments for integrated environmental management.
Recognising that the countries have progressed in the development and implementation of tools for Amazonian environmental management, it is necessary to unite their efforts to use the tools of land use management and criteria for developing environmental impact assessments and strategic environmental assessments. In this sense, the exchange of experiences on progress made in the respective countries is a starting point for regional discussion on these issues. It should also be stressed that implementing these tools in a harmonious manner is a highly strategic element in planning the development of Amazonia from a regional perspective.

››› Design and implement regional strategies that lead to sustainable exploitation of the Amazonian ecosystem
Considering that the Amazonian countries share a variety of ecosystems, it is important to have joint, or closely coordinated, strategies for the integral management of ecosystem goods and services. To do this it is necessary to concentrate efforts along three lines of action: forest conservation and climate change; integrated water resource management; sustainable management of biodiversity and environmental services, taking prior progress into consideration. It is also important to share the strategies defined among the stakeholders, in order to obtain their commitment to participate in the achievement of the proposed goals.

To facilitate the implementation of these strategies, it will be necessary to draft a joint strategy for financing. This will allow for the improvement of national technical abilities, for the execution of investment within compatible timeframes in each of the Amazonian countries, and the expansion of the links to international cooperation.

››› Incorporate risk management into the public agenda.
The heterogeneity and complexity of Amazonia, in a context of growing vulnerability to climate events, demands the design of policies and measures that promote adaptation to climate change. This makes it vital to incorporate risk management, as a part of strategic environmental evaluation, into the definition of Amazonian development strategies. This will allow for avoiding or reducing the costs associated with the occurrence of disasters.

A fundamental element that accompanies risk management is environmental monitoring, based on previously defined indicators. Monitoring also allows for the identification of sources of future risk, which facilitate the functioning of early warning systems.

››› Strengthen Amazonian environmental institutional structure.
It is important to adequately exploit the existing venues and opportunities for discussion and action on the region's priority environmental topics. To this effect, it is fundamental to bolster ACTO and other regional forums that promote dialogue among national, regional, departmental and/or local authorities, as well as with experts on priority Amazonian environmental issues. It is also necessary to promote the participation of different stakeholders from civil society in the decision making process. Furthermore, mechanisms and measures must be designed to make the actions agreed upon viable.

-Establish an Amazonian forum of regional and local environment authorities and evaluate the suitability and viability of reactivating and perfecting the ACTO Special Committee on the Environment.
-Design and implement mechanisms tools and measures to facilitate and make viable the coordination, execution, monitoring and evaluation of the adopted regional accords.

››› Strengthen the efforts for generation and diffusion of environmental information in the region.
Considering the importance of scientific production and the generation of statistics in the countries of the region for adequate environmental management of Amazonian issues, it is important to systematise and articulate the several on-going efforts, in order to design an integrated information system, and, specifically, one for environmental statistics. It is also imperative to expand the links of scientific and technological cooperation among the countries, in order to draft and carry out an agenda of scientific research for the region, with emphasis on applied research.

A strategy for diffusion and communication should also be prepared for priority environmental issues, considering the different target audiences (policy makers, business sector, academia, NGOs and the general public).

There follow the principal actions suggested for these purposes:

-Generate an Amazonian environmental information system, taking the currently existing platforms into account (geo-referencing systems, statistics, and others).
-Generate scientific and technological research that responds to the region's priority environmental problems, and promote the exchange of experiences and experts.
-Develop applied research in social sciences to contribute to an improved design of regional policy.
-Strengthen the existing information systems and promote their articulation with the public and private sectors.
-Design and implement a dissemination strategy that will allow for adequate communication of Amazonian ecosystem issues to the different target audiences.

››› Promote studies and actions of economic assessment of Amazonian environmental services.
The assessment of environmental services is a matter that will allow for regional unification of efforts, for the purpose of recognising the value of the diverse ecosystem services that Amazonia produces. Based on this, it will be possible to design policies and instruments for retribution that provide incentives for sustainable exploitation of the ecosystem services.

To do so, it is possible to utilise existing regional university networks that can identify issues of common interest, as well as modes of collaboration for the development of studies on economic assessment of issues like water and biodiversity.

››› Design a system for monitoring and evaluating the impact of policies, programs and projects.
For the purpose of following up on the implementation of the Amazonian environmental agenda, it becomes necessary to have a monitoring system in place that has clearly defined performance indicators for the different issues contemplated therein. It is also necessary to periodically evaluate goal fulfilment, based on the pre-established indicators. Thus, it is vital that an Amazonian environmental observatory be established, to act as a strategic tool for the formulation of policies and management instruments. ●

INDEX

Foreword 10

Introduction 12

Key messages 16

Executive Summary 20

Chapter 1
Amazonia: Territory, Society and Economy Over Time 30

1.1 Geographic Characteristics 32

1.2 Sphere of Study 38

1.3 History and Culture 42

1.4 New Land Occupation Models 56

Chapter 2
Amazonian Dynamics 64

2.1 Socio-demografic Dynamics 66

2.2 Economic Dynamics 80

2.3 Land-use Change 94

2.4 Science, Technology and Innovation 96

2.5 Climate Change and Natural Events 100

Chapter 3
Amazonia Today 106

3.1 Biodiversity 109

3.2 Forests 130

3.3 Water Resourses and Aquatic Ecosystems 147

3.4 Agroproductive Systems 162

3.5 Human Settlements 176

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Chapter 4
Footprints of Environmental Degradation 194

4.1 Impacts on Ecosystem Services 196

4.2 Impacts on Human Well-being 202

4.3 Vulnerability 212

Chapter 5
Stakeholders Responses to the Amazonian Environmental Situation 220

5.1 Environmental Governance 222

5.2 Regional Players 236

5.3 Main Environmental Actions 240

Chapter 6
The Future of Amazonia 252

6.1 Introduction 254

6.2 Fundamental Assumptions 256

6.3 A Glance at the Future Amazonia 258

6.4 Emerging Themes 274

6.5 Conclusions 276

Chapter 7
The Possible Amazonia 282

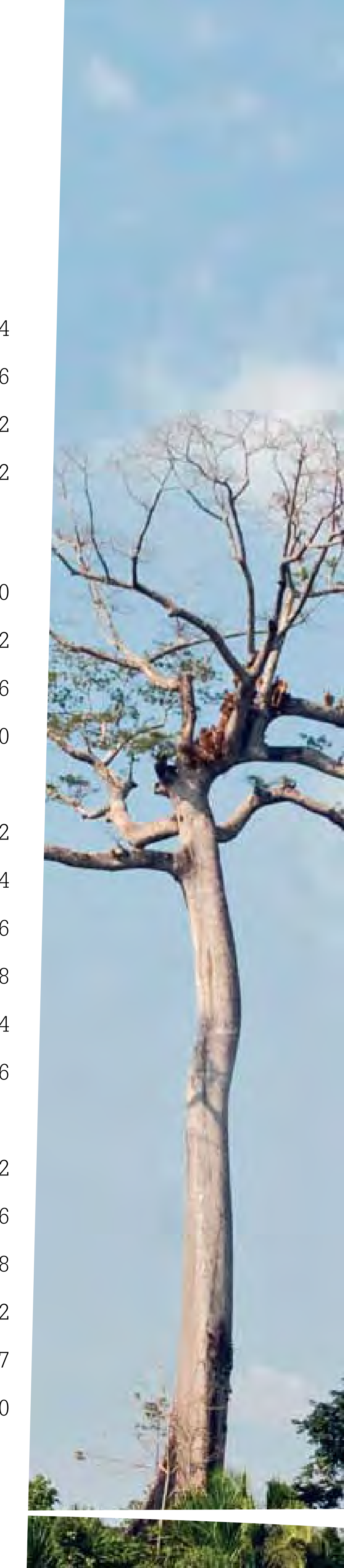
7.1 Conclusions 286

7.2 Lines of Action 288

References 292

Indexes of Tables, Figures, Maps and Boxes 317

Acronyms 320



AMAZONIA:

TERRITORY, SOCIETY AND ECONOMY

OVER TIME

1

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1.1 GEOGRAPHIC **CHARACTERISTICS**

1.2 SPHERE **OF STUDY**

1.3 HISTORY AND **CULTURE**

1.4 NEW LAND **OCCUPATION MODELS**

AMAZONIA, EXTENSIVE AND HETEROGENEOUS, HAS BEEN OCCUPIED BY humans since time immemorial; it has different but closely linked ecosystems. With the intent to provide a general framework for the analysis developed in the following chapters, this chapter will: specify the region's most notable geographic characteristics; define the scope of the study; describe the region's historical background; and present new models of territorial occupation.

1.1 | GEOGRAPHICS CHARACTERISTICS

Amazonia is the centre of attention not only for the Amazonian countries (Bolivia, Brazil, Colombia, Ecuador, Guyana, Suriname, Peru, and Venezuela)[1] but, also for the rest of the world, because of its natural, social, and cultural wealth. Besides providing a great variety of ecosystem services, this great complex of heterogeneous ecosystems covers the planet's most extensive tropical forest and largest water system. The Amazon, recognized as the world longest, mightiest, widest and deepest river, transmits sensations of vastness and majesty as it travels through this extensive and valuable area of natural and cultural life.

Amazonia's characteristics are conditioned by the different geological, geomorphological, climatological, hydrographic and biological processes that have occurred in South America. The Amazonian ecosystem is the result of these processes and its interaction with the human population has determined the region's environmental patterns.

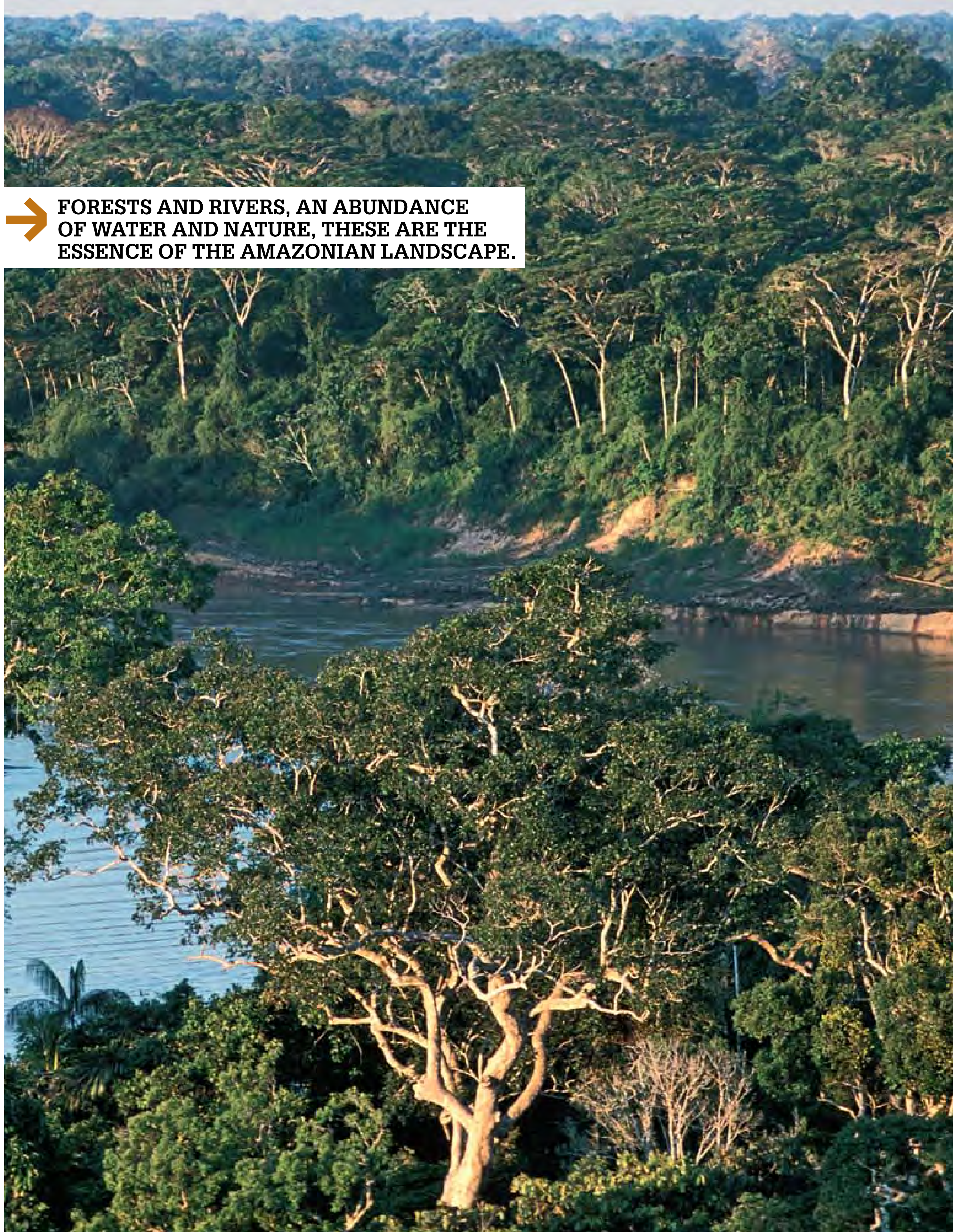
More than 100 million years ago, the territories of South America (in that geological period only the present Guyana Shield existed) and Africa gradually separated. These two continents shared a number of groups of plants and animals in the taxonomic levels of genus, family and order. South America was then a large island, for a long period of time, until some four million years ago, it became physically attached to North America. As a consequence, an invasion of plants and animals took place from one continental block to the other and, due to the influence of different groups of animals coming from the north, Amazonian fauna underwent great changes (Peruvian Amazonian Research Institute [IIAP] 2001).

The subduction or displacement of the Nazca Plate below the South American Continental Plate activated the formation of the Andes mountain range. About 15 to 20 million years ago a sedimen-

[1]France has an Amazonian territory with the status of an overseas department: French Guyana.

Tha Amazon basin is by hemispheric, its water behaviour is conditiones by the alternating dry and rainy seasons in each hemisphere.

CONSERVACIÓN INTERNACIONAL



FORESTS AND RIVERS, AN ABUNDANCE OF WATER AND NATURE, THESE ARE THE ESSENCE OF THE AMAZONIAN LANDSCAPE.

CONSERVACIÓN INTERNACIONAL


CONSERVACIÓN INTERNACIONAL

In the upper river course, the Amazon's headwaters are fast-flowing rivers running through a precipitous Andean relief.

THE AMAZON RIVER DISCHARGES INTO THE ATLANTIC OCEAN AN AVERAGE OF 220,000 M^3/SEC, ALTHOUGH IN THE RAINY SEASON THE DISCHARGE REACHES 300.000 M^3/SEC IN MOST OF THE BASIN.

tary structural basin was formed between this mountain range and the Guyana Shield (IIAP 2001). It should be pointed out that, because the Amazon basin is byhemispheric, its water behaviour is conditioned by the alternating dry and rainy seasons in each hemisphere. The Amazon river discharges into the Atlantic Ocean an average of 220,000 m^3/sec; in the rainy season in most of the basin, the discharge reaches 300.000 m^3/sec. Most water coming into the Amazon basin is from the Madeira river a tributary on the right bank of the Amazon river.

The low water and high water cycles of the Amazon basin condition different biological processes. In the high water cycle the water level and the river's flow increase significantly and allow aquatic elements to disperse and improve feeding conditions for hydrobiological resources. During the low water cycle the volume of water is progressively reduced, thus facilitating the concentration of icthic fauna in the main water courses. Because catch is easier, fishing is more productive during this period.

The Amazon rises in the Apacheta creek in the icy waters that come from a small spring located at the foot of Mount Quehuisha, in the Chila mountain range in Arequipa (Peru), at an altitude of 5,170 metres. The Amazon crosses approximately 7,000 km until it flows into the Atlantic Ocean. It should be noted that, because of its course's displacements, especially when it meanders in the Ucayali, river zone, also note that because of several factors, determining the exact length of the Amazon is complex (Novoa 1997; Martini, Duarte, Shimabukuro, Arai and Barros 2007).

The width of the river varies depending on the swell. The relative maximum is 5 km, although in some sectors in the seasonal floods, it covers land between 20 and 50 km beyond both banks. It has numerous islands that at times form a labyrinth of canals. The delta of the Amazon estuary is 320 km wide. The delta's two main river arms, the Macapa and the Para, form the island of Marajo, the largest river island, not only in South America but in the world (48.000 km^2). According

BOX 1.1

AMAZON RIVER'S ANDEAN ORIGIN

The origin of the Amazon river has aroused permanent interest among scientists, resulting in various expeditions undertaken over the course of time. Currently, all agree that the origin of the Amazon is in the Andean province of Caylloma in Arequipa (Peru).

The scientific report on the 1966 Amazon Source expedition explains that the Amazon has its origin in the Apacheta creek which has its source at the foot of the snow-capped Quehuisha mountain (5,170 m.a.s.l.) at position 15°31'05" south latitude and 71°45'55" west longitude. After covering a short distance, the Apacheta first receives water from the Ccacansa and then from the Sillanque rivers. At the confluence of the Carhuasanta and Apacheta rivers, the Apacheta becomes the Loqueta and runs from south to north. The Carhuasanta river comes down from the snow-capped Choquecorao. The snow-capped Quehuisa and Choquecorao are in the Chila mountain range, a western section of the Andes that represent the continental divide.

The report states that the Apacheta creek is considered to be the main spring, according to the criteria of volume of water discharged (the Apacheta stream discharges six times more water than the Carhuasanta river) and the morphology, showing how the river has defined its course with the passage of time.

The following are some of the authors who have studied the location of the source of the Amazon.

ZANIEL NOVOA

The Amazon begins its course in a stream called Apacheta.

AUTHOR	YEAR	SOURCE
S.J. SANTOS GARCIA	1935	VILAFRO LAGOON
MICHEL PERRIN	1953	HUAGRA MOUNTAIN
GERARDO DIANDERAS	1953	HUAGRA MOUNTAIN – MONIGOTE RIVER
HELEN Y FRANK SCHREIDER	1968	VILAFRO LAGOON
NICOLAS ASHESHOV	1969	NEVADO MINASPATA
CARLOS PEÑAHERRERA DEL AGUILA	1969	NEVADO MISMI – CARHUASANTA RIVER
LOREN MCINTYRE	1971	NEVADO CHOQUECORAO
WALTER BONATTI	1978	HUARAJO RIVER
JEAN-MICHEL COUSTEAU	1982	NEVADO CHOQUECORAO
JACEK PALKIEWICZ, ZANIEL NOVOA GOICOCHEA	1997	NEVADO QUEHUISHA – APACHETA RIVER
BOHUMIR JANSKÝ	1999	NEVADO MISMI – CARHUASANTA RIVER
BOHUMIR JANSKÝ	2000	NEVADO MISMI – REGION WITH THE CARHUASANTA, CCACANSA, APACHETA AND SILLANQUE RIVERS' SOURCES

Source: Novoa (1997); Janský and others (2008)

The last ridges of the Cordillera announce the proximity of the immense Amazonian plains.

GUYANA AMAZON TROPICAL BIRDS' SOCIETY / WWF

"The Earth receives an insult and offers its flowers in response"

RABINDRANATH TAGORE (1861-1941) INDIAN PHILOSOPHER AND WRITER.

to official information provided by the members of ACTO, the Amazon region covers between 5,147,970 km² and 8,187,965 km², depending on the criteria used to define it, and includes Andean highlands, foothills and tropical plains. Thus, this region represents between 4% and 6% of the planet's total land surface and between 25% and 40% of the surface of Latin America and the Caribbean.

An enormous volume of suspended sediment is swept along the course of the Amazon giving it a muddy aspect. Estimates indicate that 106 million cubic feet of sediment are discharged into the Atlantic Ocean every day. The mass of water that reaches the ocean makes its effect felt at more than 100 km out to sea. The depth in the lower part varies between 10 and 30 m on average, depending on the season and location, although in the Obidos (Brazil) strait its depth is close to 300 m. These characteristics are explained in more detail in the section on water resources and aquatic ecosystems in chapter 3.

It should be mentioned that other hydrographic basins and microbasins which, are not part of the Amazon river, are closely related to it (for example: the Tocantins in Brazil).

BOX 1.2

AMAZONIA AND THE AMAZON RIVER: MOST OUTSTANDING DIMENSIONS

1. The Amazon river is the world's longest at 6,992.06 km (National Institute for Space Research [INPE] 2008).

2. The Amazon river has the planet's most extensive hydrographic basin. Various studies specify the surface of the Amazon basin with some indicating it covers 7,165,281 km² (Novoa 1997, INPE 2008), while others, like Brazil's National Water Agency, specify 6,100,000 km² (Brazil: Ministry of the Environment – National Water Agency, 2006).

3. The Amazon river discharges the largest volume of water (averaging 220.000 m³ per second). It carries more water than the Missouri-Mississippi, Nile and Yangtse rivers combined.

4. The Amazon river has more than 1,000 tributaries, three of them longer than 3,000 km (Madeira, Purús and Yurua rivers).

5. The most important Amazon river tributary basins originate in the Andes mountain range; other tributaries come from the Guyana plateau, the Brazilian plateau and sectors adjacent to the Orinoco basin in Colombia.

6. Amazonia contributes approximately 20% of the fresh water that flows from the continents into the oceans.

7. The Amazonian forest represents more than half the planet's humid tropical forests.

8. It is a megadiverse region: Brazil and Colombia, Amazonian countries, have a third of the world's known vascular plants. The world record for the greatest number of butterflies is held by Peru.

9. Examples of cultural diversity: 420 indigenous peoples, 86 languages and 650 dialects. Approximately 60 populations living in isolation.

Sources: Novoa (1997), Amazon Cooperation Treaty Organization (ACTO), United Nations Environment Programme (UNEP) and Global Environment Facility (GEF) (2006), ACTO (2007), Eduardo (2005), Brackelaire (2006).

In the sector of the Amazon basin in which tropical humid forest formations predominate, three subsections are identified with their own climate and relief characteristics, and whose delimitation may be established by their altitude levels. The lowland forest or Amazonian flood plain, from the estuary up to 500 m.a.s.l., has a warm and humid climate with rainfall fluctuating between 1,500 mm/year and 3,000 mm/year or more, and an almost flat relief, with sporadic alternating hill systems. The highland forest, from 500 up to 1,000 m.a.s.l., also has a warm and humid climate, with a temperature that varies between day and night and narrow and very long valleys in which the rivers have shaped terraces on various levels. Annual rainfall may in some places exceed 5,000 mm/year, depending on the terrain's orientation. Finally there are the ceja de selva (cloud forest),also called yungas or other local denominations, that may be higher than 3,000 m.a.s.l. with a predominantly very abrupt terrain, deep canyons, valleys in gorges and fast-flowing rivers; the humid climate and it is very cloudy due to great temperature variations (sectors of the "misty forest").

Average precipitation in Amazonia is, in general, very variable, fluctuating between 1,000 and 3,000 mm/year. It is estimated that 60% of precipitation is recycled by evaportranspiration; however, there are also localized zones with very low precipitation, at times less than 300 mm/year. The average temperature is high in the region. It fluctuates between 24° and 26 °C, although there is great spatial and time variability (falling at higher altitude).

The marked variation in temperature and atmospheric humidity depending on altitude, both during the day and night throughout the year, explains the configuration of "ecological strata" that favour biodiversity effervescence in the eastern Andean foothill sectors (highland forest and mountain edge),does not impede an important connection being made between the high and low areas of Amazonia. For greater details see the sections on Biodiversity and Forests in Chapter 3.

A variety of ecosystems, recognized as the world's richest, function in these ecological strata where indigenous people have always lived. The indigenous people have traditional knowledge about the characteristics of the rich biological diversity and its use: "The indigenous people knew thousands of vegetable species and they used them for many different purposes. They collected fruits and seeds, used the *bejucos* (climbing plants) and the lianas (long-stemmed, usually woody vines) to build their dwellings and basic utensils; large tree trunks to make canoes and rafts, palm leaves to protect themselves from inclement weather; as well as magic-medicinal species (Wust 2005).

SERGIO AMARAL / OTCA

Sunset on a river of the Amazonian plains.

1.2 | SPHEREOFSTUDY

Amazonia is heterogeneous and difficult to delimit. To do so, all the member countries of the Amazon Cooperation Treaty Organization (ACTO), the regional cooperation instrument for Amazonian themes whose members are Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela, use their own criteria to establish a national definition of Amazonia. The criteria are physical (e.g., basin), ecological (e.g., forest cover) and/or other types (e.g., political/ administrative). Countries that use the same criteria may also manage different thresholds (e.g., altitude to differentiate between the Andean and Amazonian regions) or their own definitions of what they consider in each criterion. Furthermore, the region's heterogeneity includes not only physical aspects but also the multiplicity of ethnic groups, human settlements, and other criteria.

According to the political-administrative criteria, Amazonia covers an area of 7,413,827 km², representing 54% of the total area of the eight Amazonian countries members of the Amazon Cooperation Treaty Organization (ACTO). Brazil accounts for 68% of the Amazonia, followed by Peru (9%). In five of the eight countries (Bolivia , Brazil , Guyana , Peru and Suriname), the Amazon area is over 50% of their total territory (Table 1.1). Considering this criterion, Amazonia represents 3.5 times the sum of the total land area of Spain , France , Germany , Italy and the UK , 3.6 times the territory of Mexico , or 75% of the land area of China (map 1.3).

Due to the region's complexity and heterogeneity, this document uses the most used three criteria: Ecological; Hydrographic, and Political-administrative.

MAP 1.1a
Ecological criterion outline of Amazonia

MAP 1.1b
Hydrographic criterion outline of Amazonia

MAP 1.1c
Political/ administrative criterion outline of Amazonia

BOX 1.3

ACTO COUNTRIES' AMAZONIAN AREA, ACCORDING TO THREE ALTERNATIVE CRITERIA

Due to the region's complexity and heterogeneity, restrictions are encountered when attempting to give a strict definition of Amazonia; this document includes the three criteria most used in studies:

a. Ecological (or biogeographic): uses as an indicator the extension corresponding to the South American tropical and subtropical humid forest biome, located to the east of the Andes mountain range.

b. Hydrographic: considers the total extension of the Amazonian basin. However, it should be noted that, when needed for the analysis, reference is made to other basins or microbasins closely linked to the Amazon basin.

c. Political-administrative: refers to the area covered by the different hierarchical political and/or administrative limits established by the countries and defined as part of their Amazonia.

Notes:

a) The ecological or biogeographic criterion map was constructed on the basis of the archives and information provided by Conservation International / WWF, the Amazon Scientific Research Institute SINCHI of Colombia, the Environmental Management Programme of the Peruvian Amazon Research Institute (IIAP), the Tropical Agriculture Research Centre – Bolivia (CIAT-Bolivia), and the Brazilian Institute of Geography and Statistics (IBGE).

b) The basin or hydrographic criterion map was constructed on the basis of the archives and information obtained from HydroShed (USGS/WWF), the Amazon Scientific Research Institute SINCHI of Colombia, the Environmental Management Programme of the Peruvian Amazon Research Institute (IIAP), the Tropical Agriculture Research Centre – Bolivia (CIAT-Bolivia), the Brazilian Institute of Geography and Statistics (IBGE), and the Simon Bolivar Geographic Institute of Venezuela.

c) The political-administrative criterion map was constructed on the basis of the archives and information obtained from the Ministry of the Environment, Housing and Territorial Development and the Amazon Scientific Research Institute SINCHI of Colombia; the National Environment Council of Peru; the Environmental Management Programme of the Peruvian Amazon Research Institute (IIAP), the Vice-Ministry of Biodiversity, Forest Resources and the Environment of Bolivia; the Tropical Agriculture Research Centre – Bolivia (CIAT-Bolivia); the Ministry of the Environment of Brazil; the Brazilian Institute of Geography and Statistics (IBGE); the Ministry of the Environment and Natural Resources of Venezuela; the Venezuelan Institute of Scientific Research (IVIC); the Simon Bolivar Geographic Institute of Venezuela; the Ministry of the Environment of Ecuador; the Centre for Integrated Surveys of Natural Resources by Remote Sensors (CLIRSEN) of Ecuador; the Environmental Protection Agency of Guyana; and the Ministry of Labour, Technological Development and Environment of Suriname.

Source: Original production of GEO Amazonia, with the technical collaboration of UNEP/GRID – Sioux Falls and the University of Buenos Aires.

BOX 1.4

ACTO COUNTRIES' AMAZONIAN AREA ACCORDING TO COMBINED CRITERIA

Superimposing geospatial information to define Amazonia according to the three criteria indicated above, gave a composite map of the region that identified two areas: "Greater Amazonia" and "Lesser Amazonia". "Greater Amazonia" covers an area of 8,187,965 km², equal to 6% of the world's land surface, 40% of the Latin America and the Caribbean surface, 85% of the territory of the United States, more than four times the territory of Mexico, and 33 times the territory of the United Kingdom. In this respect, the Amazon region represents 60% of the total surface of the eight Amazon Cooperation Treaty Organization (ACTO) member countries. "Lesser Amazonia" covers an area of 5,147,970 km², equal to 4% of the Earth's surface and 25% of the surface of Latin America and the Caribbean.

	TOTAL AREA (km²)	CONSERVATION AREA(1) (km²)	
		ÁREA	%
GREATER AMAZONIA	8,187,965	1,713,494	20.93
LESSER AMAZONIA	5,147,970	1,159,387	22.52
WORLD	134,914,000(2)	13,626,314	10.10

NOTAS:

Greater Amazonia: the maximum extension of the Amazonian area based on at least one of the criteria (hydrographic, ecological or political/administrative).

Lesser Amazonia: the minimum extension of the Amazonian area based on the three criteria taken together.

(1) According to the definition of the International Union for Conservation of Nature (IUCN), a "Conservation Area" is an "area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." Source: World Commission on Protected Areas (WCPA n.d.)

(2) The area of the world that covers the entire Earth including continental bodies of water. Source: The United Nations Statistics Division (n.d.).

Made by: UNEP/GRID SIOUX Fall and the University of Buenos Aires.

MAP 1.2a

Outline of grater Amazonia

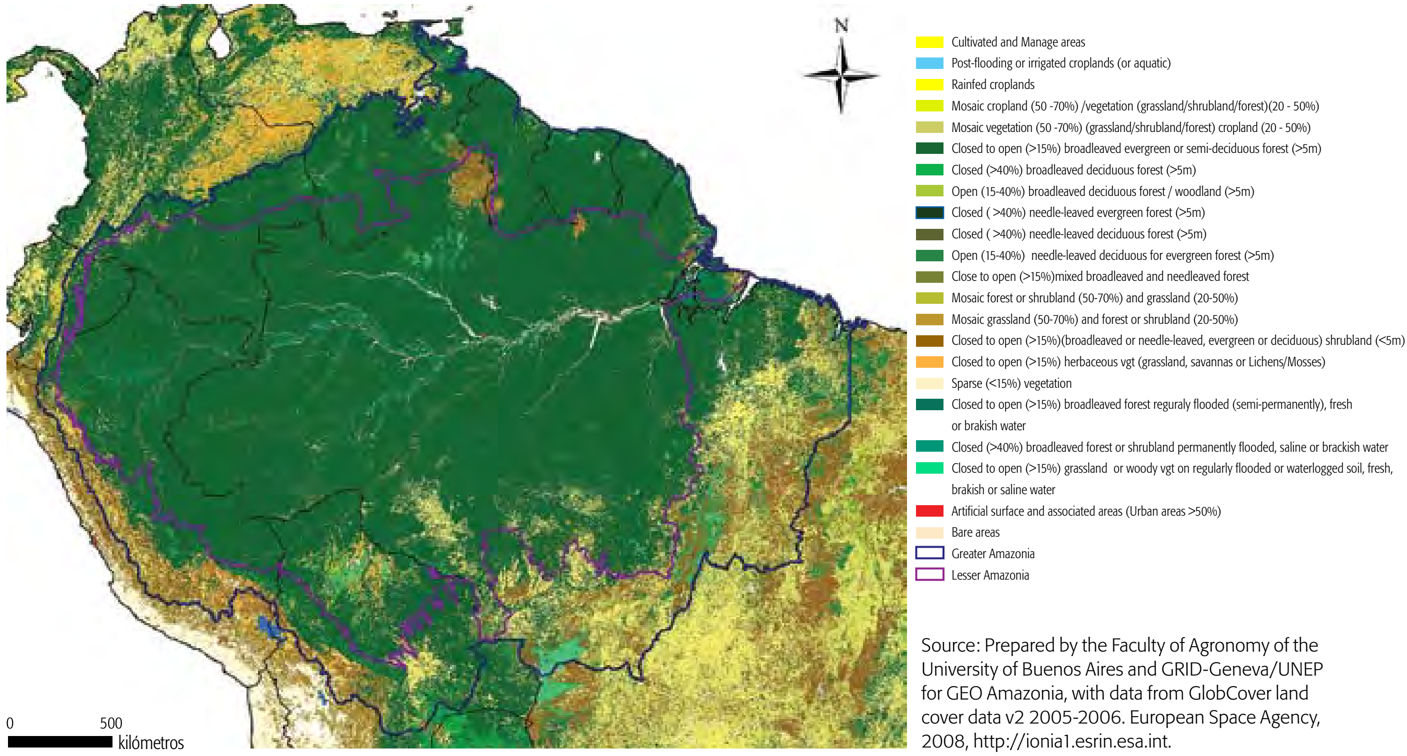
MAP 1.2b

Outline of lesser Amazonia

The Amazon region represents 60% of the total surface of the eight Amazon Cooperation Treat Organization (ACTO) member countries.

MAP 1.3

Vegetation cover in Amazonia (2006)



Source: Prepared by the Faculty of Agronomy of the University of Buenos Aires and GRID-Geneva/UNEP for GEO Amazonia, with data from GlobCover land cover data v2 2005-2006. European Space Agency, 2008, http://ionia1.esrin.esa.int.

TABLE 1.1

Area of Amazon, according to crite

COUNTRY	TOTAL EXTENSION OF COUNTRY (km²) (A)	EXTENSION OF AMAZONIA HYDROGRAPHIC CRITERIO (km²) (B)	EXTENSION OF AMAZONIA ECOLOGICAL CRITERION (km²) (C)	EXTENSION OF AMAZONIA POLITICAL/ ADMINISTRATIVE CRITERION (km²) (D)	REGIONAL IMPORTANCE OF NATIONAL AMAZONIA (%) (D COUNTRY/D TOTAL)	NATIONAL IMPORTANCE OF AMAZONIA (%) (D/A)
BOLIVIA	1,098,581*	724,000*	567,303** (b)	724,000*	9.8	65.9
BRAZIL	8,514,876*	3,869,953*	4,196,943*	5,034,740*	67.9	59.1
COLOMBIA	1,141,748	345,293*	452,572*	477,274*	6.4	41.8
ECUADOR	283,561*	146,688**(a)	76,761** (b)	115,613*	1.6	40.8
GUYANA	214,960*	12,224** (a)	214,960*	214,960*	2.9	100.0
PERU	1,285,216*	967,176*	782,786*	651,440*	8.8	50.7
SURINAME	142,800*	-	142,800*	142,800*	1.9	100.0
VENEZUELA	916,445*	53,000*	391,296** (b)	53,000*	0.7	5.8
TOTAL	13,598,187			7,413,827	100	

Notes:

(1) It should be noted that calculating the surface of the Amazon basin is open to research. The information on the map has been prepared on the basis of the GIS information the countries provided to UNEP. It should also be noted that some studies (Novoa 1997, INPE 2008) indicate that the Amazon basin surface covers 7,165,281 km², while others register it as 6,100,000 km², as indicated by the National Water Agency of Brazil (ANA). The difference is explained by excluding from the Amazon basin the Tocantins and Araguaia rivers and their tributaries. The Tocantins basin has an approximate extension of 900,000 km². For more information consult <http://www.ana.gov.br/hibam>.

(2) Venezuela and Bolivia only use the hydrographic criterion to define Amazonia and, as explained by the responsible authorities in the respective countries, it is recognized as being political-administrative.

(3) The information is recorded according to the criteria used by the countries.

* Official sources: Bolivia: Military Geographic Institute; Brazil: Ministry of the Environment (2006a). Brazilian Institute of Geography and Statistics [IBGE] (2004); Colombia: Ministry of the Environment, Housing and Territorial Development of Colombia – SINCHI (2007); Ecuador: Institute for Amazon Regional Ecodevelopment (ECORAE) (2006); Guyana: Environmental Protection Agency (2007); Peru: Peruvian Amazonia Research Institute [IIAP] (2007). *Peruvian Amazonia spatial demarcation*; Suriname: General Statistics Bureau; Venezuela: Simón Bolívar Geographical Institute (IGVSB). (2008).

** Unofficial national sources which, based on scientific studies, have produced information on Amazonia: (a) Freitas (2006). (b) Martini *et al.* (2007). Panamazonia Project II. INPE.

1.3 | HISTORY AND CULTURE

Considered in continental terms, at least three factors must be taken into account in relation with the history of Amazonia: geographic and ecological diversity that influences human occupation processes and methods; the continued human presence in the region for more than 12,000 years, as well as interruptions and a lack of continuity as to how the territory was occupied; and the diversity of colonization processes begun by European countries in the sixteenth century and continued by the new independent national states established in the first half of the nineteenth century.

PRE-COLONIAL OCCUPANTS OF AMAZONIA

Amazonia has been occupied and its territory used since time immemorial. It should be stressed that the original land occupation of this region is subject to serious controversies, especially concerning the extent of the occupation and how it took place. Although research on pre-Columbian Amazonian society is still limited (Heckenberger 2005, Calandra and Salceda 2004, Meggers 1996), two currents may be identified that explain human occupation. One is the Amazonian archaeology, developed since the 1950's, which considers that pre-colonial indigenous groups would have been organized in the same way as present-day indigenous Amazonian groups (small population and low demographic density, societies with few hierarchies, etc.). The impoverished soils would have been one of the determining factors that limited local human societies and impeded the development of complex cultures in the humid tropics. A corollary of this affirmation is that cultural innovations such as pottery and agriculture could not have taken place locally, and that they arrived in Amazonia with different groups of pre-colonial immigrants native to areas of diffusion located in the Andes and in the northeast of South America.

Another more recent theory sustains that the tropical forest would not only be a receiver of cultural traditions, but also an innovation-producing centre. An example of this is that Amazonia is considered to be a centre where plants, such as the *yuca (Manihot esculenta)* and the *pejibaye (Bactris gasipaes)*, were domesticated.

In spite of this divergence, there is no doubt that the Andean and Amazonian people sustained close relations for thousands of years in a mountainous area of between 500 and 2,000 m.a.s.l., generally travelling on rivers that connected the mountains to the lowland forest areas. Various archaeological records refer to their presence since the pre-Inca era, but it was only during the Inca Empire that they established closer relations. It should be pointed out that the Incas were unable to exercise control over the Amazonian people as they did over other people in the Andean region (Santos Granero 1992).

In the Peruvian-Ecuadorian zone, between 3500 and 300 B.C. a cultural and trade link existed between the Pacific coast, the Andean altiplano and the eastern slope of the Andes (Upper Amazonia). The ceramics of that era testify to the exchanges between these regions. Ethnic groups, often of distant origin, led that exchange process. These populations were characterized by a complex and hierarchical social system. There were large exchange centres around the Napo, Marañon, Ucayali and Huallaga rivers. Products traded included salt, gold, cotton and turtle oil (De Saulieu 2007).

FUNDACIÓN DEL BANCO CONTINENTAL

"Forest" Indians in a canoe. Watercolour by Baltazar Jaime Martínez Compañón (18th century). Taken from Macera, P.; A. Jiménez Borja and I. Francke, *Trujillo del Perú*, edited by the Banco Continental Fund, 1997, p. 190.

"The thirteen Captain, Capac Apo Ninarua. Andesuyo". (Huamán Poma de Ayala).

Calling into question the idea that the environment would have been a limiting factor, various archaeologists say that, especially in the várzea (floodable areas of the Amazon and some of its tributaries) conditions would have allowed numerous human groups to develop relatively complex societies some 2,000 years before the arrival of the Europeans. The banks of the Amazon would have been continuously and densely populated between 1,000 B.C. and the sixteenth century. Historic demographic studies conducted by William Denevan in the 1970's state that the population of Amazonia once reached more than five million (Ribeiro 1992: 79).

There were significant contrasts in pre-Columbian human settlements with, for example, large and sedentary communities and relatively intensive subsistence economies (Heckenberger 2005). The heterogeneity of Amazonian nature led to development of diverse strategies to improve the exploitation of natural resources for survival, with respect to food, technology, medicine and trade; reality that conditioned the degree to which economic activities developed: hunting, mining, fishing, agriculture, among others, in the different Amazonian areas (Meira 2006).

Pre-Columbian Amazonian occupation came from different locations. One of the migratory currents – the Arawac family – reached from the eastern Andes; this current expanded to the northeast towards the Antilles. The Tupi-Guarani left the El Chaco region, split into two groups with one heading to central Brazil and the other to the Atlantic coast towards the northeast. Finally, another migratory current – from the ethno-linguistic family of Carib origin – entered the Amazon basin through a low rainfall corridor. They introduced crops such as peanuts *(Arachis hypogaea)*, maize *(Zea mays)* and beans *(Phaseolus vulgaris) (Morey and Sotil 2000).*

The migratory currents brought a diversity of language and forms of social organization. The indigenous people of the Maku, Tukano and Arawac families lived for more than 2,000 years in the Negro river region and adjacent area. The people of the Ararwac family now live in Brazilian, Colombian and Venezuelan Amazonian territory. As a result, Amazonian languages include Andean, Guarani and Caribbean voices.

In the case of Guyana, the Warrau Indians were established in 900 B. C. followed later by the Caribe and Ararac tribes. The native settlers' main activities were subsistence agriculture, hunting and fishing. The word *guiana* meaning "land of many waters" is one of the legacies of the native settlers (Guyana: Environmental Protection Agency 2007).

The pre-Inca Chachapoyas culture developed in Peruvian Amazonia and, according to research by the Amazon Archaeological Institute, it has Andean origins. Archaeological remains provide evidence of the splendour of this culture including: the ruins of Kuélap, the sarcophagus of Carajia, the mausoleums of Revash, among others. As to population and demographic density, Joaquin Garcia (1993) refers to various investigations indicating that the Amazonian population settled in groups of high demographic density.

Some pre-colonial Amazonian populations altered the landscape by constructing drained cultivable plots and land elevations for agriculture, housing, defence and burials, for example in areas that are part of Bolivia, Brazil, Guyana and Venezuela (Beckerman

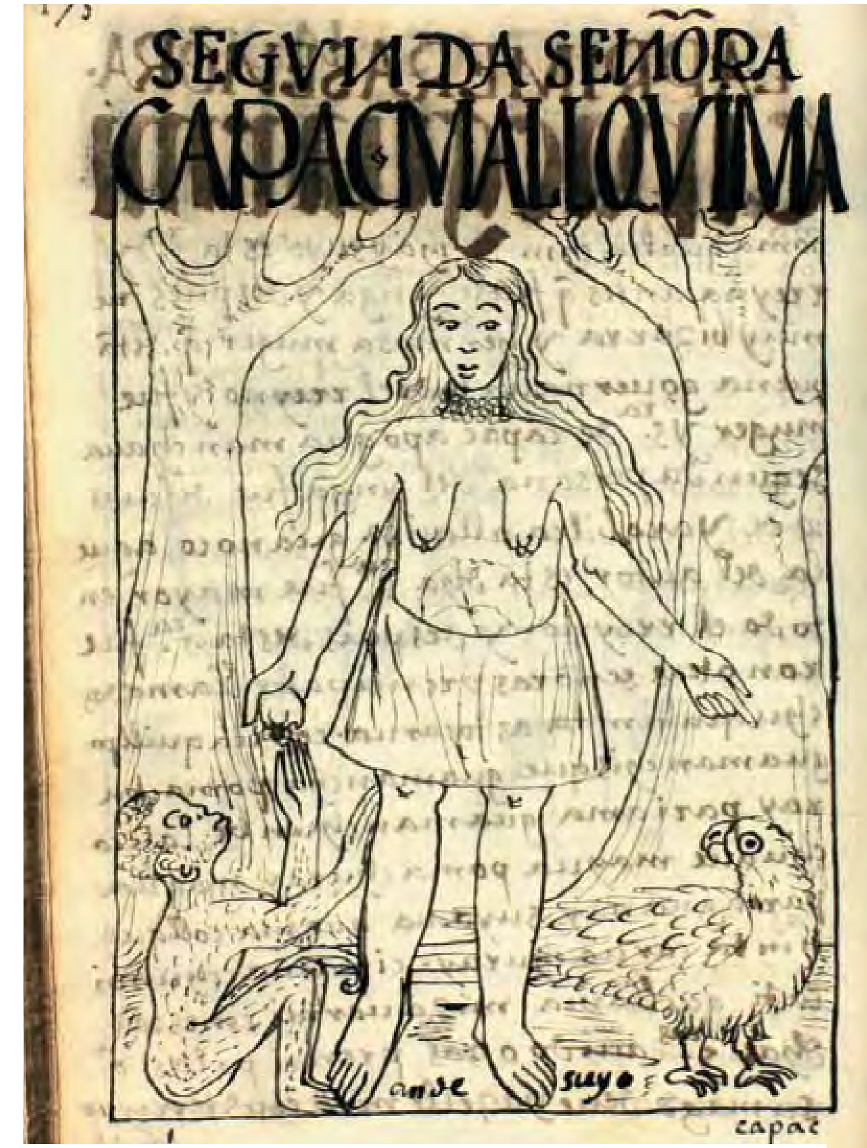
1991: 145, Roosevelt 1991: 120), or by involuntarily creating the so-called "Indian black lands", the highly fertile lands resulting from the decomposition of organic material in old human settlements. However, the discontinuance of human occupation following the arrival of the Europeans allowed the forest to grow again in the formerly inhabited areas which hid the evidences of human activity (Costa 2002).

CONFIGURATION OF THE TERRITORY

The present configuration of the territory we know as Amazonia is, broadly speaking, the result of the European colonizers' occupation of the region between the sixteenth and nineteenth centuries, with conflicts not only between them and the different native populations, but also disputes between Spain, Portugal, England, the Netherlands and France during the different colonial wars of the period. According to the Treaty of Tordesillas (1494), South America was supposed to be divided between Spain and Portugal; however, after occupying a large part of the continent's northern coast at the end of the sixteenth century, now belonging to Guyana, French Guiana and Suriname, the English, French and Dutch ended the so-called Iberian dominion of the whole continent.

Dutch and French seventeenth century cartographic records projected the virtual dominion of their countries over the whole of what was then known as the "Region of Guyana" or the "Kingdom of the Amazon", much more extensive than what we know today as the region, was delimited to the south by the Amazon river, to the west by the Orinoco river, to the north by the Caribbean sea, and to the east by the Atlantic Ocean (Costa 2002).

In the first four decades of the seventeenth century, English and Dutch expeditions to the Amazon penetrated the great river from north of the island of Marajo until they arrived at the confluence of the Xingú river, leading to long struggles by the Portuguese to control the inland course of the river and its estuary. At the end, these enterprises were not very successful and they only consolidated their control over Guyana.



"Second woman, Capac Mallquima. Andesuyo". (Huamán Poma de Ayala).

The French, established in Cayenne since the end of the sixteenth century, tried several times to occupy the present northern coast of Brazil, where in 1612 they founded the city of San Luis, and then went north until they reached the Tocantins river as part of a broad colonial project named "Equinoctial France". Their attempts at territorial expansion being a failure, they established themselves in Guyana (Costa 2002).

The Dutch and English were especially concentrated in the regions of the Esequibo, Demerara, Berbice and Suriname rivers, and alternated in controlling these areas from the middle of the seventeenth to the beginning of the nineteenth century. The colonies of Esequibo, Demerara and Berbice were founded by the Dutch and controlled by them until the last decades of the eighteenth century. The different private initiatives of the early years were replaced, in 1621, by the monopoly of the West Indies Company that lasted until the second half of the seventeenth century when control and administration of the colonies passed to the chambers of the Dutch cities of Veere, Middelburg and Vlissengen (Farage 1991: 88-9). At the end of the following century the English, in 1796, occupied that territory by force of arms and, after successive conflicts and changes in control, they bought it from the Dutch in 1814 and, in 1831, unified the three colonies under the name of British Guyana.

In 1656 the English were the first Europeans to become permanently installed in the Suriname river where they dedicated themselves to cultivating sugar cane. But the Dutch assumed control of the region when, in 1667, the Treaty of Breda put an end to the Anglo-Dutch war and, among other agreements, exchanged Suriname for New Amsterdam in North America. The region welcomed the sugar cane growers who had previously been installed on the northeast coast of Brazil, from where the Dutch had been expelled in 1654.

In the first half of the sixteenth century the Spaniards undertook a series of excursions to the east of the Andes, the most famous of which was the Gonzalo Pizarro/Francisco de Orellana (1541-1542) expedition that went down the Napo river; they were the first Europeans to navigate to the mouth of the Amazon river. However, a series of other incursions between 1536 and 1560, "allowed the more systematic penetration and the recognition of a strip about 100 kilometres wide consisting of the external slope of the eastern mountain range and the sub-Andean system (deep and small mountain ranges parallel to the general axis of the Andes and groups of hills in the lower reaches) and its provisional incorporation in the colonial economy" (Deler 1987: 55). Consequently, activities such as gold mining and cotton cultivation developed and different population centres were established following a rigorous plan to build a relatively complex administrative structure (Deler 1987).

By the end of the sixteenth century, due to the decline of gold mining, the shifting of interest to the silver mines discovered in Potosí, and the serious indigenous insurrections of the period, such as the general uprising of the Audience of Quito and of the Jibaros in Amazonia, the eastern slope entered into a state of total decadence with Spanish establishments being abandoned or destroyed (Deler 1987).

Following the failure of these first initiatives, missionaries took almost exclusive charge of the Spanish colonization of Amazonia between the end of the sixteenth century and the middle of the seventeenth century since, as a way to contain the excesses of the conquistadores, the Spanish Crown, by Royal Warrant of 1573, prohibited new armed expeditions to the east and ruled that only religious orders could colonize in that region (Tibesar 1989: 16).

The Portuguese movement on Amazonia, whose first landmarks were the conquest of San Luis from the French in 1615 and the foundation of Belén in 1616, centred on discovering the course of the Amazon river which was the foundation for Portuguese domination in the area of Amazonia. This large river plain presented the Portuguese colonizers with a region to explore and occupy, especially after Pedro Teixeira, taking the opposite direction to Orellana, arrived in Quito after going up the Amazon and pushing the limits much further than the meridian of Tordesillas later claimed by Portugal, at the confluence of the Napo and Aguarico rivers, which today is Ecuadorian territory.

While it cannot be considered as a determining element, the geographic factor played a relevant role in favour of the Portuguese by facilitating the displacement of the movement upriver in an environment that was relatively homogeneous over its entire extension, if we compare it to the difficulties encountered by the Spaniards; not only the great disparity between the Andes and the Amazonian areas of the lowland forest that was an obstacle to movement (abrupt terrain, river not navigable), but also rigorous climate differences that cost the lives of thousands of indigenous people who had been obliged to move from the mountain range to the tropical forest to work in servitude.

Throughout the nineteenth and twentieth centuries, the region's frontier disputes were gradually solved. Some of the disputes resulted from old inaccurate definitions of limits; others from territorial expansion due to the exploitation of forest products. The main divergences between the Spaniards and Portuguese in Amazonia about borders were solved by the Treaties of Madrid (1750) and San Ildefonso (1777) that traced the political outlines of the Amazonia territory.

ARCHIVO BIBLIOTECA AMAZÓNICA: PRADO MAYOR Y CABEL SOTIL, RED AMBIENTAL

European colonisers explored and occupied the region between the 16th and 19th centuries

The present configuration of the territory we know as Amazonia is the result of the European colonizers' occupation of the region between the 16th and 19th centuries, with conflicts not only between them and the different native populations, but also disputes between Spain, Portugal, England, the Netherlands and France.

The colonization of Amazonia did not take place in empty spaces. It was by no means an unpopulated territory that the European colonial powers were disputing and sharing. On the contrary, during the colonization process relations were established between the colonizers and the indigenous populations who were the territory's original occupiers.

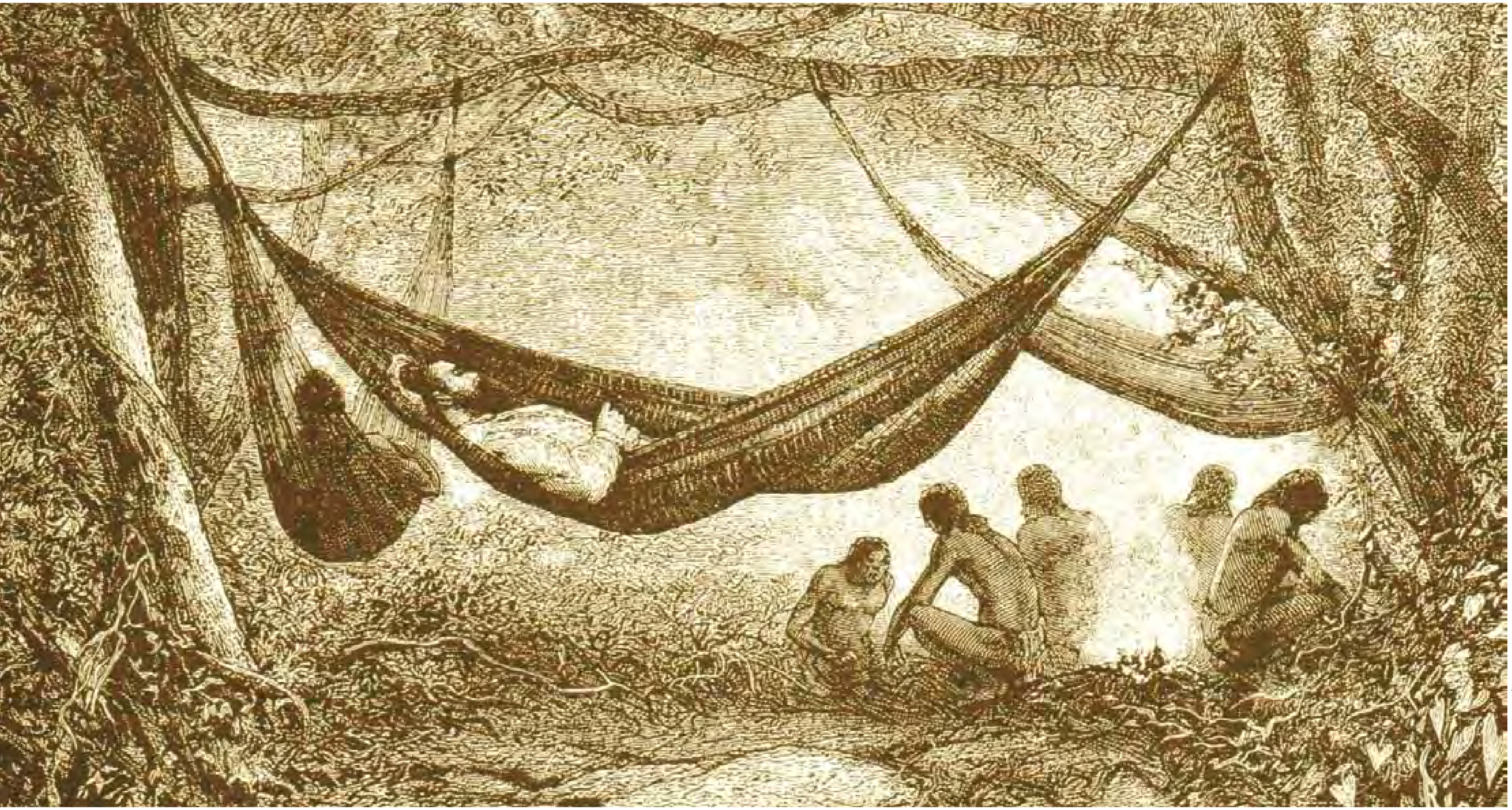
INDIGENOUS, AFRICAN AND ASIAN WORKERS

Sixteenth century chronicles, outstanding among which are those of Gaspar de Carvajal, who wrote about Orellana's expedition, and of the different chroniclers of the Pedro de Ursúa and Lope de Aguirre expedition, recount the very numerous populations that lived on the banks of the Amazon. However, less than a century later the situation had changed: referring to how the Jesuits of the Maynas missions, established in 1638 behaved, Jean Pierre Chaumeil (1988) warned that the societies with which the missionaries had contact were already considerably reduced and altered by the presence, both direct and indirect, of the Europeans.

"We do not inherit the land from our forefathers; we borrow it from our children".

A SIOUX PROVERB

Chaumeil pointed out that, even without a permanent and continued presence in some regions, in a few decades the colonizers caused the destabilization and reduction of various populations, whether by spreading diseases or by wars to capture slaves. This phenomenon was accentuated in the



ARCHIVO BIBLIOTECA AMAZÓNICA: PRADO MAYOR Y GABEL SOTIL, RED AMBIENTAL

In the European imagination, the indigenous peoples of Amazonia lived in primitive conditions.

following decades so that, by the middle of the eighteenth century almost all the people who had inhabited the floodable forests (várzeas) of the Amazon had been extinguished or their numbers reduced, and many others had fled to the high courses of the tributaries (Porro 1996: 37). The natives were in part replaced by those dislodged towards the missionaries' villages that spread from east to west and causing a great change in the ethnic and cultural composition of the Amazonian várzeas. Two hundred years after the first incursions, the European colonizers had provoked the depopulation of very remote areas where they had not yet been able to establish themselves but where they had arrived, directly or indirectly, with expeditions to collect forest products or because of the different ramifications of the indigenous slave trade.

Economic activities in most of Amazonia (fishing, cultivation and collection of products such as cocoa, cloves, quinine, sarsaparrilla, among others) were sustained by the indigenous work force that was exploited by different forced labour methods. This lasted throughout the colonial period, in most of the nineteenth century and, in some areas, even in the first decades of the twentieth century.

While indigenous work predominated throughout Amazonia, African slaves were very important in some regions. In Portuguese colonized Amazonia, they were more numerous in the eastern part (San Luis and the surroundings of Belén, Lower Tocantins, Lower Amazon), working mostly on sugar cane, rice and cotton crops; and in the second half of the eighteenth century also in the Guaporé valley, close to the present frontier with Bolivia. These black populations were the origin the hundreds of the *quilombos* (fenced enclosures) still existing in Brazilian Amazonia.

In the case of the older Spanish colonies the occupation of the forested region suffered a serious reverse with the crisis in the colonial system and the decline of the missions in the former Audiences of Lima, Quito, Charcas and Bogota, as well as the Viceroyalty of New Granada.

But it was in Guyana, in Suriname and in French Guiana where, from the seventeenth century, Africans made up the main work force, however, it is important to note that the indigenous slave work in the Dutch dominions persisted almost up to the nineteenth century. In these colonies, the main activity was not mining but agriculture in small units, as in French Guiana, or in large-scale productive units in the Dutch colonies where the plantation system predominated with large sugar cane fields and, in the eighteenth century, with cocoa, cotton and indigo.

Most African slaves arriving in the region were brought to Suriname. There, between the seventeenth and nineteenth centuries the resident white population was never more than 7% of the slave population. There were massive escapes by slaves who settled in the country's inland forest. Unlike what occurred in other regions of America, where the fugitive slaves' small communities were destroyed by white suppression or remained isolated, in Suriname the slaves were able to keep fighting the colonizers for decades. Those who escaped formed different ethnic groups such as the Saramacá, Djuka, Paramaka, Matawai, Aluku and Kwinti whose right to parts of the Surinamese territory is today recognized. After the abolition of slavery (in Guyana en 1837 and in Suriname in 1863), workers of different nationalities, mainly from India, were recruited to replace African labour and toil in semi-servitude; they produced immigration waves that altered the population's ethnic makeup.

INTERNAL BORDERS

In the first decades of the nineteenth century the young independent States (Guyana and Suriname who only became independent in 1966 and 1975 respectively, and French Guiana is still a French territory) had large territories still unoccupied by the incipient national societies and, in many cases, totally unknown to them. Treaties signed in the eighteenth century and the areas under jurisdiction of the old Spanish dominated administrative units defined, although often somewhat precariously, the limits between the new countries. However, there was a great distance between the delimited territories and the territories that were actually occupied. In fact, the "conquest" and occupation of the territory was a hit-or-miss process. In this respect, in the following paragraphs the term "frontier" alludes not to the limits between national States but to where a society expanded towards the interior of its own territory across the lands occupied by indigenous populations (Leonardi 1996, Martins 1997).

In the case of the old Spanish colonies, the occupation of the forest region, until then based mostly on missionary activity, took a serious backward step with the colonial system crisis and the weakening of the missions in the former Audiences of Lima, Quito, Charcas and Bogota, as well as in the Viceroyship of New Granada. This retreat was also due to the great indigenous rebellion led by Juan Santos Atahualpa between 1742 and 1752, in which the different indigenous groups (Conibo, Piro and Amuesha, among others) retook control of the central forest in what is now Peru and that had been in the hands of the Spaniards. For example, in the first decade following that country's independence there was practically no advance of the internal frontier towards the east (Garcia Jordan 1995). Important population centres continued to exist in Moyobamba and neighbouring regions along the Marañon river, but as late as the 1840's the region appeared on maps as "unknown lands".

In Bolivia quinine production continued to make a modest advance; in Upper Beni cattle raising increased, starting in Santa Cruz de la Sierra. However, most of what was then known as the "east", a concept that included all the Bolivian Amazonian territory as well as El Chaco, remained practically unknown and isolated from the rest of the country. During the first 50 or 60 years of the Republic, the

ENRIQUE CASTRO MENDÍVIL / PRODAPP

Indigenous groups: cultural values are transmitted from one generation to the next.

efforts of those governing were concentrated on projects of public land concessions for colonization, on reconnaissance explorations and on the search for an outlet to the Atlantic from the Amazonian rivers (Jordan 2001).

In Colombia, the occupation of the Caqueta Territory, covering the whole of the country's Amazonian forest, suffered a setback after the expulsion of the Jesuits (1767) and the failure of the Franciscan missions at the end of the eighteenth century. This meant that the expedition of General Agustin Codazzi to the region in the 1850's, organized by the National Chorographic Commission, "signified a fundamental change in knowledge of the east of New Granada and of both governments and the inhabitants in general learning about it" (Dominguez, Barona, Figueroa and Gomez 1996: 45).

There was a similar situation in the territory of what is now Ecuador. According to Jean Paul Deler (1987), in the eighteenth and nineteenth centuries Quito's historical sovereignty on the Maynas missions, by then in decline, was only formal. Even after the new Republic of Ecuador was established (1830) it was 1860 before the Ecuadorian State began to pay more attention to the Amazonian region (Esvertit Cobes 1995). For Alexander von Humboldt (in 1800) the great Orinoco waterfalls in Venezuela, much more than the decadent religious missions, were the natural limit of the "wild and unknown interior regions" (Humboldt 1985).

In the case of Brazil, we can identify a different situation in which reference is made to the occupation of Amazonia in the two or three decades following independence. In one extreme is Belén, the former capital of Amazonia colonized by the Portuguese, the State of Gran-Para and Marañon, independent of the federal government of Brazil, with its own colonial authorities and directly subordinate to Lisbon which, in 1822, strongly resisted breaking colonial ties and becoming part of the Brazilian Empire. Belén was the main urban centre from which Portuguese and Brazilians ventured into Amazonia, and it was the port through which the region communicated with Portugal.

Colonial methods of occupying the territory continued, as did the exploitation of the work force. In many regions violence against indigenous people was even worse than in the colonial period. For example, in 1880 in the Caqueta river region in Colombia, the illegal traffic of Indian slaves to Brazil grew from the middle of the nineteenth century (Dominguez Ossa et al. 1996), and throughout the twentieth century the indigenous populations of that region were still being exploited as semi-slaves (Hildebrand, Bermúdez and Peñuela 1997).

Throughout the nineteenth century the various national societies devised plans for their Amazonian territories, motivated, above all, by the different extraction activities of products such as quinine and rubber.

FRONTIER EXPANSION IN THE NINETEENTH CENTURY

Throughout the nineteenth century the various national societies devised plans for their Amazonian territories, motivated, above all, by the different extraction activities of, for example, quinine and rubber. Nevertheless, that movement was not uniform in all countries.

In the Andean-Amazonian countries quinine, that had been exploited in the Andes since the eighteenth century and had gained great acceptance in European markets because of its medicinal properties, was the first product that encouraged them, in the nineteenth century, to move towards their Amazonian areas. Quinine is produced over a very vast area and is not limited to Amazonian lands. However, as it was becoming exhausted in regions close to inhabited centres – extraction meant cutting the trees – quinine exploitation advanced towards the east. For 34 years trade in quinine was of very significant for national economies and from 1881 to1883 was the main export of Colombia where, in the Upper Caqueta and Upper Putumayo regions, exploitation had begun in the 1870's. In Bolivia quinine was exploited in Caupolican and, later, in Larecaja and Upper Beni. It was very important for Bolivia's economy and the central government took action to control its trade (Dominguez and Gomez 1990, Zarate 2001).

Areas that extracted and traded only in quinine suffered a general weakening of the economy and society with companies becoming bankrupt, and the population leaving and abandoning entire communities. However, there remained a minimum infrastructure of services and road systems especially in Colombian Upper Amazonia and Bolivian Amazonia; advantage was taken of this when these areas were included in the production and sale of rubber bands. Furthermore, some of the principal quinine traders were able to convert their businesses to producing and selling rubber (Zarate 2001).

In the first half of the eighteenth century the Omagua Indians of the Upper Amazon, as well as other indigenous groups, told the Portuguese about the properties and uses of the rubber tree latex.

BOX 1.5

BOLIVIA: LINKS BETWEEN AMAZONIA AND THE ANDES

At the end of the nineteenth and the beginning of the twentieth centuries, there was a boom in rubber production in the Bolivian Amazonian. Its extraction produced local wealth, mainly centred around Cachuela Esperanza, Riberalta and Guayaramerin. Due mainly to communication problems, there was very limited development of the departments of Beni, Pando and the north of La Paz.

The establishment of the Bolivian Mining Corporation (1952) led to a huge rise in the consumption of meat from Beni and its transport by air, a boom that brought increased economic power to Bolivian Amazonia. The Mamoré river had always been one of the channels of communication, although an extremely costly one, for the rest of the country.

However, in spite of the communication difficulties, the Andes and the Tropics have been connected ever since the time when paths were used to extract quinine in pre-colonial times, then to mine gold in the north until 1985 when the collapse of Andean mining increased the flows of migrants to the east. The communication corridors between Cochabamba and Santa Cruz and between La Paz and Beni are areas where immigrant Andean populations caused the increased expansion of the agricultural frontier, a process that has been going on for more than 50 years.

Prepared by: Baudoin, Mario (2007). Ecology Institute, San Andrés University, Bolivia.

CONSERVACIÓN INTERNACIONAL

The canoe is the basic vehicle for family transportation or over short distances on the rivers in Amazonia.

For decades, the latex extracted in Brazilian Amazonia was only used locally, and was restricted to producing syringes and waterproofing clothes and footwear. In 1820, footwear produced with latex began to be exported through the port of Belén (Santos 1980). But, in fact, it was not until the advent of vulcanization in 1841 that possibilities were increased of using latex industrially, and the world demand for the product grew to the extent that it caused a commercial boom that lasted for almost 70 years and, in different degrees of intensity, reached all the independent Amazonian countries.

It was also in the 1880's that latex production greatly increased in Bolivia, Colombia, Peru and Ecuador, although records show it had been produced since the 1860's. This expansion had to do with various disputes over territories previously considered remote or "empty" spaces.

In Colombia, latex production in the 1860's and 1870's took place in the forests of the area within the influence of Cartagena and Panama, in what was then Colombian territory. Only in the 1880's did it reach Upper Amazonia, where it replaced quinine production, and in the regions of the Guaviare, Vaupés and Negro rivers. In the following decade it reached Middle Caqueta and Middle Putumayo, and various indigenous groups, among them the Witotos and the Boras, were expelled from their lands (Dominguez and Gomez 1990). In the Venezuelan Amazon this activity had a local impact on the territory's exploitation, on consolidating local powers and on disseminating semi-servile work relations, although it did not have the same economic importance as in the other countries (Iribertegui 1987: 138). In Guyana balata (latex) was collected at the headwaters of the Esequibo river and in some areas along the banks of the Rupununi river (Silva 2005).

In Bolivia, in the northern regions towards Acre, rubber was first produced in the 1870's and large enterprises were established in the 1880's. The first populations in the region, such as Riberalta, arrived when large companies like Casa Braillard, founded in 1892, began their operations (Beltran 2001).

The relatively rapid expansion of rubber production areas in most of the Amazon basin, with men and merchandise travelling over thousands of kilometres, would not have been possible without the introduction, in 1853, of steam navigation. This important progress in regional transport, apart from the significant increase in cargo capacity, allowed the length of journeys along the Amazonian rivers to be drastically reduced. Until then, regional transport depended exclusively on the small sail and row boats used by traders and the journey from Belén to Manaus could take between 40 and 90 days, depending on the rivers' flows, the intensity of the

PHOTO REPORT: ENRIQUE CASTRO MENDÍVIL / PRODAPP

THE COMMERCIAL BOOM FOR LATEX EXTRACTED IN AMAZONIA LASTED FOR ALMOST 70 YEARS, DUE LARGELY TO THE ADVENT OF VULCANISATION IN 1841.

There was intensive exploitation of latex rubber during the 19th century; it formed the basis of a significant economic and social dynamic. However, this activity was closely associated with labour exploitation.

ENRIQUE CÚNEO / EL COMERCIO

Depopulation and regimes of servitude: consequences of the European colonisation of Amazonia.

SERGIO AMARAL / OTCA

"We don't have another world to move to."

GABRIEL GARCÍA MÁRQUEZ.

winds and the seasons. With steam boats the same journey could be made in eight days. Introducing this technical innovation on Amazonian rivers not only stimulated the advance of national societies to unoccupied areas; it also facilitated access from the Amazonian foothills to the Atlantic. Furthermore, it permitted remote points in the region to be connected to the main trading centres, reaching beyond national frontiers, and linking them all in a single process of distributing the merchandise, and sustained by the extraction and sale of latex.

The expansion of rubber exports, with investments of companies in Europe and the United States, brought great changes to the region. Urban development was accelerated not only with new populations appearing where expansion took place, but also with the growth of old urban centres. Iquitos, Peru, had only a few hundred inhabitants in 1870 but by 1896 it had grown to a city with a population of 10,000. Manaus also showed dizzying growth, from a small town with very precarious buildings in the 1850's it became a large city in the nineteenth century and, together with Belén, was one of the first Brazilian cities to have electric light and tap water.

The changes also affected the world of labour: large-scale employment of indigenous workers continued, still in the same conditions as during the colonial period, but Amazonia also brought in large contingents of workers from other regions such as the Andean mountains and the semi-arid Brazilian northeast, and they ended by outnumbering the indigenous workers, once again changing the regional population's composition.

The region also received immigrants from many countries. For example, when the Madeira-Mamoré railway in Brazil was being built, people of about 50 nationalities worked on it: in the region they came from Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela; from outside they came from Cuba, Granada, Ireland, Sweden, Belgium, China, Japan, India, Turkey and Russia, etc (Hardman 1988). However, activities in the rubber forests and on large works cost human lives; while each tonne of rubber exported cost one human life, about 6,000 lost their lives between 1907 and 1912 during the construction of the Madeira-Mamoré railway, a railway that was never finished.

In the second decade of the twentieth century, because of competition with rubber plantations in Southeast Asia, latex suffered an irreversible drop in price that led to the collapse of the rubber-based economy (Santos 1980: 237). Many areas incorporated to extract latex were abandoned and old rubber trading connections were weakened and even fell apart. There also began a process of commercial diversification of extractive activities (timber extraction, collecting resins, hunting to sell the skins) and new extraction fronts were opened, such as for Brazil nuts in Upper Tocantins. It is worth remembering that rubber bands were still traded, although on a small scale, and briefly recovered when, during the Second World War, consumers in Europe and the United States could not depend on Southeast Asian production. Rubber production had caused great negative impacts on the indigenous populations in terms of autonomy and traditional values.

The fauna was used above all for food consumption but also to export skins and feathers, it is worth remembering that great pressure were placed on aquatic species such as the paiche or the pirarucú *(Arapaima gigas)* and the manatee *(Trichechus manatus)*. However, special mention should be made of the production of different species of fresh water chelonions, in particular *Podocnemis expanda*, known as the charapa, the arrau or Amazon turtle. This turtle had been eaten since pre-colonial times but its consumption spread widely in the following centuries, principally in areas colonized by the Portuguese where producing turtles was a very important commercial activity (IIAP 2001).

Environmental damage, while not a great threat to the integrity of the Amazonian biome, often endangered the colonial occupation's sustainability because the localized exhaustion of some natural resources unleashed local crises and made it impossible for human settlements to remain in the affected areas.

The changes also affected the world of labour: large-scale employment of indigenous workers continued, but Amazonia also brought in large contingents of workers from other regions.

ENRIQUE CASTRO MENDÍVIL / PROMPERÚ

The natural environment sustains different life styles in Amazonia.

1.4 | NEWLAND OCCUPATION MODELS

The new Amazonian land occupation models have been significantly modified compared to those predominating in earlier centuries: the speed of how the are displaced and the level of transformation they are able to produce in occupied spaces seem to make it impossible to reverse the process of occupying these "last frontiers of the planet".

In the Andes, the direction toward which the frontiers of expansion were displaced is the same as in earlier days, while in Brazil the situation is different: the penetration routes changed so that, without replacing the old land occupation model, a new model was introduced. Until the middle of the twentieth century, the point of entry to Brazilian Amazonia was the mouth of the Amazon river, and riverside land occupation was predominant. The main Amazonian cities were, and still are, on the banks of large rivers. It was hard to have access to higher land, in the region of the Brazilian altiplano to the south and the Guyanas to the north, because the large waterfalls that are the transition between the altiplano and the river plain are obstacles to river navigation. Since the middle of the 1950's, when regional planning defined what is known as the "Legal Amazon", the situation changed and occupation began from the centre of the country with highways crossing the altiplano and connecting the rest of the country to the principal Amazonian cities. These highways opened the way for the new frontiers.

The historic process of Amazonian territory occupation has led to different political, economic, social and environmental structures being established in the region. Amazonian environmental institutions are managed independently in each country; while efforts are being made to carry out joint programmes and projects, there is still no common vision of Amazonia. Each country's partial and particular views have resulted in a variety of organizational structures concerning the theme of the environment, and the theme of Amazonia in particular, as well as a diversity of policies, instruments and implementation levels (for more details see Chapter 5).

At present, the countries making up the Amazonian region have very different levels of economic development. A relevant indicator is the heterogeneity of the countries when it comes to their Gross Domestic Product (GDP), that is to say, the level of added value that each one generates. Thus, Amazonia countries like Brazil and Venezuela have a national GDP of over US$3,000, and others, such as Bolivia, have a GDP of less than US$1,000. An analysis of regional Amazonian economies gives a better view of the levels of economic development, as shown by the indicators in Table 1.2.[2]

The analysis of Amazonian regions' GDP per capita shows that some regions have a higher level than the national. This is because these regions have a relatively small number of inhabitants and a large amount of exploited

The speed with which the different frontiers advance seems to make it impossible to reverse the processes that occupy "the planet's last frontiers".

[2]Major political division criteria of the countries were used to prepare the table since the GDP figures are only available in these terms.

TABLE 1.2
GDP per capita and growth rate of the Amazonian regions (in constant 2000 US$)

REGIONS	GDP PER CAPITA 2005	GDP PER CAPITA REGIONS / NATIONAL 2005 (%)	GDP GROWTH RATE 1992-2005
BOLIVIA (a)	1,178.07		3.23%
BENI	817.81	69.42	0.84%
PANDO	1,489.10	126.40	4.75%
SANTA CRUZ	1,586.22	134.64	3.95%
BRAZIL (b)	3,609.52		2.34%
ACRE	1,908.13	52.86	4.42%
AMAP	2,521.51	69.86	3.60%
AMAZON	4,242.13	117.53	4.69%
MARANHÃO	1,019.55	28.25	4.45%
MATO GROSSO	3,769.99	104.45	7.70%
PARA	1,852.04	51.31	2.81%
RONDONIA	2,314.37	64.12	4.66%
RORAIMA	1,810.99	50.17	7.79%
TOCANTIS	1,400.98	38.81	6.26%
COLOMBIA (c)	2,018.35		12.95%
AMAZON	940.95	46.62	13.90%
CAQUETÁ	1,111.15	55.05	11.63%
GUAINIA	769.73	38.14	12.72%
GUAVIARE	1,210.03	59.95	5.75%
PUTUMAYO	705.33	34.95	11.70%
VAUPÉS	1,424.66	70.59	13.28%
ECUADOR (d)	1,605.58		3.22%
MORONA SANTIAGO	705.94	43.97	-2.52%
NAPO	871.43	54.28	-4.13%
ORELLANA	25,628.22	1,596.20	97.61%
PASTAZA	6,620.34	412.33	33.58%
SUCUMBIOS	10,083.96	628.06	63.86%
ZAMORA - CHINCHIPE	990.77	61.71	0.21%
GUYANA (e)	960.61		1.73%
PERU (f)	2,352.47		3.32%
AMAZON	1,247.53	53.03	1.19%
LORETO	2,136.18	90.81	0.31%
MADRE DE DIOS	3,223.56	137.03	6.47%
SAN MARTIN	1,323.30	56.25	5.04%
UCAYALI	1,601.35	68.07	3.17%
SURINAME (g)	2,551.00		3.35%
VENEZUELA (h)	5,117.04		1.97%

(a) Source: National Statistics Institute of Bolivia; (b) Data from 2004 instead of 2005. Source: Brazilian Institute of Geography and Statistics; (c) Data from 2003 instead of 2005. Source: National Administrative Statistics Department of Colombia; (d) Data from 2004 instead of 2005. Figures from the provinces correspond to the gross added value. Source: Central Bank of Ecuador; (e) Source: Bureau of Statistics of Guyana; (f) National Institute of Statistics and Informatics of Peru; (g) General Bureau of Statistics in Suriname; (h) Central Bank of Venezuela.

TABLE 1.3
Principal productive activities in the Amazonian regions

COUNTRY	PRODUCTIVE ACTIVITIES
BOLIVIA	Agriculture (maize, manioc, legumes)
	Hydrocarbons (petroleum, natural gas)
	Mining (gold, lithium, bauxite)
	Forestry (timber-yielding and non timber-yielding [chestnut])
BRAZIL	Agriculture (millet, livestock)
	Forestry
	Industry (agroindustry, petrochemical, manufactures)
	Mining (gold, copper, bauxite, iron)
COLOMBIA	Agriculture (coffee), livestock
	Forestry
	Hydrocarbons (petroleum)
	Fishing (for consumption and ornamental)
	Industry (agroindustry, aquiculture)
	Services (tourism, banking, restaurants)
ECUADOR	Agriculture (bananas, flowers, cocoa, coffee)
	Forestry
	Hydrocarbons (petroleum)
GUYANA	Agriculture (sugar, rice)
	Forestry
	Mining (bauxite, gold)
PERU	Agriculture (oil palm, coffee, yellow maize)
	Mining (gold)
	Forestal
	Hydrocarbons (petroleum, natural gas)
SURINAME	Agriculture (rice, bananas)
	Forestry
	Hydrocarbons (petroleum)
VENEZUELA	Mining (bauxite)
	Tourism

Source: Prepared by The GEO Amazonia Technical Committee.

ABOUT 500 INDUSTRIES OPERATE IN THE INDUSTRIAL/ MANUFACTURING CLUSTER IN MANAUS AND GENERATE 400,000 JOBS DIRECTLY OR INDIRECTLY.

natural resources, such as minerals, petroleum or gas (Amazon in Brazil; Orellana in Ecuador), that are major added value sources. However, it is not possible to say that these regions are highly developed because the profits are usually not re-invested in them. On the contrary, in most of these zones poverty indicators are high. Ecuador is an example of this: the GDP per capita levels in Orellana and Sucumbios are particularly high because the principal petroleum deposits are in these regions and concessions have been given on close to 5 million hectares. However, poverty indexes are higher than the national index: 84.2% in Sucumbios and 80.2% in Orellana, compared to 55% nationally. As to public sanitation, Sucumbios has a drainage coverage rate of 27% and Orellana a rate of 19%, compared to 48% nationally, while only 14% of the population in Sucumbios and 13% in Orellana have tap water compared to 48% of the national population[3].

It is also important to observe that there are population migration processes in regions where significant productive activities are concentrated because more jobs are available, causing a greater demand for basic services which, in many cases, cannot be met. This, together with scant re-investment of economic surpluses in the region, means very low development levels. An exception is in Amazon (Brazil), where industrial, non-extractive growth has produced significant development.

Some regions with GDP per capita levels 50% below the national level (Marañon and Tocantins in Brazil; Amazon, Guainia y Putumayo in Colombia; and Morona Santiago in Ecuador) also have natural resources that have not yet been exploited.

In spite of the economic development heterogeneity outlined in the above analysis, a common aspect can be seen in the eight countries: Amazonia's principal productive activities depend on its natural resources. In the Amazonian nations, agriculture, mining and hydrocarbons and forestry production are very important wealth producers. In agriculture, cereals like millet, rice and coffee are especially important. Mineral and energy resources are widely distributed throughout Amazonia. A variety of minerals are exploited, and ready to be exploited, such as bauxite, zinc, coal, manganese, iron and a large number of minor minerals. There are also deposits of petroleum and natural gas. Forest activity is also a developing economic activity although its industrialization is not homogeneous. Most of these activities are extractive with reduced added value and this shows there is a potential for economic growth (for more details see Chapter 2).

It should be pointed out that, unlike the other countries in the region, Brazil has developed an industrial/manufacturing cluster in Manaus. The main stimulus for growth was the establishment of the free zone in the mid-1960's which, with almost 500 industries, directly employs some 50,000 people and indirectly 350,000. Predominant industries are electrical appliances, informatics, professional equipment and electronic components. Also produced are motorcycles, time keeping equipment, chemicals, optical equipment, toys, and others.

[3]Data from the Social Information Integrated System of Ecuador (SIISE) (2001).

SERGIO AMARAL / OTCA

Hydrocarbon exploitation and infrastructure mega-projects alter the forest's integrity.

"Instead of seeking what you don't have, find what you have never lost".

NISANGARATTA (HIMALAYA, 2000 B.C.)

ENRIQUE CASTRO MENDÍVIL / PRODAPP

ENRIQUE CASTRO MENDÍVIL / PRODAPP

ENRIQUE CASTRO MENDÍVIL / PRODAPP

ENRIQUE CUNEO / EL COMERCIO

DANTE PIAGGIO / EL COMERCIO

JUAN PRATGINESTÓS / acervo PPG7-GTZ

The historic process of Amazonian territory occupation has led to different political, economic, social and environmental structures being established in the region. Amazonian environmental institutions are managed independently in each country; while efforts are being made to carry out joint programmes and projects, there is still no common vision of Amazonia.

CONSERVACIÓN INTERNACIONAL

THE RIVERS OF AMAZONIA: DRAINAGE AXES, SOURCES OF LIFE AND A MEANS OF COMMUNICATION

THE AMAZONIAN REGION

Amazonia is a privileged nucleus of world biodiversity. According to political-administrative criteria, it occupies an extension of 7,413,827 km², representing 54% of the surface of the eight Amazonian country members of ACTO.

Francisco de Orellana
The Spanish conquistador, member of an expedition sent by Francisco Pizarro to search for the "Land of Cinamon", reached the Amazon river with a troop of men. In February 1542, he became the first European to navigate the full length of the river, to the river's mouth in the Atlantic Ocean.

Areas of concentration of global biodiversity
There are four zones around the world that are privileged by the biological diversity they contain; all are tropical forests. These tropical rain and cloud forests are being devastated at an accelerated pace, which threatens the future availability of ecosystem goods and services.

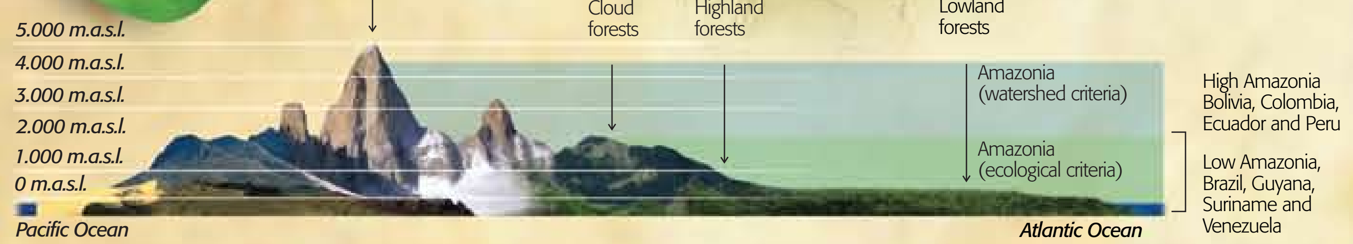
Amazonian biodiversity
Amazonia only occupies 6% of the Earth's continental surface, yet it represents over half of the planet's tropical rainforest. It is also home to over 10% of the world's plant species and a quantity of animal species that is difficult to calculate.

40% of South America's territory is considered to be Amazonia.

40,000 species of plants have been identified in the Amazonian basin.

6 million km² is the approximate area currently covered by forest.

Tourism. In 2007, the member countries of the Amazon Cooperation Treaty Organization (ACTO) launched the initiative: **Destination Amazonia Year 2009**, to promote the region as an area for sustainable tourism.



AMAZONIAN POPULATION

Diverse and ancient, made up of different groups: indigenous peoples, settlers, riverside dwellers and urban dwellers, among others. It is the foundation of a complex social and economic mosaic.

39 million persons live in Greater Amazonia, among them, there are **420** indigenous groups, bearers of traditional values and knowledge.

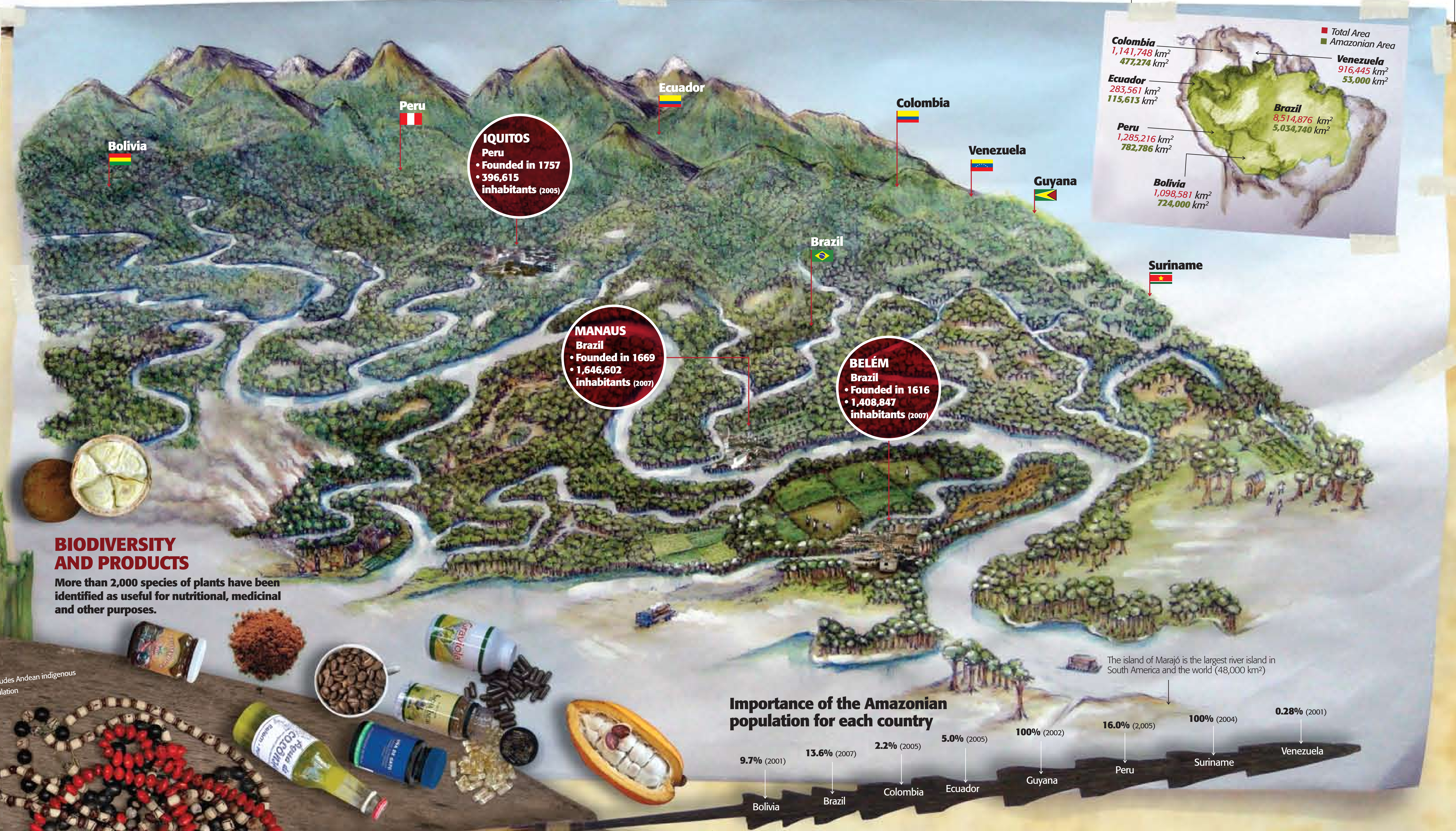
Indigenous population

Country	Number of inhabitants	Number of indigenous groups
Brazil	300,000 (2007)	175
Peru	300,000 (2005)	59
Colombia	107,231 (2005)	62
Bolivia	48,123 (2001)	25
Venezuela	37,362 (2001)	17
Guyana	-	-
Ecuador *	369,810 (2006)	10
Suriname	12,000	-

* Includes Andean indigenous population

BIODIVERSITY AND PRODUCTS

More than 2,000 species of plants have been identified as useful for nutritional, medicinal and other purposes.



THE EXTENSION OF THE AMAZONIAN FOREST

The Amazonian ecosystem covers the largest area of continuous tropical rainforest, approximately 6 million km², and plays an essential role in the diversity and conservation of natural life on earth.

The soils of Amazonia

1. The nutrients of the Amazonian forest are found mainly in the biomass.
2. The trees have a high capacity to uptake the nutrients from decomposition of the organic matter through their superficial roots and the abundance of fungi.
3. They have a thin layer of organic matter, source of nutrients for plants because of the wealth of micro-organisms found in it. Their permanent use for agriculture requires prior forest clearing, which impoverishes the soil and reduces its fertility.
4. In floodable alluvial areas, the soil is more fertile, owing to mud and clay deposits, but it has poor drainage. The soils in non-alluvial zones, the restingas (sandy, acidic, and nutrient-poor soils, where coastal forests are located), hills and mountains are enriched by the biomass they sustain.

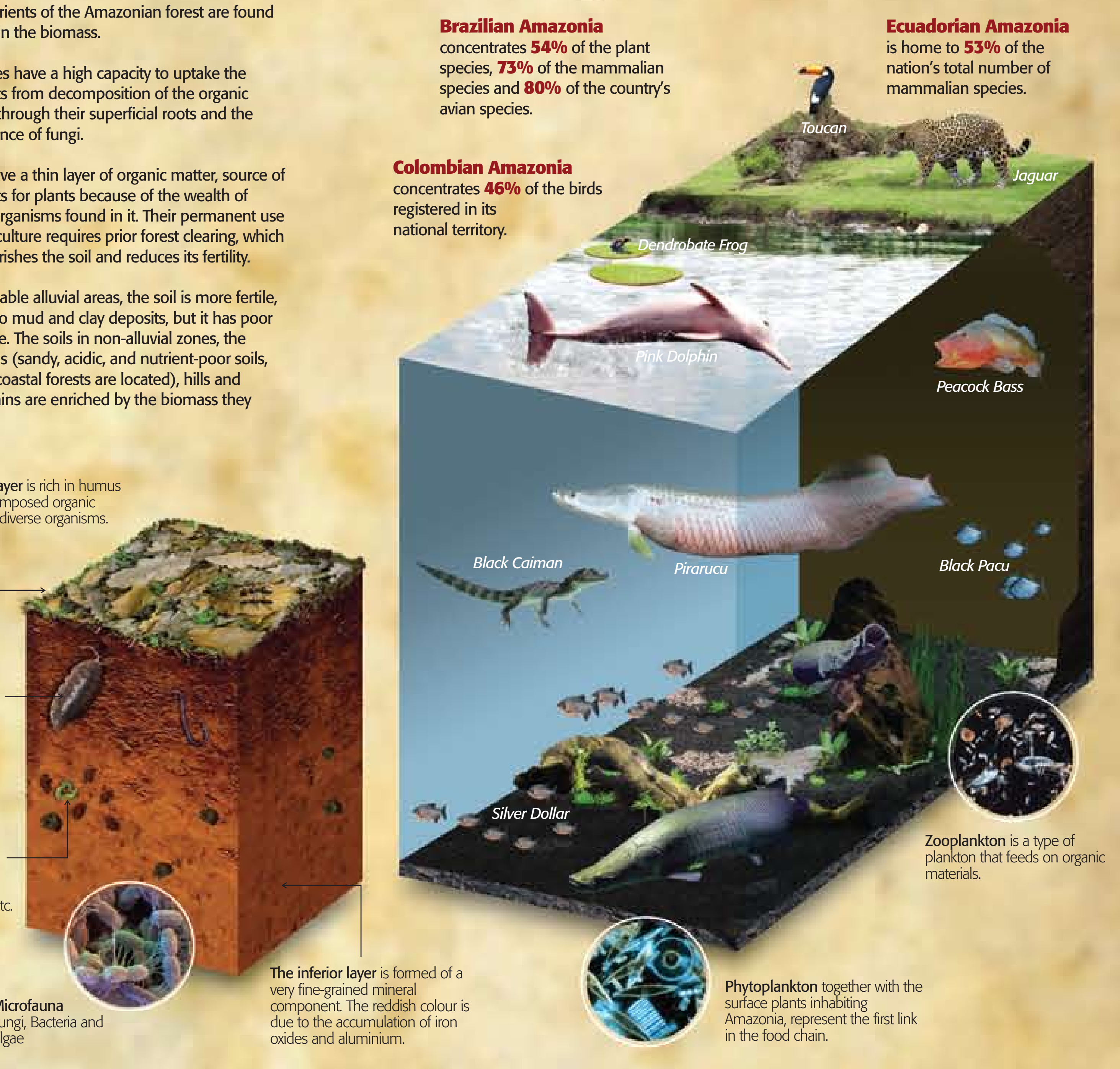
Biodiverse land

Peruvian Amazonia holds the world record for the number of butterfly species (**4,000**). It also stands out for the concentration of reptiles (**48%**) and amphibians (**79%**) found in the entire country.

Brazilian Amazonia concentrates **54%** of the plant species, **73%** of the mammalian species and **80%** of the country's avian species.

Ecuadorian Amazonia is home to **53%** of the nation's total number of mammalian species.

Colombian Amazonia concentrates **46%** of the birds registered in its national territory.



The surface layer is rich in humus (partially decomposed organic material) and diverse organisms.

Macrofauna Roly-poly bug Worms, Millipedes, Centipedes, Ants, etc.

Mesofauna Springtails, Opilions, Nematodes, etc.

Microfauna Fungi, Bacteria and Algae

The inferior layer is formed of a very fine-grained mineral component. The reddish colour is due to the accumulation of iron oxides and aluminium.

Phytoplankton together with the surface plants inhabiting Amazonia, represent the first link in the food chain.

Zooplankton is a type of plankton that feeds on organic materials.

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AMAZONIAN DYNAMICS

2.1 SOCIO-DEMOGRAPHIC **DYNAMICS**

2.2 ECONOMIC **DYNAMICS**

2.3 LAND-USE **CHANGE**

2.4 SCIENCE, **TECHNOLOGY AND INNOVATION**

2.5 CLIMATE CHANGE **AND NATURAL EVENTS**

THE ENVIRONMENTAL SITUATION IN THE AMAZONIAN REGION IS THE RESULT OF the interaction of a set of socio-demographic and economic politico-institutional and scientific-technological driving forces, as the closely combined pressures that drive land-use change. Such a set of driving forces establishes processes that condition changes in patterns of how natural resources are used and the resulting environmental impacts. As these pressures are factors that directly affect the ecosystem services, it is important to analyze the characteristics of such forces and how they are linked to the way the Amazonian ecosystem functions.

2.1 | SOCIO-DEMOGRAPHIC DYNAMICS

As explained in Chapter 1, the heterogeneous Amazonian population has diverse socio-cultural characteristics with different ways of taking advantage of the Amazonian ecosystem services. Population growth in Amazonia is closely linked with an increasing demand by its inhabitants for goods and services to meet their basic needs such as food, electricity, drinking water, drainage, and health services, among others.

POPULATION AND MIGRATIONS

The determination of the Amazonian population will depend on the criteria used to define Amazonian territory, as well as on how each country selects the methodology and criteria to define its respective Amazonian population. The following section presents the population in the areas of Greater Amazonia and Lesser Amazonia, as defined in Chapter 1, which is calculated on the basis of georeferenced demographic information and international sources. An analysis is then made of the Amazonian population based on official information provided by the countries that constitute the Amazonia.

Taking into consideration the areas of Greater Amazonia and Lesser Amazonia, in 2005 the Amazonian population was 38,777,600 inhabitants in the first case and 11,037,260 inhabitants in the second case (UNEP 2008) (Table 2.1). The contrast in maps 2.1a and 2.1b reveals evidence of population growth but also of its concentration in the south of Brazilian Amazonia, in the western part of Amazonia (principally in Peru) and along the course of the Amazon River (the zone of Iquitos in Peru, the Brazil-Colombia-Peru border zone and the urban conglomerates of Manaus and Belen in Brazil). It also shows the almost total lack of population in the Colombian, Ecuadorean and Venezuelan Amazonian plain, although in the first two countries there are population centres in the Andean foothills.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

Family of settlers, frequent inhabitants of Amazonian river banks.

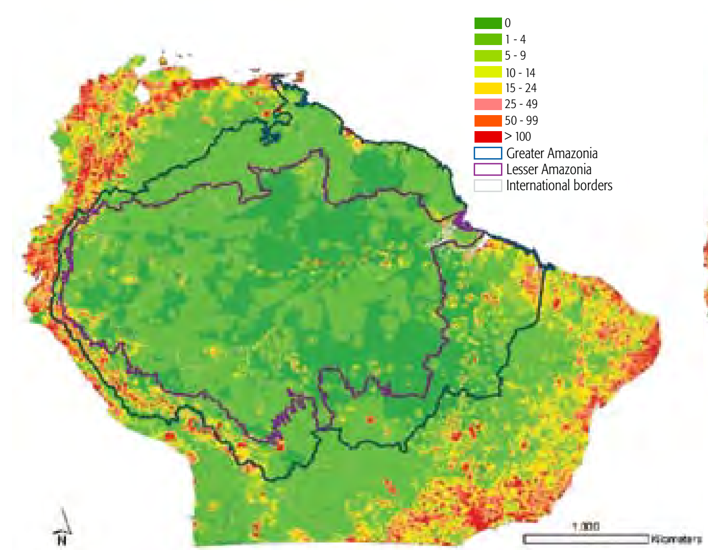
TABLE 2.1
Approximate population of Greater Amazonia and Lesser Amazonia (2005)

AREA	TOTAL POPULATION (2005)	POPULATION DENSITY (INHABITANTS/km²)	POPULATION PRESSURE (% OF AMAZONIA)		
			HIGH >100	MEDIUM 25 -100	LOW < 25
GREATER AMAZONIA	38,777,600	4.74	0.61	2.81	96.58
LESSER AMAZONIA	11,037,260	2.14	0.32	1.23	98.45
WORLD	6,453,628,000	47.83	8.28	12.61	79.11

Notes:
Population pressure: high = more than 100 people/km², medium = between 25 and 100 people/km², and low = fewer than 25 people/km².
Source: Prepared by UNEP/GRID Sioux Falls using the Gridded Population of the World, version 3 (GPWv3), Center for International Earth Science Information Network (CIESIN) of the Earth Institute, the University of Columbia.

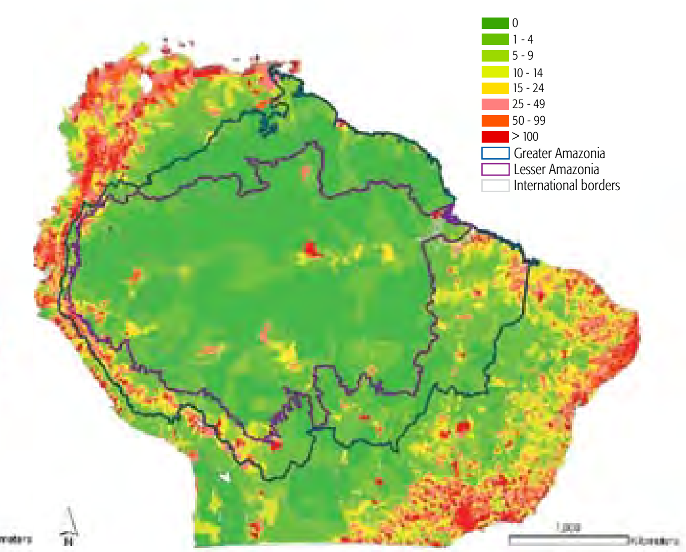
MAP 2.1a

Population density in Greater Amazonia and Lesser Amazonia (1990)



MAP 2.1b

Population density in Greater Amazonia and Lesser Amazonia (2005).



Based on information reported by the Amazonian countries and the respective average annual growth rates in the two last census periods, it was estimated that in 2007 there were 33,485,981 inhabitants in Amazonia (prepared by GEO Amazonia), representing 11% of the total population of the ACTO countries. Close to 75% of the Amazonian population lives in Brazil, followed by 13% in Peru (Table 2.2). Evidence shows that, among the Andean-Amazonian countries, Peru has the largest Amazonian population and the highest proportion of the national population settled in that region (16%).

IT IS ESTIMATED ABOUT 75% OF THE TOTAL AMAZONIAN POPULATION LIVES IN BRAZIL

TABLE 2.2
Population in Amazonia

COUNTRIES	NUMBER OF INHABITANTS			AVERAGE ANNUAL GROWTH RATE	
BRAZIL	**1980** 11,015,363	**1991** 16,146,059	**2007** 24,970,600	**1980-1991** 3.5	**1991-2007** 2.8
COLOMBIA	**1985** 1,607,093	**1993** 658,723	**2005** 960,239	**1985-1993** -10.5	**1993-2005** 3.2
ECUADOR	**1982** 263,797	**1990** 372,533	**2005** 629,373	**1982-1990** 4.4	**1982-2005** 3.6
GUYANA	**1980** 759,568	**1991** 723,673	**2002** 751,223	**1980-1991** -0.4	**1991-2002** 0.3
PERU	**1981** 1,253,355	**1993** 3,542,391	**2005** 4,361,858	**1981-1993** 9.0	**1993-2005** 1.38
SURINAME	**1980** 354,860	**1993** s.i	**2004** 492,823	**1980-1990** s.i	**1980-2004** 1.38
VENEZUELA*	**1981** 45,667	**1990** 55,717	**2001** 70,464	**1981-1990** 2.2	**1990-2001** 2.16

Notes:

* Information taken from Melvy Aidde Vargas (2005) ("Demography of the Amazonian region: the case of Bolivia"), whose work is based on the National Population Census of Bolivia. In: Aragón (2005).

In Peru ecological criteria is considered.

Sources: Aragón (2005). Bolivia: National Statistics Institute (INE - Bolivia). Brazil: IBGE (2007). Colombia: SINCHI; Ecuador: Ecorae (2006). Guyana: Environmental Protection Agency (2007). Peru: National Institute of Statistics and Information (INEI) – Peruvian Amazonia Research Institute (IIAP) (2006). Suriname: General Bureau for the Statistics. Venezuela: National Statistics Institute (INE - Venezuela). General Population and Housing Census, 1981, 1990 and 2001.

The Amazonian population grew at an average annual rate of 2.3% from 1990 to 2007 and Ecuador was the country with the highest rate of average annual growth (3.6%). It is worth pointing out that during the years from 2000 the speed of population growth in Amazonia was higher than the respective national population growth rate in most Amazonian countries, particularly in Ecuador, Colombia and Brazil (Figure 2.1).

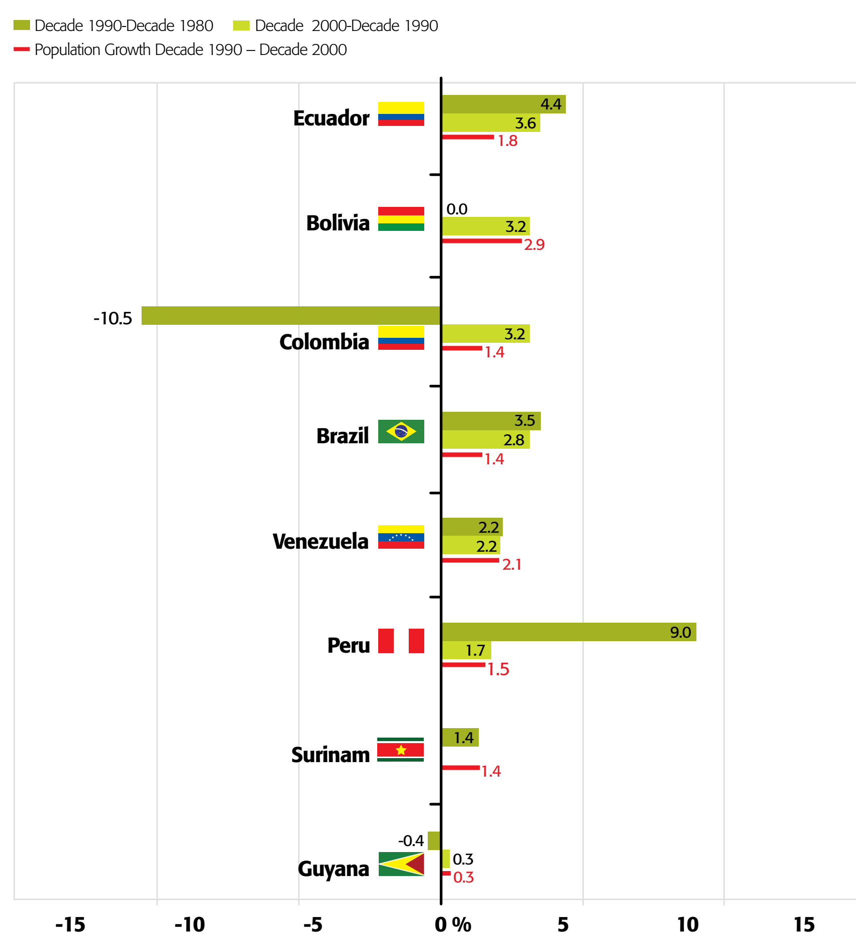
The growth of the Amazonian population is associated with the continuous migrations that have been taking place in the region. These migrations are the result of several determining factors. On the one hand, there are State colonization and populating policies (in Brazil and Peru for example) and the expansion of productive activities (for example monoculture agriculture, raising cattle, mining and hydrocarbons, timber, and others)., and on the other hand, there is the contingent of people displaced because of violence who migrate in search of more peaceful zones. In addition, the development of transport infrastructure encouraged the establishment of population centres. The combination of these factors converted Amazonia into an escape valve for social tensions, led to the occupation of land and the establishment of human settlements as well as to developing agriculture and ranching.

In Brazil, "A land without men for men without land" was the slogan with which governments in the 1970's sought to stimulate occupation of Amazonia by creating agricultural colonies along the Trans-Amazonian highway. Furthermore, the expansion of tourism and industry in development centres such as Manaus, the development of hydroenergy and road projects, as well as agricultural, livestock and forestry activities, brought a large flow of migrants (mainly in the north of Mato Grosso, Rondonia and Roraima).

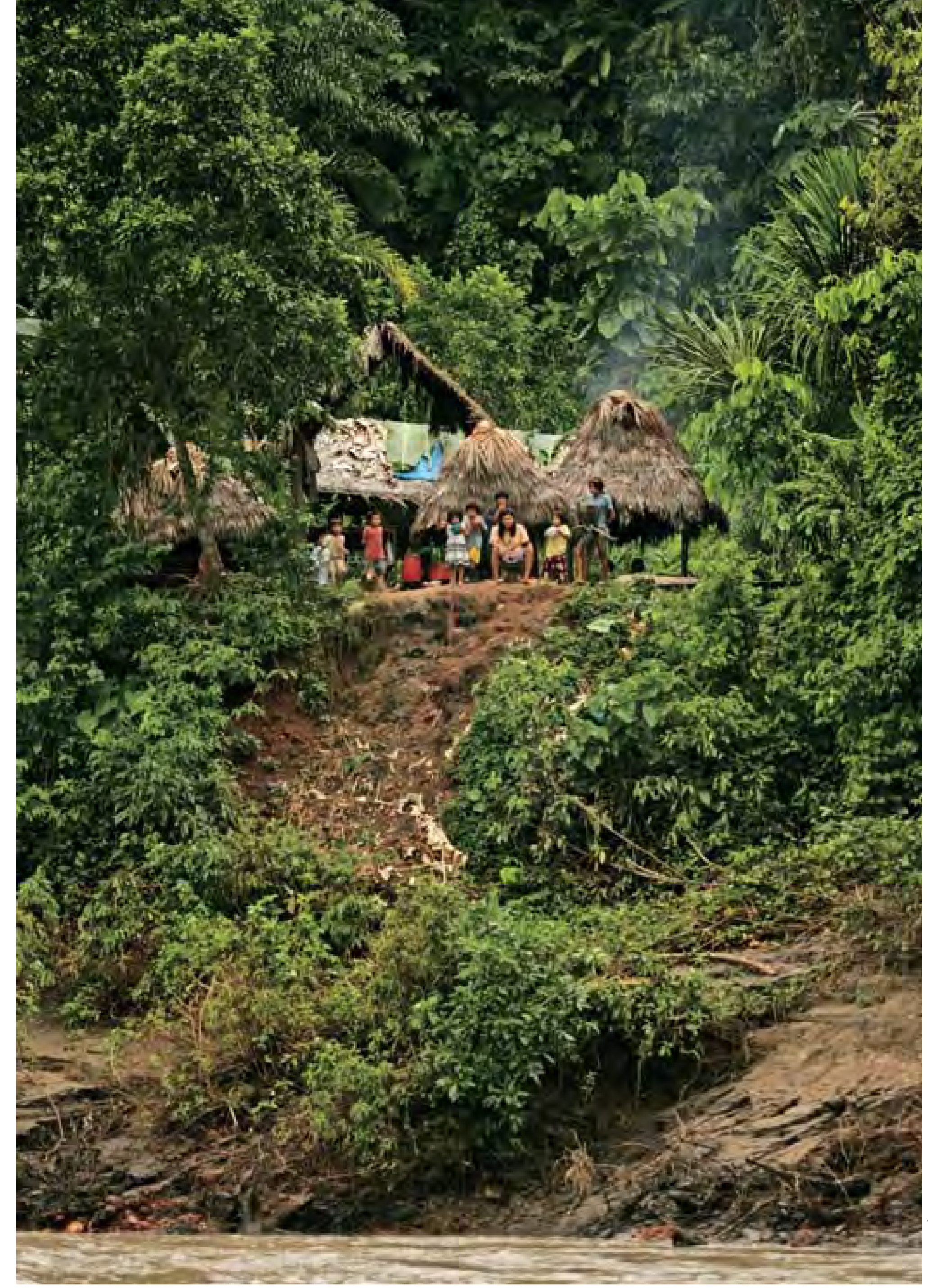
In Colombia, Amazonia turned into an escape valve during the time of "the violence". From the 1950's to the 1970's expansion in this area was stimulated by large flows of migrants entering the indigenous regions that make up Northwestern Amazonia. Amazonian geography was transformed to accomodate the development of an extensive livestock model and intensive oil activity that stimulated colonization and had great impacts on the indigenous peoples' territories (Cofán and Inga, and others).

In Peru's Amazonian region there was also a large increase in population, multiplying fourfold between 1940 and 1981 (from 414,452 to 1,796,283 inhabitants) due mainly to intensified migratory movements in the 1960's. For example, the departments of San Martín and Ucayali are important population

FIGURE 2.1
Average annual Amazonian population growth rate per country



Sources: Aragón, Luis (2005). Bolivia: INE. Brazil: IBGE (2007). Colombia: SINCHI. Ecuador: ECORAE (2006). Guyana: Environmental Protection Agency (2007). Peru: INEI-IIAP (2006). Suriname: General Bureau for the Statistics (2007). Venezuela: INE. General Population and Housing Census, 1981, 1990 y 2001..

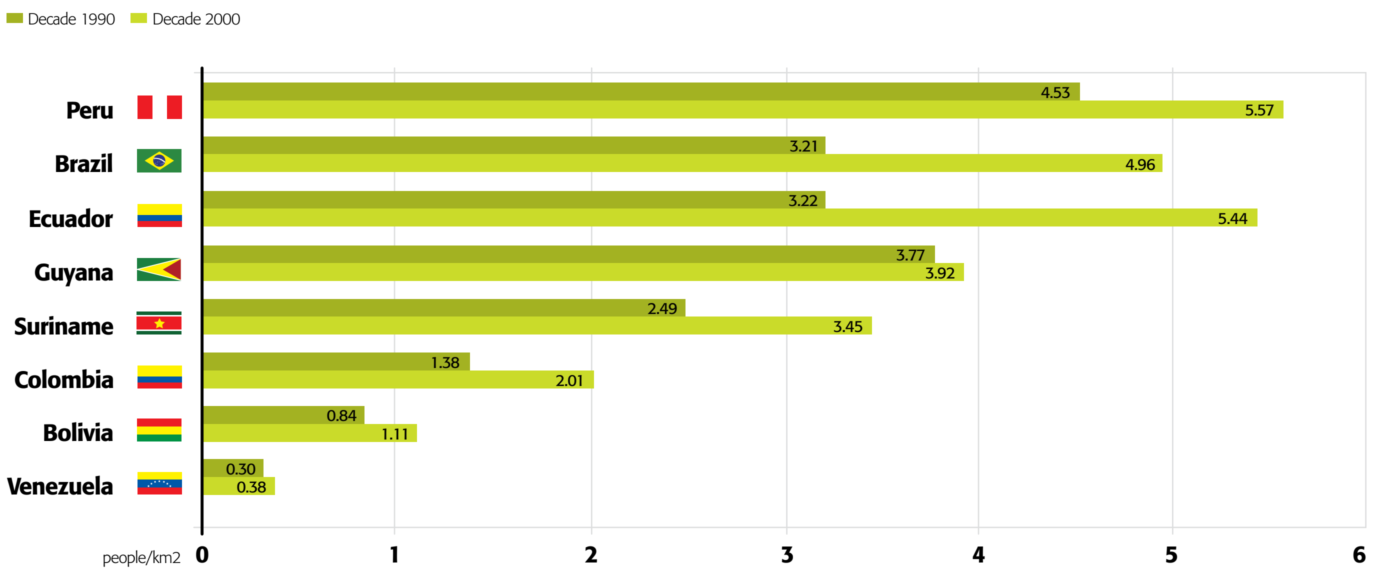


ENRIQUE CÚNEO / EL COMERCIO

Family and indigenous housing in the high Amazonian forest

The growth of the Amazonian population is associated with migrations resulting from State colonization and populating policies, expanding productive activities, displacements to more peaceful zones due to violence, and the development of transport infrastructure.

FIGURE 2.2
Population density in Amazonia per country



Source: Aragón (2005). Bolivia: National Statistics Institute. Brazil: IBGE (2007). Colombia: SINCHI. Ecuador: ECORAE (2006). Guyana: Environmental Protection Agency (2007). Peru: INEI-IIAP (2006). Suriname: General Bureau for the Statistics. Venezuela: INE. General Population and Housing Census, 1981, 1990 and 2001.

centres because they are areas where the agricultural and livestock designated areas have expanded and, more recently, because they serve as strategic coca production and processing centres. The department of Madre de Dios is a centre of attraction for artisan exploitation of gold, timber extraction, non-timber producing forest activities (chestnut for example) and, recently, the expansion of ecotourism. Due to population growth and changes in land use, Peruvian Amazonia now holds a very important position in the national economy (Barclay and others 1991).

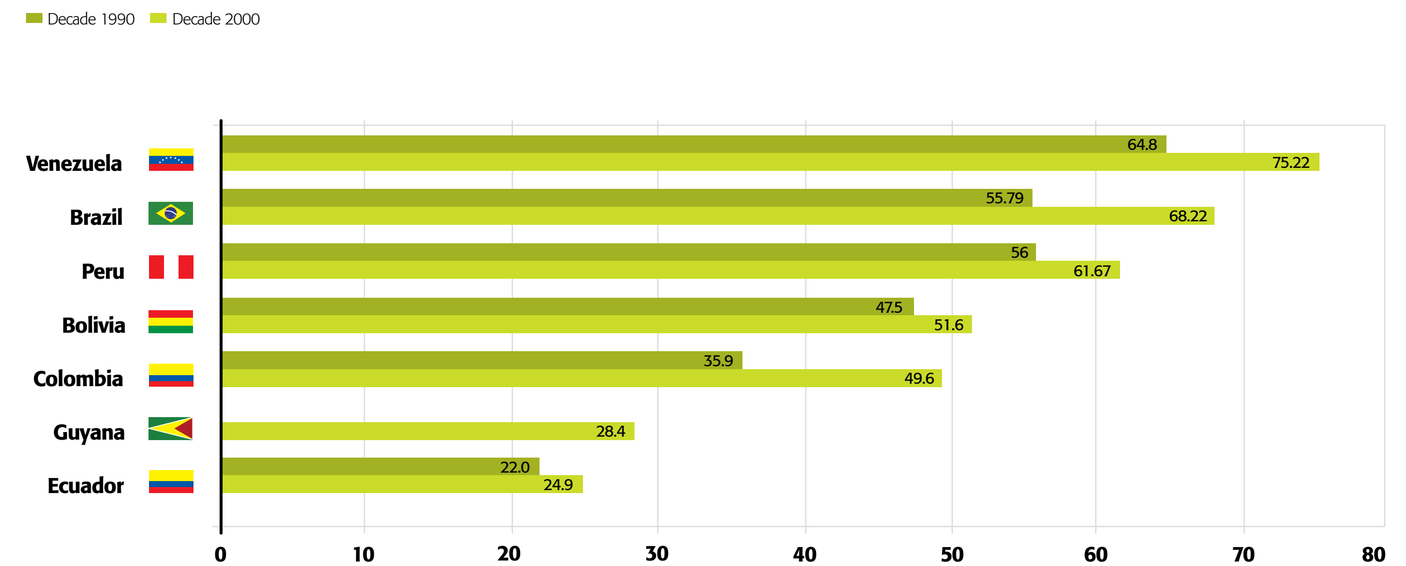
In Bolivia the migratory process began in the 1970's when large extensions of land were freely distributed to private owners on the condition that they make productive investments; in most cases, however, this condition was not met. The policy of allocating land on request and with practically cost-free title led to agricultural land being re-concentrated in the western part of the country (Urioste 2004). Colonization encouraged the expansion of the agricultural frontier in Bolivian Amazonia where crops developed included sugar cane, yellow hard maize, cotton, rice and soya (in the department of Santa Cruz) and coca (in El Chapare) (Bolivia: Unidad de Analisis de Politicas Sociales y Económicas [Udape] 2004).

Similarly, in Ecuador oil exploitation principally, followed by agricultural and livestock activities, encouraged migration to Amazonia. In Guyana, mining expansion acted as a stimulus to attract workers both from within the country and from neighbouring countries.


CONSERVACIÓN INTERNACIONAL

Indigenous peoples sustain their way of life with goods and services provided by nature.

FIGURE 2.3
Amazonia: Urban population (%)



Note: No information available for Suriname.

Sources: Aragón (2005). Bolivia: INE. Brazil: IBGE (2007). Colombia: SINCHI. Ecuador: ECORAE (2006). Guyana: Environmental Protection Agency (2007). Peru: National Institute for Statistics (2002). Venezuela: INE. General Population and Housing Census, 1981, 1990 and 2001.

In the Amazonian region, population density increased from 3.4 people/km² in the decade of the 1990's to 4.2 people/km² between 2000 and 2007. This increase in population density has been concentrated in urban areas. In the region, the largest increases in population density (45%) were registered in Brazil, Colombia and Ecuador (Figure 2.2).

According to the population distribution in the Amazonian territory by urban-rural area, the main population increases were in Brazil, Bolivia and Venezuela and demonstrated the dynamic growth of cities. In Brazil the urban population grew from 55.8% of the total population in 1991 to 68.2% in 2007 (Figure 2.3). The rural population represents more than 60% of the total Amazonian population only in Ecuador and Guyana.

Population dynamics in the Amazonian territory has led to the expansion of cities of different sizes as a response to the expansion of productive and social centres. In Brazil there are very large cities like Manaus (1,646,602 inhabitants [Brazil: Brazilian Geographic and Statistics Institute - IBGE 2007]) and Belén (1,408,847 inhabitants [IBGE 2007]); Santa Cruz in Bolivia (1,545,648 inhabitants [National Statistics Institute of Bolivia [INE] 2008]); Iquitos in Peru (396,615 inhabitants [Peru: National Institute of Statistics and Informatics – INEI 2005]), as well as intermediate cities with fewer than 100,000 inhabitants but that allow productive zones and facilitate regional economic activity (Yurimaguas in Peru and Lago Agrio in Ecuador for example). Urban growth in Amazonia is explained in the section on human settlements in Chapter 3.

"Based on sustainable forest management, forestry businesses can provide a large number of jobs and export products, and make degraded lands productive."

ANTONIO BRACK (TAKEN FROM ANTONIO BRACK - LA BUENA TIERRA)

The Amazonian population is diverse and ancient and has formed a complex social and economic mosaic (see Chapter 1). This population is made up of different human groups including indigenous peoples, colonists, riverside settlers, urban settlers, among others, who account for Amazonia's cultural diversity.

In the first years of the 21st century there are still remote, and almost intact, areas similar to those which, some 500 years ago, were known to the men who came with Alonso Mercadillo, Díaz de Pineda or Francisco de Orellana. There still are people who live in the forests of Bolivia, Brazil, Colombia, Ecuador and Peru who do not maintain constant

TABLE 2.3
Indigenous populations

COUNTRY	NUMEBER OF INHABITANTS	NUMBER OF ETHNIC GROUPS	NUMBER OF LINGUISTIC FAMILIES
BOLIVIA	48.123 (2001)	25	18
BRAZIL	300.000 (2007)	175	34
COLOMBIA	107.231 (2005)	62	n.i.
ECUADOR	369.810 (2006)*	10	n.i.
GUYANA	n.i.	n.i.	n.i.
PERU	300.000 (2005)	59	15
SURINAME	12.000	n.i.	n.i.
VENEZUELA	37.362 (2001)	17	n.i.

n.i.: no Information.
Notes: (1) The data for Brazil do not include indigenous peoples in voluntary isolation and their linguistic families.
(2) It should be pointed out that in Ecuador indigenous population encompass both the native Amazonian population and the non-native mountain people from other indigenous groups. Another source, Servicios de Iniciativa Local para La Amazonía Ecuatoriana (SILAE) taken from http://www.silae.org, registers 160,000 Amazonian indigenous inhabitants in the strict sense. That is to say, they have their own regional ancestral way of life and limited contact with the outside world.
Sources: Aragón (2005). Brazil: Instituto Socioambiental (ISA) (2007). Bolivia: INE (2003), Ecuador: Ecorae (2006). Guyana: Environmental Protection Agency (2007). Peru: INEI-IIAP (2006). Suriname: General Bureau for the Statistics.

Isolated or unconnected indigenous peoples live in places in the tropical forest to which access is difficult and they subsist by taking advantage of the forest's resources. Brazil and Peru have the largest number of indigenous people living in this situation.

contact with the national societies ("unconnected" groups). Isolated or unconnected indigenous peoples live in places in the tropical forest to which access is difficult and they subsist by taking advantage of the forest's resources. Brazil (4) and Peru (20) have the largest number of indigenous people living in isolation (Brackelaire 2006).

Indigenous peoples have their own cultures and values and settle in different areas. They have a tradition of harmonious coexistence with nature and much knowledge about the various uses of flora and fauna. There are 420 different indigenous peoples in Amazonia who speak 86 languages and 650 dialects (ACTO 2007) that are an expression of Amazonian cultural diversity. These groups have their own levels of demographic dynamics and profiles of birth and death as well as distinct patterns of human settlements; for example, they cross borders freely and move on the basis of social rather than geographic patterns. The socio-economic and environmental changes that have taken place in the region have had a very severe effect on the indigenous Amazonian population, forcing them to change their lifestyles and reducing their numbers. For example, in 1997 in Peru there were 11 extinct ethnic groups and 18 in danger of extinction recorded. This gradual process of disappearance goes back to the occupation of the territory by Europeans (see Chapter 1). Other factors to consider are the demographic growth, social and cultural disintegration of some indigenous groups, assimilation of other groups and their inability to self-reproduce (Brack 1997b) (Table 2.3).

Limited information is available about the size of the land occupied by indigenous Amazonian peoples. Brazil records 175 indigenous groups, with a population of 300,000 (representing 1% of the Brazilian Amazonian population) living on 107,721,017 hectares which covers 21.52% of Legal Amazonia. In Brazil, the importance of indigenous land is recognized as a way of projecting the collective rights and cultural identity of indigenous peoples. These lands are of great value in conserving the forest even if they have been invaded by miners, agricultural producers, timber merchants, fishermen and hunters who take advantage of their natural resources, causing conflicts between the invaders and the indigenous populations. While the indigenous population suffered a drastic reduction over the past 25 years, a significant raise in their population has now been recorded (ISA 2007) (table 2.2).

BOX 2.1

SURINAME: INDIGENOUS PEOPLES AND PROPERTY RIGHTS

Suriname is one of the South American countries that do not recognize indigenous peoples' rights to land tenure. Forty-five indigenous groups live in seven distinct areas of the country with a total population of 12,000 inhabitants. In an attempt to remedy this situation, the Association of Indigenous Leaders (VIDS) organizes dialogues with the government and has prepared a proposal for a law on the rights of indigenous peoples; it also presents petitions to United Nations human rights bodies.

All this is done to improve understanding of the theme both in Suriname and elsewhere. In addition, in the country different indigenous peoples are trained in mapping and on the sustainable use of natural resources.

Source: Prepared by Mariska Millieu, Ministry of Health, Suriname.


DANTE PIAGGIO / EL COMERCIO

An Amazonian woman peeling cassava or manioc, a staple food of the Amazonian population.

On the other hand, from the 1980's national and international pressure to preserve Amazonia has increased. In that context, political action was intensified by ecological groups and groups defending forest people.

In numerous cases the exploitation of Amazonian natural resources in indigenous territories, such as activities by timber and oil companies, without consulting with or having the consent of the local communities, caused a deterioration of the environment and endangered their survival. Agreement 169 of the International Labour Organization (ILO) support the participation and prior consultation of indigenous peoples in cases where natural resources are used, their right to reap the benefits from such activities as well as to be compensated for any damage that might result from such activities. In Brazil, also a signatory to the agreement, indigenous peoples have the exclusive right to use the water, energy or mining natural resources within their territories. In spite of the existence of norms that recognize these principles of participation, conflicts are still common between indigenous communities and private companies.

In many Amazonian countries, and in certain circumstances, attention has been paid to the problems of the social exclusion of indigenous peoples. The central state has facilitated and opened a number of more accessible spaces that have helped the indigenous peoples to negotiate better conditions or guarantees to allow them to meet their needs (ILO 1996).

POVERTY

The concept of poverty has evolved from an exclusive idea of reduced income to one that is more integrated and complex and that considers cultural, geographic and environmental factors. To survive, indigenous peoples, as well as other traditional populations, extract forest or river products (collecting fruits, fishing or hunting). The well-being of such populations depends not only on income but also on the availability of and access to natural resources, as well as on having the conditions and capacities to manage them (Celentano and Verissimo 2007). Poor people are exposed to events beyond their control (among them diseases, violence, and natural events). In these situations they are the ones who are most vulnerable, lacking the means they need to protect themselves, to take advantage of opportunities, to develop capacities and to assert their rights means the exclusion and ill-being of such populations (Roca Rey and Rosas 2002). Also, the probability of being poor increases for indigenous populations, as the poverty gap gets wider and is very slow to improve.

The Amazonian region illustrates well the rich-poor duality because, although it is an area with a great amount and variety of natural and cultural resources, a large part of the population lives in poverty or extreme poverty; nevertheless, because each country uses different methodologies to measure poverty, in comparative terms its analysis is limited. What is evident is that in a large part of each country's Amazonian region, a larger proportion of the population lives in poverty than rest of the respective population. For example, in Peru in 2007 the proportion of the Amazonian region population living in poverty was higher (48.4%) than nationally (39.3%); this being a reduction from the 2005 figure of 60.3%. In addition, the greatest reduction in poverty was in urban areas where it passed from 53.9% in 2005 to 40.3% in 2007. Extreme poverty also showed a significant reduction, falling from 25.5% in 2005 to 17.8% in 2007 (Peru: INEI 2008).

In Brazilian Amazonia an assessment of the Millennium Goals led to the conclusion that the population in extreme poverty was reduced by 6 percentage points, from 23% in 1990 to 17% in 2005. However, there has been no change in the percentage of people living in poverty which still remains at 45%. Another indicator of poverty is the proportion of households with food insecurity. FAO defines "food insecurity" as a situation in which individuals have a reduced amount of food available and limited access to food because of their low income; they do not have enough food because of a lack of, among other services, water and sanitation; and they live in a state of instability when faced with contingencies of climate.

In 2004 in Brazilian Amazonia, 35% of the population lived in a household with medium or serious food insecurity, 21% being the national average. However, there are important differences between states; those facing the most critical situation are Roraima (52%) and Marañón (50%) (Celentano y Veríssimo 2007).

In Guyana poverty decreased both in urban and coastal areas, the greatest reduction being seen in Georgetown. In Guyana most poor people live in rural areas and are self-employed in agriculture, or do manual labour.

Social inequality goes beyond differences in income; it is also related to the level of access to basic services (for example drinking water, drainage system, energy, domestic waste collection, well-built houses and access to housing). There are differences between countries in basic services coverage. In Brazilian Amazonia there has been an improvement in water supply from 48% in 1990 to 68% in 2005, as well as in sanitation coverage from 33% to 48% during the same period (IPEA 2006, taken from Celentano y Veríssimo 2007).

In the Andean-Amazonian region, the deficiency in drinking water supply and drainage services is a common denominator in the countries and affects more than 4 million people. Sixty-one percent of the population does not have drinking water and 70% have no drainage (Nippon Koei, Secretary General of the Andean Community [SGCA] and Water and Sanitation Programme [WAP] 2005.

Besides limiting their quality of life, the lack of basic services available for marginalized citizens, affects local environmental quality by increasing water and soil contamination and damaging flora and fauna. Marginalized groups are generally the first to be affected by environmental degradation; for example, the proliferation of mosquitoes that transmit malaria, yellow fever and dengue fever, causes a strong impact on human health and the population's quality of life.

ENRIQUE CASTRO MENDÍVIL / PROMPERU

35%

OF THE POPULATION IN BRAZILIAN AMAZONIA LIVE WITH MEDIUM OR SERIOUS FOOD INSECURITY (2004)

4,000,000

PEOPLE IN COUNTRIES IN ANDEAN AMAZONIA SUFFER FROM DEFICIENT DRINKING WATER SUPPLY AND DRAINAGE SERVICES.

While the level of poverty in the Amazonian region is an important theme, the predominant perception among the indigenous peoples themselves, and acknowledged by most of their leaders, is that they are not poor but that they have a different life style, more in harmony with nature, even though in western eyes this may be seen as a synonym for poverty. These populations are usually found among the most vulnerable groups of society. As in other cases, poverty implies unemployment, malnutrition, illiteracy (especially amongst women), environmental risks and limited access to social and sanitation services, including health services in general (OEA 2000).

ENRIQUE CÚNEO / EL COMERCIO

Children vaccination helps to prevent diseases and to reduce infant mortality.

IN ECUADOR THE INFANT MORTALITY RATE WAS

39.5

FOR EACH 1,000 LIVE BIRTHS.

HEALTH

The condition of the population's health depends on sanitary and hospital infrastructure facilities, but most importantly on the availability of medical personnel to attend to the population's needs. In general, health services in the Amazonian region are limited in comparison to health services in other areas. The vulnerable population is, therefore, more likely to get gastrointestinal and respiratory diseases because of water and air pollution, respectively, as well as those that are extended by different environmental conditions such as malaria.

Historically, the productive booms in Amazonia and the attraction of migrants have unleashed epidemics that have affected the local, and especially the native, population unprotected by any type of vaccination. The health of migrant settlers is also exposed to tropical diseases associated with the forest's ecosystem. Recent studies in Iquitos (Peru) have shown that, because the malaria vector abounds on land where there is stagnant water which is a characteristic of recently deforested areas, malaria transmission is greater in deforested areas (Vittor and others 2006).

In a recent publication on the situation of Brazilian indigenous peoples, the *Instituto Socioambiental* (ISA) of Brazil pointed out the increase in the number of deaths caused by infant malnutrition in Mato Grosso as well as the resurgence of malaria in Roraima. In addition, a greater incidence of cases of tuberculosis has also been detected, an epidemic present in various indigenous tribes (ISA 2006b).

DANTE PIAGGIO / EL COMERCIO

A growing population and a greater need for health.

LINO CHIPANA / EL COMERCIO

The state and international agencies help to improve the living conditions of the Amazonian population.

TABLE 2.4
Brazilian Amazonia: health and the environment

DISEASE	NUMBER OF CASES PER 100.000 INHABITANTS
AIDS	From 1,2 in 1990 to 12,4 in 2004
MALARIA	From 3,3 in 1990 to 2,0 in 2004
TUBERCULOSIS	From 73 in 1990 to 48 in 2004

Source: Aragón (2005).

The rate of infant mortality is an indicator related to families' socio-economic, nutritional and sanitary conditions such as access to health services, in a context in which there could be preventive management of a large number of the factors that increase infant mortality. There has been a remarkable improvement in this indicator in Brazilian Amazonia. The infant mortality rate in one-year-old children fell from 51 to 36 deaths for each 1,000 live births between 1991 and 2000. There was even more of an improvement in the case of the infant mortality rate in children under 5 years of age, which dropped from 67 to 46 deaths for each 1,000 live births (Celentano y Veríssimo 2007).

In Ecuador in 2001 the rate of infant mortality was 39.5 for each 1,000 live births (Instituto para el Ecodesarrollo Regional Amazónico, 2006). It is pointed out that in the state of Amazonas (Venezuela) there is limited public investment in this area and that diarrhoea is the principal cause of medical consultations (Aragón 2005).

Diseases recorded in the Amazonian zone, in general with a different degree of incidence in each country are: AIDS, malaria, dengue fever and tuberculosis. The increase of the number of cases of malaria in urban areas is significant (Table 2.4).

ENRIQUE CÚNEO / EL COMERCIO

EDUCATION

The illiteracy rates, although they vary in each country, are considered high in the Amazonian region. For example, in Bolivia and Ecuador 12% are illiterate while in Venezuela, it is 93% of the population of 10 years of age or more who cannot read or write. In Brazilian Amazonia there has been a reduction of 7 percentage points between 1990 and 2005 in the illiteracy rate which corresponds to a drop from 20% to 13% in the population older than 15 years. There was also an increase in the number of years spent in school, from 4.1 years in 1990 to 5.9 years in 2005. In addition, the participation of children from 7 to 14 years in basic education improved from 85% in 1990 to 96% in 2005 (Celentano and Veríssimo 2007).

It is worth noting that in Guyana the level of education in poor homes is lower than the educational level of the total population. Less than 15% of heads of poor households have finished secondary school or higher levels of education. In rural areas school attendance is low. The situation is worse in interior regions where less than 13% of poor households have finished secondary school. In addition, 41% of households below the poverty line are engaged in agricultural activities (Guyana; Environmental Protection Agency 2007).

It should be stressed that educational conditions are substantially worse for the indigenous population, making clear the restrictions faced by this population group on having access to the service and its poor quality. As previously explained, this limits a highly vulnerable population from developing capacities (Hall and Patrinos 2004).

Precarious infrastructure limits children's ability to learn.

JUAN PONCE / EL COMERCIO

Poor quality of education and conditions that make school attendance difficult, particularly by the indigenous population, are problems that urgently need to be overcome.

Another important educational challenge in Amazonia is the development of programmes consistent with the local reality that allow this complex and rich region to be understood from a holistic point of view. On the other hand, it is important to monitor the quality of the service in terms of school dropouts and skills learned. To do so it is necessary to have information systems that will permit adequate follow-up on how the education service performs.

JUAN PONCE / EL COMERCIO

Children make every effort to get to school.

ENRIQUE CÚNEO / EL COMERCIO

«

Livestock expansion stimulates land use change and affects ecosystem services.

2.2 | ECONOMIC DYNAMICS

Throughout the past 50 years Amazonia has been occupied by different human groups that have used its natural resources like rubber (until about 1945). More recently, Amazonia has been explored in search of mineral resources such as petroleum, gas and metals. The population making a living from mining is increasingly important in the region; the *garimpeiros* or informal gold miners are a reality that cannot be overlooked. Forest and hydrocarbon exploitation is also an important source of jobs and foreign currency; as a consequence of these activities, in recent years the communications infrastructure has grown significantly.

In general, all economic activities carried out in the Amazonian region have put pressures of different magnitudes on its natural resources. An analysis follows of the trends, in recent years, of the main productive activities in Amazonia: agricultural and livestock activities, forestry, mining and energy activities, and the development of the road infrastructure.

AGRICULTURAL AND LIVESTOCK EXPANSION INCREASES

Starting in the 1970's governments in different countries began building large road and development projects towards and in Amazonia, promoting migration of small-scale farmers by giving them various types of subsidies. At the same time, large properties were installed in Amazonia, mainly in Brazil, and also encouraged by state policies. With the passage of time, both of these situations had impacts on Amazonia that are now visible such as the "fish bone" type of deforestation in Rondonia, Acre and Roraima in Brazil; the pattern of deforestation with its epicentre close to Santa Cruz in Bolivia; and the less organized but highway-linked type of deforestation close to Pucallpa and Iquitos in Peru.

There are different types of agricultural activities (more details on agroproductive systems are given in Chapter 3). Some agricultural areas are dedicated to a large extent to self-sufficient crops, mainly cassava, maize, rice, beans, bananas and different native or introduced fruits, while agro-industrial crop areas grow African oil palms, cocoa, annatto, fibres, tea, coffee, and others. More recently, the consolidation of the complex of grains (soya, rice, sunflower, sorghum and maize),led by Brazil, and that is gradually taking place in Bolivia, is rapidly expanding the agricultural frontier towards the interior of Amazonia (Soya *in Bolivia* 2005, Working Unions and the Environment in Latin America and the Caribbean 2005, Pasquis 2006). As far as livestock is concerned, Brazil is one of the countries where the growth of cattle raising has been most rapid; in 1990 there were 26 million head of cattle in Brazilian Amazonia and in 2006 the figure was 73.7 million.

The low efficiency of the land used for agriculture and livestock in Amazonia is worrying. There is a very high rate of land abandonment in sectors of Bolivia and Peru. According to Antonio Brack Egg (1997), between 0.8 and one million square kilometres of Amazonian forest land have been colonized or occupied; of this 40% is farmland and forest and 60% land that has been abandoned and covered with secondary or degraded forests. This is because farming systems that have been introduced on forest soils have transformed the forest into crop and grassland zones. In the south-eastern part of

The low efficiency of the land used for agriculture and livestock in Amazonia is worrying.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

CONSERVACIÓN INTERNACIONAL

Many sectors of the Amazonian forest are cleared for market farming without the respective permits or care for the environment.

DANTE PIAGGIO / EL COMERCIO

Cultivating coca has deep roots in the high forest and forest edge (yungas) in Bolivia and Peru.

Soya is one of the agro-businesses which, in recent years, has grown more and received more investments.

Brazilian Amazonia there are some 500,000 km² of degraded lands of which 15% are abandoned (Brazil: Ministerio del Medio Ambiente 2004). In Amazonia pasture production is unsuited to the region's ecological conditions. In foothill and lowland forests are deforested to make way for livestock farming, extensive agricultural and timber extraction expansion.

Soya is one of the agrobusinesses which, in recent years, has grown more and received more investments, and the trend is that demand will increase because of the need to provide balanced feed for birds, pigs, fish, among others, as well as for a growing world population. For example, in the Mato Grosso region soya covers more than 5 million of Brazil's total soya production which is of 21 million hectares. Cotton production in that state has also shown strong growth with a significant increase from 1,390 kg/ha to 3,302 kg/ha. This expansion in soya production on savannah and forest land encourages farmers and cattle ranchers to penetrate deeper into the forest in search of new land. It should be noted that, according to Nepstad and Campos (2006), commercial markets have recently begun to demand more legality and better administration for the entire Amazonian production meat chain and grains so as to provide incentives to conserve the tropical forest. The development of extensive agricultural activities in the eight countries of the region has resulted in more deforestation which in Brazilian Amazonia has meant an accumulated increase in the surface deforested from 41.5 million hectares in 1990 to 58.7 million hectares in 2000, most of which ended up as grassland. However, it must be stressed that while livestock farming causes 75% of deforestation, soya is only responsible for 5% although its increased production is a potential threat.

Similarly, the boom caused by some monocultures such as rice and sugar cane in the Beni and Santa Cruz area in Bolivia has been an important factor in the loss of forest land and this, together with the use of agrochemicals (fertilizers, pesticides and herbicides) has accelerated deforestation of large forest zones in the Amazonian provinces of Napo, Sucumbíos, Morona Santiago and Pastaza in Ecuador.

Another recent trend that is now affecting the countries of Amazonia, and could affect them even more, is the production of biofuels (biodiesel and ethanol for example) mainly derived from organic products such as maize and sugar cane. The raw material for biofuel production requires intensive agriculture which implies the extensive use of fertilizers, pesticides and machinery, with less intensive agricultural methods, more land would be required and costs would be very high. While Brazil is the main world sugar and sugar cane ethanol producer and exporter, Legal Amazonia is responsible for less than 3% of the national sugar cane production with an annual production of 30 million tonnes and 17,500 million litres respectively. The main argument in favour of introducing biofuels is that they would help reducing the emission of greenhouse gases. On ther other hand, recent studies (Russi 2007) show that the savings in energy and CO2 are not so high. It is still not clear what the costs and benefits of biofuel production might be (Ballenilla 2007).

IN COLOMBIA THE COCA GROWING AREA MULTIPLIED BY

4.5

IN A 19-YEAR PERIOD.

Coca is an ancestral crop which grows in the high forest and forest edge zones (see Chapter 1) where the poppy has also been cultivated; both are now mainly used to produce narcotics. Coca production is concentrated in Bolivia, Colombia and Peru and has increased in recent years compared to 2003 which saw the lowest area of coca cultivation in the period between 2000 and 2006. In Colombia, the 15,500 hectares of coca cultivation in 1985 rose to 85,750 in 2005. This means that the country's coca crop surface multiplied by 4.5 incrementally over a period of 19 years (Colombia: Instituto Amazónico de Investigaciones Científicas 2007).

The ecological impacts of coca cultivation and the production of the drug are: heavy soil erosion due to poor management and establishing crops in steep slopes (that should function to protect the forest); inva-

FIGURE 2.4
Coca cultivation in Andean-Amazonian countries (hectares)

Source: UNODC (2007).

sion of protected areas and destruction of unique ecosystems and their biodiversity; and serious pollution of water courses due to the use of large volumes of various toxic substances to prepare the drug, especially the basic cocaine paste. It is estimated that the deforested areas in Bolivian, Colombian and Peruvian Amazonia varies between 200 and 500 km^2 because of the effect of illicit crops, depending on the year assessed and the source consulted (Sistema Integrado de Monitoreo de Cultivos Ilícitos [Simci] II 2005). To the above must be added pollution caused by ongoing fighting drug trafficking or by prevention programmes that use herbicides. For example, in Colombia fumigation, for which gliphosato is mainly used, caused coca cultivation to be expanded to zones where it had not previously existed, thus increasing deforestation and pollution (United Nations 2007) (Figure 2.4).

UNSUSTAINABLE FOREST ACTIVITY

When well managed, forest activity is not a threat to the state of the resources in Amazonia. Many Amazonian countries have norms that regulate access to forest resources and determine the requirements for sustainable forest management. However, for various reasons the norms are not complied with, These actions resulted is the loss of forest cover which has led to some economic operators defining forest exploitation in Amazonia as a type of selective, opportunistic and anarchist activity that has resisted all kinds of efforts to be regulated and to apply forest management practices (Dourojeanni 1998). In this context, only a very small proportion of the deforestation of the Amazonian forest is due to forest activities.

The pressure of timber exploitation on the forest may lead to the extinction of species that have a high economic value (Tabarelli and others 2004). Cases have been documented where deforestation has been caused by a cycle of economic growth being followed by a collapse of the activity. In Brazil, during a phase of economic growth, timber exploitation produces significant incomes for the municipalities and creates direct and indirect jobs. Such incomes disappear when species of commercial value become scarce making the timber merchants migrate to other municipalities and affecting other local economies (Schneider and others 2000). In these cases ecosystem services (biodiversity, water cycle, among others) are also lost.

Forestry production trends vary according to each country. The indicator of volume produced (round wood) in Brazil, as reported by the Amazon Institute for People and the Environment (IMAZON), shows 24.5 million m^3 in 2004, with a downward trend since 1998. In Bolivia, annual production is approximately 500.000 m^3 and in Peru it is of 1.8 million m^3. Unmanaged forest exploitation will rarely cause species to become extinct, on the other hand, it can cause many species to become rare and lose their commercial value.

Logs seized in operations against logging and illegal trade in forest products.

"We are in favour (of the highways) if there is a policy to preserve the forest that will encourage agriculture and prevent land ownership being concentrated in the hands of very large owners".

CHICO MENDES, PRESIDENT OF THE RURAL WORKERS' UNION OF XAPURI, ACRE, ASSASSINATED IN 1988.

A recent phenomenon of forest exploitation in Amazonia is the arrival of large-scale foreign investors, mainly Asiatic, to carry out massive forestry exploitation. This process began in Suriname and Guyana but quickly expanded to Brazil (Traumann 1997) and the other countries in the region; which represents a cause of great concern because not all the enterprises offer management guarantees (Sizer and Rice 1995). Another problem associated to large lumber companies is that extensive areas of Amazonia are opened up and will probably be invaded by landless *campesinos* leading to the consequent acceleration of the region's deforestation.

It must be pointed out that most Amazonian countries give forestry or private property concessions governed by sustainable forest management norms. In Bolivia, for example, there are 2 million hectares of certified forests; and in Brazil there are 1.8 million hectares. However, it can also be seen that the lack of supervision and control results in cases of unsustainable forestry practices, land on which small-scale illegal loggers, whose activity is very difficult to control, cause the most pernicious negative impacts on the Amazonian forest.

Illegal logging, just like any other ecological offence, is a problem that has economic, social and environmental repercussions that threaten government efforts to achieve good natural resource management. Illegal logging, in practice, is also a disincentive for those countries, owners or forestry companies that have decided to invest in sustainable management of their forestry resources and do not receive a better market price because of the oversupply of cheap but illegally extracted timber. This is an alarming situation in Amazonian countries where sometimes the authorities do not have the capacity to control and supervise. According to figures provided by INRENA and the Multisectorial Commission

ENRIQUE CÚNEO / EL COMERCIO

Artisan techniques used for informal mining contribute significantly to water and soil pollution.

Against Illegal Logging (CMLTI), in 2005 in Peru it is estimated that each year more than 221,000 m^3, or 15% of national production of illegal timber is extracted with a value of US$44.5 million (World Bank 2006).

The demand of the Forest Stewardship Council (FSC) for certification of international trade in forest products is the main incentive to get rid of illegal logging. However, approximately 70% of the wood logged in Amazonia is for the domestic market (Rodríguez 1995); although in Peru, due to the change of regime on the use of production forests, recent years have seen growing trends in the volume and value exported, from US$45.3 million in 1997 to US$169 million in 2005 (World Bank 2006).

MINERING AND ENERGY: NEW SOURCES, MORE PRODUCTION

Mineral and energy resources are widely distributed throughout the Amazon basin where gold, bauxite, zinc, coal, manganese and iron, as well as a large amount of minor minerals, are found. Amazonia also has large oil and natural gas reserves, many recently discovered. In addition, the enormous water resources of Amazonia make it possible to generate the hydroelectric energy needed for the growth of economic activity.

Mining

Mining has been, and continues to be, a significant threat to aquatic and land ecosystems in the Amazon basin, especially in the Guyana Shield, in the Andean mountains of Bolivia and Peru, and in the Colombian foothills. Small-scale gold mining is the most extended and destructive given that large scale industrial operations may be subject to more regulation. Mercury pollution from gold mining now appears to be minimum and local in the Amazonian tributaries; however, in some rivers with high acidity and a small amount of sediments, this may cause more serious problems by increasing sedimentation and altering the streams' natural courses. (Franco and Valdés 2005, USAID 2005).

In the Amazon basin, gold is found in the Brazilian and Guyana Shields where it is mined from alluvial deposits in the large rivers and streams. In Brazil the principal gold producing regions, with large enterprises and *garimpeiros*, between 1960 and 1990 were in the northern part of Mato Grosso, along the banks of the Tapajós, the garimpo in Sierra Pelada in Pará and the state of Amapá. In Ecuador gold and copper production are taking place in the provinces of Morona Santiago and Zamora Chinchipe. It is estimated that mining companies have concessions in 40% of the territory in Morona Santiago where there are

TABLE 2.5
Oil mining activity in Amazonia (2006)

COUNTRY	PETROLEUM PRODUCTION (BLS/YEAR)	PRINCIPAL PRODUCTION AREAS
COLOMBIA	4,611,786	PUTUMAYO
BOLIVIA	2,744,161	SANTA CRUZ
BRAZIL	16,753,500	URUCU (AMAZONAS)
ECUADOR	182,693,891	SUCUMBÍOS, NAPO, ORELLANA, PASTAZA
GUYANA	-	-
PERU	16,500,615	UCAYALI, LORETO
SURINAME	4,800,000	-
VENEZUELA	-	-
TOTAL	243,822,237	-

Sources: Ministry of Mines and Energy of Colombia <http://www.minminas.gov.co>, Ministry of Mines and Energy of Brazil <http://www.mme.gov.br>, Ministry of Mines and Energy of Ecuador <http://www.menergia.gov.ec>, Ministry of Energy and Mines of Peru <http://www.minem.gob.pe>, Ministry of Hydrocarbons and Energy of Bolivia <http://www.hidrocarburos.gov.bo>.

Mining is a significant threat to the aquatic and land ecosystems of the Amazon basin.

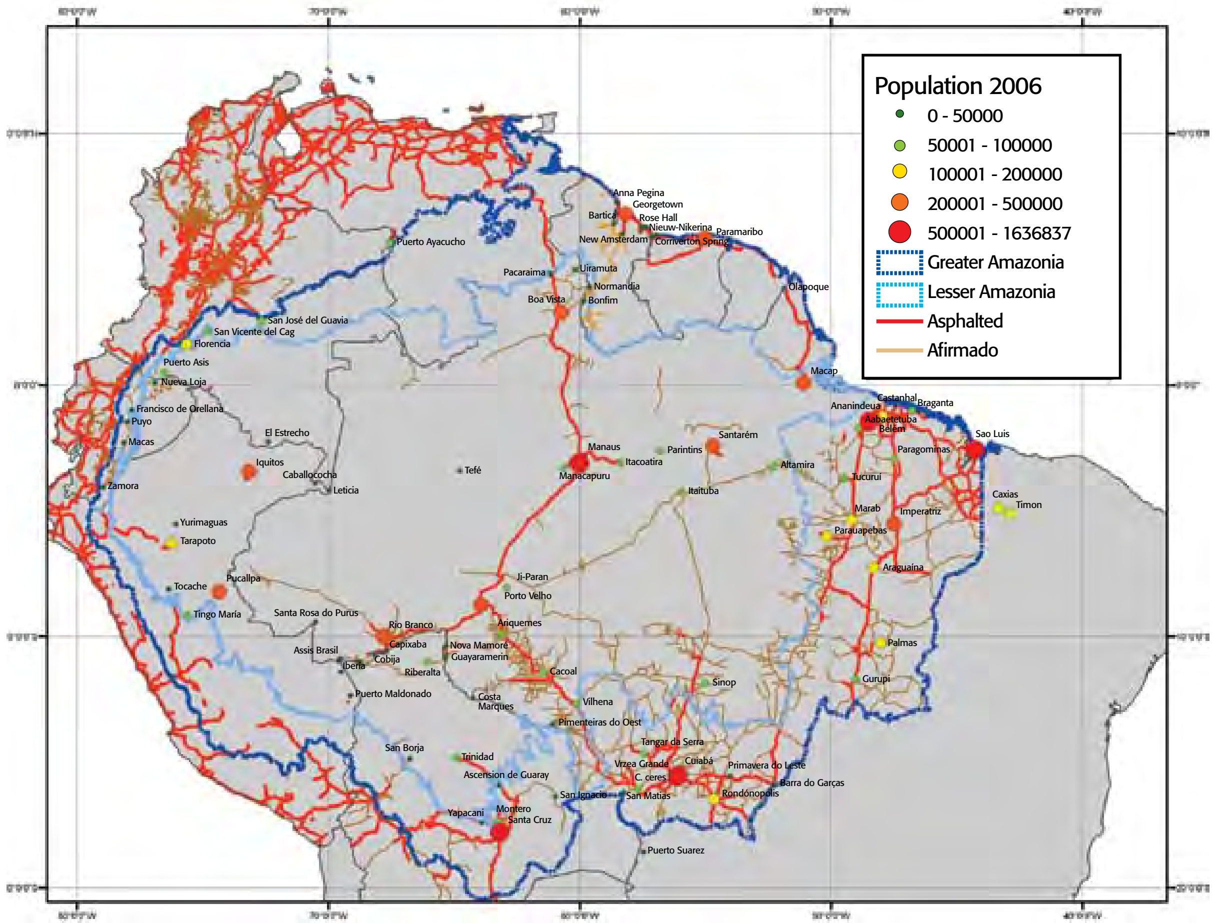
serious conflicts between them and indigenous communities over using and polluting water sources. It is calculated that there may be between 100,000 and 200,000 *garimpeiros* in Colombia, a similar number in Peru and double that number in Brazil (Instituto Socioambiental [ISA] 2006).

Gold production in Brazilian Amazonia has declined since the beginning of the 1990's; however, it has become more extensive in the Madre de Dios (Peru) high basin and in the highlands of the Beni region in Bolivia. Today there are thousands of small-scale gold miners in the Madre de Dios high basin; this has become an environmental problem because of mercury pollution of the water, the diversion of the current by using artisan methods and by washing heavy metals. However, it is also possible that, for natural reasons, the concentration of mercury is higher in the basin of the Madre de Dios river than in other regions to the east of the Amazon basin due to intense erosion in the Andes. In the case of fishing, as mentioned in Chapter 3, mining activity particularly affects the large catfish that are found between the Amazon estuary and the Andes foothills (TCA 1995; Barthem and Goulding 1997; Goulding,and others 2003a).

Clandestine mining is also carried out along the border between Brazil and Venezuela (while there is no hydrocarbon exploitation in Venezuelan Amazonia there is artisan mining as well as large-scale bauxite mining). Levels of mercury contamination in much of the fish eaten by the population in these places are above the Brazilian legally recommended consumption limit (Goulding, and others 2003b; Barthem 2004). There are gold mining problems along the border between Colombia and Brazil and arsenic pollution in Ecuador.

In Guyana, large mining enterprises with foreign capital are the only ones that produce diamonds while gold and bauxite are mined by small and medium size companies. There is very dynamic foreign investment in mining. Canadian enterprises have entered this market although there are also Australian and Brazilian companies. On a small scale, the *garimpeiros* who come from Brazil also exert heavy pressure on Guyana's Amazonian region.

MAP 2.2
Main highways in Amazonia



Source: Original GEO Amazonia production with the collaboration of UNEP/GRID – Sioux Falls and the University of Buenos Aires, with data from Bolivia: Conservation International and INE; Brazil: IBGE; Colombia: CIAT and DANE; Ecuador: INEC; Guyana: EPA; Peru: INEI; Suriname: General Bureau for the Statistics; and Venezuela: National Statistics Institute.

ENRIQUE CÚNEO / EL COMERCIO

The case of Suriname is not much different where small-scale gold mining has a long history. The large-scale silver mining has not succeeded in this country because the lack of highways makes production expensive. In addition to the *garimpeiros*, there is also *"porknokking"* mining (see description in Chapter 1) that is carried out by the Maroons and, just like in Guyana, it results in serious contamination problems from the use of mercury. In Suriname Canadian capital predominates in mining with important concessions in the Brokopondo district.

Petroleum extraction

Although petroleum is found throughout the basin, most of the exploitable deposits are in western Amazonia and the largest oil and gas fields are close to the Andes in Colombia, Ecuador, Peru and Bolivia. Commercial petroleum extraction in Brazilian Amazonia is basically restricted to the region of the Urucú river, a tributary of the Coari river from where it is pumped to the banks of the Tefé river (natural gas is also extracted from the Urucú). The largest oil refineries in Amazonia are found close to where the Amazon and Negro rivers converge in Manaus. Very little is known about the impact of oil pollution in the Amazon.

Peru, Colombia and Ecuador have oil pipelines from the oil fields to the refineries in the Andes and the Pacific coast. For example, the Yanacu Terminal on the Marañón river to the north of the Pacaya-Sasmiria reserve, is the beginning of the oil pipeline in the north of Peru that transports crude oil from Amazonas across the Andes. There is only one oil well in Pacaya-Samiria, and the government has rights to exploit two areas in the reserve. In Guyana the only information available reveals that oil exploration programmes are being carried out in the Takatu river basin (TCA 1995; Goulding and others 2003a). As it can be seen in table 2.5, Ecuador is the country with most oil production in the Amazonian region (74.9% of total production). The greatest petroleum activity is in the provinces of Sucumbios, Napo, Orellana and Pastaza, places that also have great human and natural diversity. Unfortunately, the environmental impacts of petroleum activity have not been properly controlled and oil spills and other types of pollution are a threat to the forest and its inhabitants.

Oil and gas reserves are found in some of the most sensitive ecological areas. A clear example of this is the superimposition of oil exploration lots on protected areas. In Peru hydrocarbon operations are taking place in some protected areas such as the Pacaya-Samiria National Reserve, the Machiguenga Communal Reserve and the Pucacuro Reserved Zone. Eleven lots are also being offered for petroleum exploration in protected or buffer areas (Peru: Defensoría del Pueblo 2007). This situation reflects the great pressure of the oil industry on the Amazonian ecosystem.

While some of these petroleum exploration areas were discarded in the past because they were inaccessible, at present the high prices of oil and gas justify reactivating the exploration work. The proper balance between hydrocarbon exploration and exploitation and the conservation of critical ecosystems is only feasible by establishing strict and specific environmental conditions, including strengthening national regulatory frameworks and guaranteeing benefits and compensation for affected areas and local populations.

Natural gas reserves in Amazonia are a rather recent discovery. The Camisea gas deposit in Peru is one of the largest energy projects in South America. This mega-investment of

BOX 2.2

ENERGY IN BRAZILIAN AMAZONIA

Brazil gives priority to hydro-electricity as an electric energy source. At present it has 90,732 MW of electric capacity installed and in 2004 hydraulic generation represented close to 94% of total electric energy consumption. Brazil has accumulated plenty of technological capacity to build large reservoirs. Since the 1980's it has gained experience in managing energy complexes and has created an institutional base that guarantees participation by those affected by and interested in decision making. Brazilian Amazonia has a water source energy potential of 112,039 MW, 43% of the national hydroelectric potential of which only 10% is being used.

With respect to socio-environmental aspects related to its reservoir construction programme, Brazil has advanced legislation, an organized civil society and a Public Ministry careful to minimize the negative consequence of its implementation. In addition, complex management methods have been established in the affected areas. It is, therefore, very probable that hydroelectricity will continue to be the principal source of electric energy for Brazil and that Amazonia will be the supplying region. A notable Brazilian initiative in the energy field is the use of biofuels produced from sugar cane. Brazil produces 32 billions litres of alcohol a year, half the world's alcohol production.

Source: Prepared by Marcos Ximenes Ponte, Amazon Institute for Environmental Research (IPAM)

TABLE 2.6
Principal hydroelectric complexes in the Amazon basin

COUNTRY	HYDROELECTRIC COMPLEXES	RESERVOIR AREA (km^2)	INSTALLED POWER (MW)
BRAZIL	SERRA DA MESA	1,784	1,275
	CANA BRAVA	139	465
	SÃO SALVADOR	104	243
	PEIXE ANGICAL	294	452
	IPUEIRAS	934	480
	LAJEADO	626	902
	TUPIRANTIS	370	620
	ESTREITO	590	1,087
	SERRA QUEBRADA	386	1,328
	MARABÁ	1,115	2,160
	TUCURUI	2,430	TUCURUÍ I 4,200* TUCURUÍ II 8,370
	COARACY NUNES	23	68
	SAMUEL	579	216
	BALBINA	2,360	250
	TOTAL BRAZIL**	11,734	13,746
SURINAME	AFOBAKA	1,560	100

*Total capacity
**Total with reference to hydroelectric complexes in this table
Sources: Adapted from the Water Resources Strategic Plan of the Water Basin of the Tocantins and Araguaia rivers. In: Agencia National del Agua (2006); Goulding and others (2003a) Namuncura (2002); Lopes and Cardoiso (2006)).

The hydroelectric complex of the Madeira river will have a very great impact on fish, fauna and flora, the population, sediments and the spread of tropical diseases.

US$1,400 million pumps the natural gas from deposits situated at a depth of 4,000 metres in the lower Urubamba forest. In Bolivia there are also gas reserves that may supply energy to countries in the region which in the future could imply that Amazonia will have to undertake infrastructure projects for the trade of this product.

Hydroelectric Complexes

Building dams to generate hydroelectric energy and reservoirs for different reasons (agriculture, mining) has not changed the region's water flow, but it has the potential to modify the water discharge cycle. At present there is no proof of annual reductions in Amazonian rivers' discharges. Brazil is the only Amazonian country that has built large reservoirs of which the largest are the Tucuruí and the Balbina (Goulding and others 2003a), although in Ecuador proceedings are under way to build nineteen new water projects including the Negro river, Anisa, Zamora and Hidrobanico (the latest is now being implemented). Many of these projects are associated with mining development.

Research has been carried out on the Tucurui, the largest existing dam in Amazonia, about this activity's environmental impact. The results show the variable and complex effects on local fishing; it has been found that there are more risks of fish populations disappearing close to the river's waterfalls (USAID 2005).

It should be mentioned that the largest hydro energy project in Amazonia is the Hydroelectric Complex on the Madeira river which, if it becomes a reality, will dam the basin's second largest river. Because of its characteristics and Andean origin, the Madeira river carries half of the basin's sediments and drains one of the world's regions with the greatest physical and biological diversity. The Madeira river is shared by three countries: Bolivia, Brazil and Peru. The government of Brazil has now issued a licence to build the Santo Antonio and Jirau dams. Studies on the environmental impact of the two downriver dam complexes in Brazilian territory identified the very serious impacts they would have on fish, fauna and flora, the population, sediments and the spread of tropical diseases.

Paludismo and schistosomiasis, that already exist in the region, are impacts caused by the reservoirs that directly affect the population. The experience of other large reservoirs in the Amazonian region, such as the Tucuruí, gives the impression that they might increase the habitats of these diseases' vectors (mosquitoes and molluscs) (Fobomade 2005). Building reservoirs implies flooding large areas; for example, in Suriname the construction in 1963 of the Afobaka dam meant flooding half the Saramacca territory (about 1,560 km^2 of tropical forest) and displaced 6,000 people.

Local efforts are being made in isolated communities in Brazil to use alternative energies such as solar panels. The combination of energy needs and the protection and conservation of important biodiversity areas has presented the energy industry and the conservationist community with new challenges. In the Amazonian countries there is a demand to modernize and expand their economies and, due to the potential of petroleum and gas resources to meet international demand, new foreign companies are showing increased interest in investing.

EXTENDING THE ROAD INFRASTRUCTURE

The existence of immense natural resources in Amazonia creates the need to develop projects to take advantage of them. In this respect, large energy, transport and communications projects are a growing trend.

Concerning road infrastructure, in particular, 1975 Brazilian Amazonia had 29,400 kilometres of roads; in 2004, almost 30 years later, there were 268,900 kilometres. In the past two years Brazil has registered two road infrastructure projects with Bolivia, four with Peru and one with each of the other countries. In each Amazonian country there are also numerous new highway projects, or projects to improve already existing highways, at a total cost of many thousands of millions of dollars which, it is expected, will be provided by public and private capital.

The most notable case of road infrastructure development in Amazonia is in Brazil and, to a certain extent, it reflects what is happening in the other countries. In Brazil, the 1970 National Integration Plan resulted in a great change in the region's infrastructure, not only on roads but also on building ports, airports and the beginning of a complex communications network.

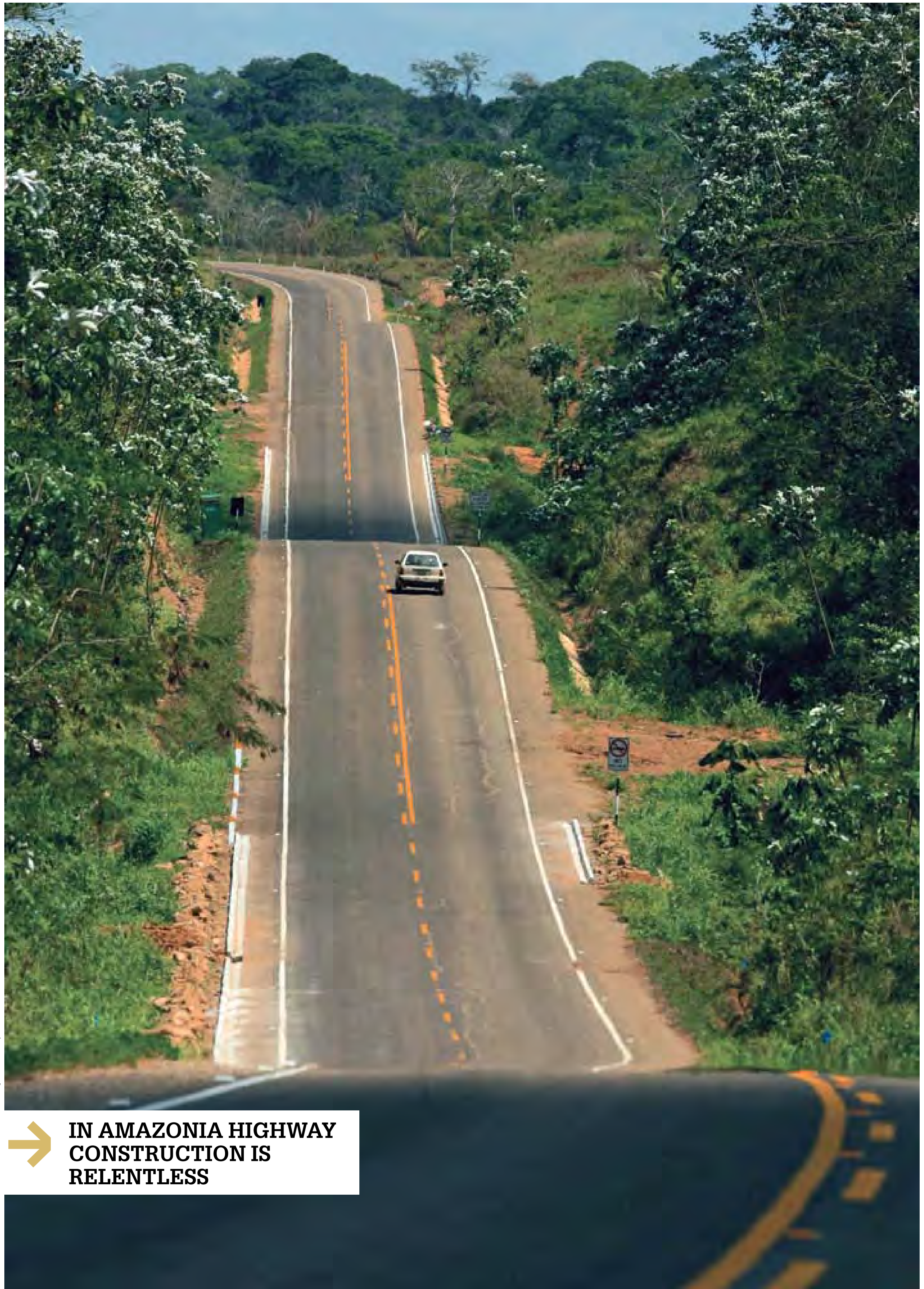

SERGIO AMARAL / OTCA

New roads, more development?

Besides building the highway between Belén and Brasilia, road density was high in Marañón and Tocantins, in east Pará, Mato Grosso and Rondonia. The first roads were poorly built by farmers and lumberjacks and, later, the municipalities and states converted some roads into paved highways, although many still remain unpaved.

Most of the paved highways are in the states of Marañón, Pará and Tocantins, precisely where the large highway junctions that advance on Amazonia are located. In 1975, there were 29,400 km of highways in Brazilian Amazonia of which 5,200 km were paved and 24,200 km were unpaved. In 2004 highways covered 268,900 km of which 246,600 km were unpaved; that is to say, in almost thirty years the road network multiplied tenfold (Ximenes 2006). Given present trends, it can be foreseen that more highways will be constructed in zones where there are now few, such as the states of Amazonas and Acre, creating more pressure in years to come on Amazonian ecosystems and natural resources.

IN 1975 BRAZILIAN AMAZONIA HAD 29,400 KM OF ROADS; IN 2004, ALMOST 30 YEARS LATER, IT HAD INCREASED TO 268,900 KM.



IN AMAZONIA HIGHWAY CONSTRUCTION IS RELENTLESS

Because of their importance to the occupation of Amazonia, informal roads deserve a special analysis. Some informal agents build highways that cover thousands of kilometres on public land, especially in forest areas, without any planning or the authorizations required by law. In an study by IMAZON in the state of Pará, in the zone with the greatest concentration of illegal highways that give access to natural resources, it was shown that the extension of roads increased four times in a period of ten years, from 5,042 km in 1990 to 20,769 km in 2001. Most of them were built on public land, on reserves and in indigenous areas.

In order to reduce their impact, new projects must include social and environmental considerations. The Initiative for the Integration of Regional Infrastructure in South America (IIRSA), to promote infrastructure development with a regional outlook by physically connecting the countries of South America, is an ambitious multi-national programme financed by the Inter-American Development Bank (IDB), CAF *(Corporación Andina de Fomento)* and in part by Brazil and, for the first time, involving the twelve South American countries. It is the project aims to proceed to the construction of 300 highways, bridges, hydroelectric complexes, gas pipelines and other infrastructure works. According to Killeen, if the total impact of IIRSA investments is not anticipated, a combination of forces will be unleashed that will result in a perfect torrent of environmental and social destruction in Amazonia, in addition to putting at risk the survival of indigenous communities that try to adapt to a globalized world. IIRSA might intensify the factors that endanger the survival of Amazonia such as climate change, timber exploitation and clearing forests for land to grow crops (Killeen 2007).

It is indisputable that highways are an instrument for development. The problem lies in the way the territory is planned. Amazonian history is full of ecological and social disasters and, in many cases, economic disasters, associated with the highways: the Marginal Forest Highway in Peru or the BR-364 in Brazil and many dozens more (Dourojeanni 1998).

BOX 2.3

BRAZIL: SUSTAINABLE BR-163 HIGHWAY PLAN

The Regional Sustainable Development Plan for the BR-163 highway, area of influence on the stretch between Santarém and Cuibá, was prepared to guarantee sustainable development and avoid the negative impacts of processes that historically have accompanied asphalting highways in Amazonia. The plan is based on the experience of the Pilot Programme to Protect Tropical Forests in Brazil – PPG7 and is in accordance with the principles of the Sustainable Amazonia Plan. This highway will benefit one of the areas of greatest economic potential and social and biological diversity in Amazonia. Traditional communities, urban and rural populations and more than thirty indigenous groups live in this region, a total of approximately two million people in an area that covers 24% of Brazilian Amazonia.

A group of twenty-one ministries and federal bodies, in agreement with state and municipal governments and with civil society, will define the action to be taken on the basis of established priorities. Fifteen public consultations have been held, given that the Regional Development Sustainable Plan and the government seek to strengthen participatory management policies to create protected areas, to highlight sustainable economic opportunities and to consolidate monitoring and environmental control policies with which it is hoped to reduce natural resources degradation.

As soon as the actions are implemented, many of the enterprises involved, as well as state governments and other government bodies, will intensify their control over agriculture and the transport of illegal timber products. The Ministry of the Environment, in association with the National Indigenous Foundation (FUNAI), is working to fight deforestation in the Xingú Park and on indigenous lands Kaiabi, Baú and Menkrangnoti. The region will benefit with the creation of 10.6 million hectares of conservation units. Other conservation units will be created by the governments of Amazonas and Pará with federal government support.

Investments will be made in road infrastructure and in electric energy networks. The government has also invested in ecological economic zoning of the whole area of influence of BR-163. Instruments will be developed to activate land use planning and environmental management in the area. The National Colonization and Agrarian Reform Institute (Incra), the Federal Highways Police and the Brazilian Environment and Renewable Natural Resources Institute (IBAMA) will be strengthened in the region. Also included in the joint operations plan are the Federal Police, the Army and others whose mission it is to disband groups that invade public lands and combat illegality and crimes in the region. Actions will also be taken to promote civil responsibility by means of social protection programmes for the poorest families, eradicating child labour and combating slave labour. The National Education and Agrarian Reform Programme (PRONERA) will also broaden its care networks in the region

Source: Prepared by Muriel Saragoussi, Ministry of Environment, Brazil

2.3 | LAND-USE CHANGE

Throughout history, the process of land occupation of the great Amazonian region is linked to socio-economic dynamics. The perception of Amazonia as a huge empty space with great risks and opportunities to develop various economic activities was an incentive to occupy the territory that did not take into account the interaction with native cultures or with fragile ecosystems. As a consequence of this, the accelerated changes in land use, mainly the significant forest loss, now attracts attention and causes concern.

More than fifteen years have passed since the publication of *Amazonia Without Myths* (Commission on Development and Environment for Amazonia 1992) that pointed out that one of the existing myths is that the Amazonia is empty. It is important to repeat and emphasize this theme in order to organize and control how land is used in the region. In this respect, it is pertinent to remember that the report says:

"It is common to refer to Amazonia as one of humanity's last frontiers and as an immense empty space that must be occupied. Some even think that it is a virgin region. These ideas are common in both countries outside the region, especially in the northern hemisphere, and in those in the region itself. The ones living outside the region are often interested in conserving Amazonia intact as a natural reserve for all humanity, forgetting that there are people living in the region who need to prosper. On the other hand, the nations living in the Amazonian region have considered it, and still consider it, to be one of the great possibilities to exploit natural wealth, to extend the agricultural frontier and clear peripheral zones, populating it with people who are unaware that it is already occupied by inhabitants who also have rights.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

Deforestation is the first step in intense land use changes in Amazonia.

Amazonia is neither a virgin nor an empty space where nature is in a pristine or in an intact state. It does not constitute an immense laboratory where the forces of nature act without human intervention. The region, in fact, has a long history of human occupation [...]" (Commission on Development and Environment for Amazonia 1992: 16-7).

Changes in land use in Amazonia are the result of an accelerated and disorganized occupation of the territory over time that has altered the Amazonian vegetation cover. The underlying factors causing land use changes include: regional productive dynamics such as expanding the agricultural frontier (principally driven by monoculture) and livestock activity; informal mining; illegal logging; the development of mega-projects (for example, reservoirs and highways) (see Section 2.2); incomplete normative frameworks (for example, poorly defined property rights); limited capacity to comply with norms and apply penalties; market incentives, and changes in the population's attitudes and values. The factors differ as to strength and relative importance in each country (see Chapter 1 and Chapter 2 Section 2.1).

The change in land use is the result of an accelerated and disorganized land occupation in Amazonia over time.

Given that soils have their own physical, chemical and ecological characteristics, the changes they undergo affect how their ecosystems function and, therefore, the goods and services they provide. Land use change has consequences on the availability and/or quality of natural resources and ecosystem services including: soil erosion and increased sediments in bodies of water; landscape fragmentation; the introduction of species and removal of native species; alterations in hydrological and biogeochemical cycles; air pollution; and deforestation, among others (see Chapter 3) (Coe 2008).

It has been reported that in most countries, only limited advance were made in implementing land use regulations as an instrument to organize local, national and regional sustainable development processes that help to make sustainable use of the territory as well as to reduce conflicts. Public policies promoting occupation of Amazonia were centred on developing a connecting highway infrastructure to give access to markets. It should be stressed that Brazil, through its Amazonia Sustainable Development Plan, is committed to implementing public policies that promote sustainable development in the region. Brazil began to promote the plan in 2000 and has undertaken to include transversal environmental management in public policies. On their side, Guyana and Suriname have areas where there is little or no exploitation; therefore, they both have the opportunity to plan and organize sustainable use of their resources on the basis of an integral, multisectorial and participatory approach which would allow a re-assessment to be made of the culture-nature and well-being relationship. In Colombia, as part of the process on the Amazonia 21 agenda, they now have the bases for the sustainable development of Colombian Amazonia.

The accelerated occupation of the territory, in an area characterized by the fragility of its ecosystems, has not only disturbed their balance but has also entailed socio-economic dynamics and led to demands being made that put pressure on environmental quality. For example, cities that are expanding without proper solid waste management systems improperly dispose of their waste in bodies of water or in the soil, thus affecting the provision of ecosystem goods and services.

On the other hand, the intensive operation of activities such as agriculture, mining and hydrocarbons, and the disposal of chemical waste, also affects the quality of bodies of water and the soil.

For example, in Peru between 1986 and 2006 in Huaypetue (Madre de Dios), a gold mining zone, the Amazonian forest landscape was converted into a desert landscape due to gold extraction (IIAP 2007).

FÁBRICA DE IDEAS

Increasingly, investigations are done on Amazonia and more publications are disseminated.

2.4 | SCIENCE,TECHNOLOGY ANDINNOVATION

Amazonia's natural wealth and culture makes the region very attractive as a space to promote scientific and technological development. In effect, scientists from outside the region often look on Amazonia as an open and easily accessible laboratory. In this respect, scientific and technological development is a driving force that can alter the availability and quality of the region's natural resources and environmental quality in addition to helping it to progress economically.

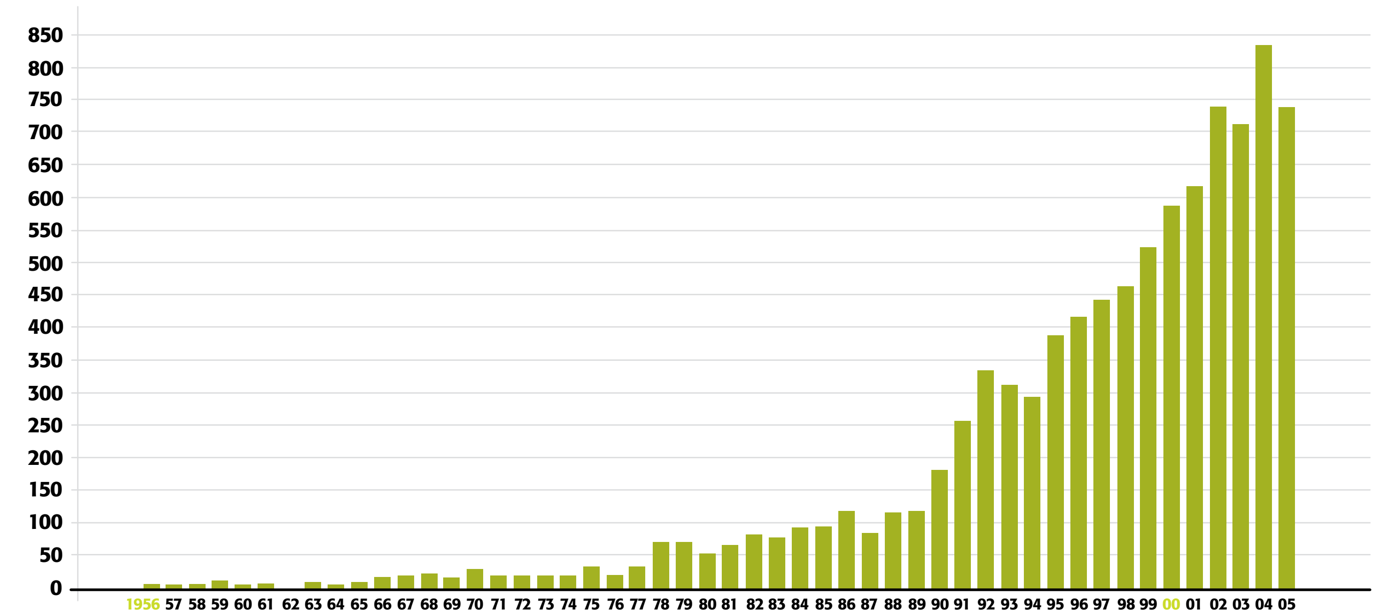
An indicator of scientific interest in Amazonia is the number of articles published in specialized journals or specialized scientific magazines. Since 1956 there has been a gradual increase in the number of articles and since the 1990's the increase has been significant (Figure 2.5).

More than 95% of the articles on Amazonia published in peer reviewed scientific journals listed in the Web of Science database were written in English, demonstrating the international academic community's interest of the in Amazonia. It is interesting to note that the number of articles published in Portuguese is more than double the number published in Spanish (GEO Tracking analysis).

Because Amazonia is an important megabiodiverse region, a vast number of studies have been carried out on diverse aspects of its biodiversity. For example, in the GEO Tracking database more than 50% of the scientific articles recorded refer to Amazonia and deal with themes such as ecology, environmental science, geoscience, and meteorology, among others. However, there is a growing demand to delve deeper into the characterization and nutritional assessment of prioritized species, vegetative growth and development, characterization of reproductive development, integrated application technology, designing commercial and marketing strategies, among other themes (Mantilla 2006).

Amazonia is not unconnected to the international scientific and technological developments that have grown significantly due to increasing demands by the agroproductive, food, cosmetics and pharmaceutical industries. Among other aspects, such developments have been directed at increasing crops productivity and reducing management costs. This has led to the production of better seeds and planting stocks, transgenic seeds, and agrochemical products. Some of these developments have taken place in Amazonia without a proper assessment being made of their impacts; for example, the use of agrochemicals in monocultures or the introduction of new forest or flora species. In addition, this scientific and technological development is associated with the registration of patents that protect intellectual property and, therefore, protect returns on private investment.

FIGURE 2.5
Published Articles per Year



Source: CLAES (2008)
Prepared for UNEP

Amazonia has made important contributions to improving knowledge and using different species of flora and fauna; new varieties of flora and fauna varieties have been discovered; and alternative methods have been developed that allow the soil to be more productive while conserving ecosystem services, among others. However, the challenge is to articulate and disseminate the results.

There are many scientific-technological institutions in Amazonia and the countries have specialized research institutes that develop collaboration and information exchange networks (Box 2.4).

In spite of inter-institutional efforts on coordination, independent initiatives predominate. Although important research work is carried out, there is limited dissemination, articulation and application. In order to socialize and capitalize research and to promote coordination and inter-institutional exchanges on regional scientific and technological development, the Amazon Cooperation Treaty Organization (ACTO) organizes regional and international symposiums, seminars and workshops. In 2006, for example, ACTO and the National Science and Technology Council (Concytec) organized the First Amazonian Scientific Symposium in Iquitos, Peru. The following were identified as being among the priority themes for the region: water management; breeding fresh water fish for human consumption (aquaculture); biotechnologies applied to the cultivation of plants of commercial interest and forest management; and biodiversity conservation (Concytec 2006). The organization is also in the process of formulating a Science and Technology Strategy for the Conservation and Sustainable Use of Amazonian Biodiversity.

> "Scientific and technological information is the key to innovative development in Amazonia."
>
> **ANTONIO BRACK (TAKEN FROM: ANTONIO BRACK. *LA BUENA TIERRA*)**

The lack of financial and human resources is a serious restriction to scientific and technological development. In many countries in the region the general science and technology budget is less than 1% of GDP and little priority is given in the public agenda to science, technology and innovation. To date, no information has been found on budgets to develop science and technology in the Amazonia.

Technological innovation on industrial production processes allows improvements to be made on the use of Amazonian products.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

In contrast, worth noting are the scientific, technological and innovation advances led by Brazil in the region on which the Ministry of Science and Technology (MCT), in coordination with other interested ministries, has organized an Amazonian Scientific and Technological Research Programme.

Furthermore, Brazil has the Brazilian Agricultural Research Corporation (Embrapa) which is linked to the Ministry of Agriculture, Livestock and Food Supply. The objective of this institution is to generate technology for the agroindustrial sector, and especially, to develop alternative technologies to improve the efficiency of agroproductive systems.

In addition, the development of robotics applied to different fields is advantageous in promptly identifying environmental problems and in reducing their social costs. In Brazil, Manaus is an important robotics development centre.

Scientific and technological development is making increasing use of the goods that nature provides, as well as of traditional knowledge, to develop new food and pharmaceutical and cosmetic products. However, local communities do not always participate equally in the benefits derived from using biodiversity and traditional knowledge. According to M. J. Balik's calculations, ethnobotanical identification made by members of indigenous communities may be four to five times more effective in detecting active compounds to develop drugs. It was also found that of a random sample of 10,000 species, only one specimen has potential commercial application; consulting with indigenous people, however, raises the probability of success to one in 5,000. Evidence shows that traditional knowledge reduces the time needed to develop products, as well as increasing the probability of their being developed (Chadwick 1990, taken from Belmont and Zevallos 2004)

Universities are also important actors in developing science and technology in Amazonia. One of the most studied subjects is the medicinal properties of diverse vegetable species.Researchers carried out the studies with valuable help from indigenous groups who passed on their knowledge about curative properties of the different flora species.

95%

OF ARTICLES ON AMAZONIA PUBLISHED IN PEER REVIEWED MAGAZINES WERE WRITTEN IN ENGLISH.

Over the past fifteen years there has been a renewal of interest in natural products and their possible applications in agriculture for pest control, as well as in the food, pharmaceutical and cosmetics industries. The constant search for new and more efficient medicines for cancer, diabetes, microbial diseases, heart diseases, pain and inflammation, has resulted in more research on natural plant products.

Scientific development in Amazonia may take two forms: on the one hand, scientific and technological development that permits ecosystem services to be preserved, traditional knowledge to be valued and the production of medium and long-term economic benefits; and, on the other hand, development that is unconnected to conserving ecosystem services and is meant to produce short-term economic benefits.

Developing scientific knowledge about Amazonia and its contribution to improving the population's living conditions, within a sustainable development framework, is a pending challenge. More cooperation is required to promote basic and applied research and to exchange existing knowledge. The lines of research on which work is needed include, among others: bioprospection, productive chains (fishing and agroindustry), forest management, water resources, health and food technology, and environmental modelling.

BOX 2.4

SCIENTIFIC AND TECHNOLOGICAL RESEARCH INSTITUTIONS WITH HEADQUARTERS IN AMAZONIA

Amazonian countries understand that putting a value on their natural resources, conserving biodiversity and properly managing the territory's ecosystems requires the participation of specialized science and technology institutions in Amazonia. At present there are three relevant science and technology institutions in the region whose main characteristic is the greater or lesser degree of autonomy they enjoy and having their headquarters in an Amazonian city.

In order of the date they were established:

The **National Institute of Amazonian Research (INPA)** in Manaus, Brazil was created in 1952 and started operating in 1954 with the objective of undertaking scientific studies of the physical medium, and the living conditions and human well-being in Brazil's Legal Amazonia. It is a relatively autonomous research unit that depends on the Ministry of Science and Technology.

3 RELEVANT SCIENCE AND TECHNOLOGY INSTITUTIONS IN AMAZONIA HAVE THEIR HEADQUARTERS IN AN AMAZONIAN CITY

The **Peruvian Amazon Research Institute (IIAP)** was created by article 120 of the Constitution of Peru in 1979 as a technical and independent institution to make an inventory of, carry out research on, evaluate and control the natural resources in Peruvian Amazonia. It has legal public right capacity as well as economic and administrative autonomy. It is connected to the Executive through the Ministry of Production. The IIAP has its headquarters in the city of Iquitos.

The **Amazonian Institute of Scientific Research (SINCHI)** was created by Law 99 in 1993 as a scientific entity linked to the Ministry of the Environment, with administrative independence, a legal status, its own patrimony and with headquarters in the city of Leticia. Its objective is to carry out and disseminate the results of high-level studies and scientific research on the social and ecological biological reality of Colombian Amazonia.

Source: Prepared by Fernando Rodríguez Achung, IIAP.

Floods are having an increasing effect in Amazonia in a context where the loss of forest cover leaves the soil unprotected and the erosion-sedimentation advances.

DANIEL BELTRA / GREENPEACE

2.5 | CLIMATE CHANGE AND NATURAL EVENTS

To the different driving forces that affect Amazonia that are presented in this chapter, one that must also be included is the pressure of world climate change. Amazonia is closely linked to how the climate is configured and modified. First of all, the forest acts as a gigantic heat consumer that absorbs half the solar energy reaching it through the evaporation of water in its foliage. This energy captured by the Amazonian forest has effects that extend all over the world through links called "climatic teleconnections", many of which we are still trying to understand. Second, it is broad and relatively sensitive reserve of carbon that is freed into the atmosphere through deforestation, drought and fires and contributes to the accumulation of greenhouse gases. Third, the water drained from Amazonian forests towards the Atlantic Ocean is 15-20% of the total world discharge of fresh river water and could be enough to influence some of the large ocean currents that are important climate system regulators (Nepstad 2007).

Climate change is a threat to Amazonia which has global implications. In its last report the Intergovernmental Panel on Climate Change (IPCC) points out that climate change is already taking place and is irreversible over the short term. The IPCC reaffirms that the main changes in the climatic pattern are the increase in world temperature, rising ocean levels and more frequent extreme climate events. Following this trend, it is possible to show the climate change that has taken place in the last century throughout the whole north-eastern part of South America, including the Amazonian region. The average monthly temperature records show a warming of 0.5 to 0.8 ºC in the 20th century (Pabón 1995; Pabón and others 1999; Quintana-Gómez 1999) and, specifically in the Amazonian region, the warming trend was +0.63 °C over a period of 100 years (Victoria and others 1998). Different studies confirm temperature rises although in different magnitudes.

While Amazonia does not make a significant contribution to greenhouse gases that cause global warming, it is a different situation if we take into account the emissions of gases caused by land use changes (in Chapter 4 details are given on how deforestation could have an impact on the climate in the Amazonian region and the world in general).

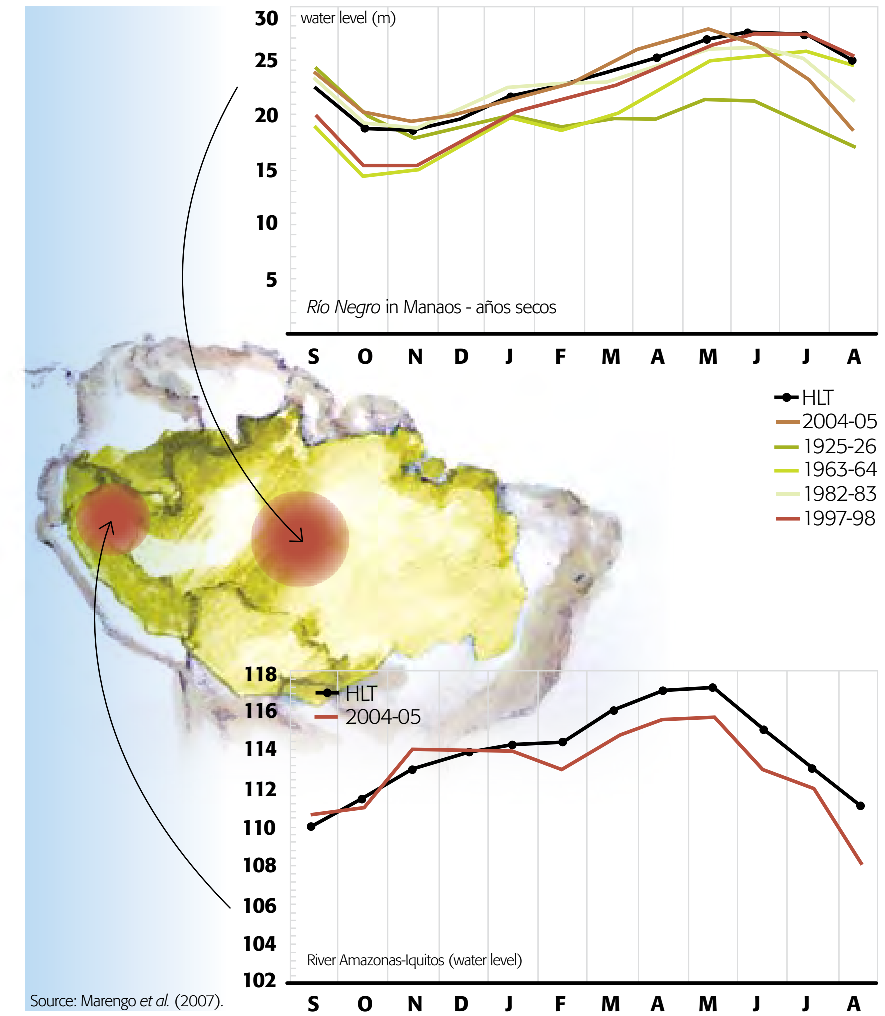
Drought and heat could be reinforced by the death of the humid forest in eastern Amazonia, replacing it with savannah-type and semi-arid vegetation, a process that could affect 60% of its territory.

This trend of increasing drought and heat in Amazonia could be strengthened by the death of the eastern Amazonian humid forest and by being replaced with savannah-type and semi-arid vegetation. According to Nobre and Oyama (2003) this situation could convert 60% of Amazonia's territory into a savannah in this century. Figure 2.6 shows the trends in the volume of the water level in the Negro and Amazonas rivers in dry years compared to the averages, as evidence of the impact in terms of the reduction in the volume of water and, therefore, the drought level.

Precipitation trends in Amazonia are not clear. Variations in rainfall in different decades have shown opposite trends in the northern and southern parts of the Amazon basin (Marengo and others 2000), as can be seen in Figure 2.7. While in the north of Amazonia it was a rainy period from 1950 to 1976, since 1977 the region has been rather dry (IPCC 2001) suggesting climate variability but not a defined rainfall pattern.

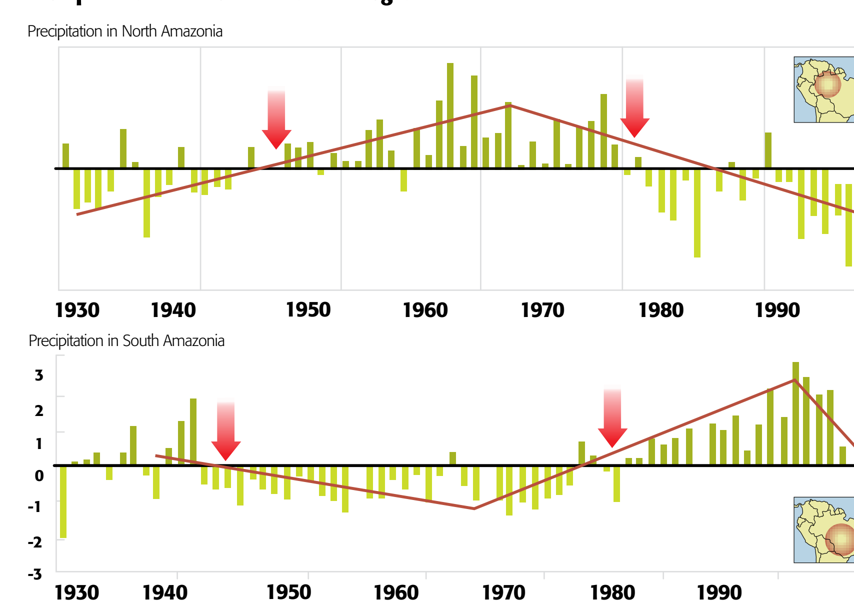
LESS THAN 1% OF THE AMAZON RIVER'S ANNUAL MASS COMES FROM MELTING ANDEAN GLACIERS.

FIGURE 2.6
Drought levels in the Amazonian region



Source: Marengo *et al.* (2007).

FIGURE 2.7
Precipitation in the Amazonian region



Source: Marengo (2004) TAC.

ERNESTO RAEZ

On the other hand, climate change has a direct effect on the melting of the glaciers in the Andes. According to Carlos Nobre, even if global warming causes the glaciers to totally disappear, the effect on the volume of flow of the Amazon will be very small and perhaps may not even be felt in the estuary. Some findings of the Páramo Andino Project 2007 reaffirm this idea: Andean experts calculated that the water contributed because of the melting ice is approximately 7,000 million m³/year, representing less than 1% of the annual mass of the Amazon river, even if no part of this water goes towards the rivers of the Pacific slope. Therefore, the small rivers of the Andes will be strongly affected and the ecological impacts will be felt in those regions; the water supply and hydroelectric complexes will also be affected.

One of the climatic events that will be more frequent and intense is the El Niño Southern Oscillation (ENSO) which, on the one hand, is a driving force that explains Latin America's climate variability (IPCC 2007) and, on the other hand, is associated with dry conditions in northeastern Brazil, in the Peruvian and the Bolivian altiplano and on the Pacific coast of Central America; in these periods there were anomalous rainy conditions in the southern part of Brazil and the north-east of Peru (Horel and Cornejo-Garrido 1986). This happened in 1997-1998 when drought caused devastating fires in the state of Roraima, and in 2005 when a moderate El Niño reduced rainfall along the Negro river, a large Amazon tributary. It should be noted that a recent study by Marengo and others (2008) shows that the drought in Brazil in 2005 was caused by the warming of the waters of the Atlantic Ocean and not by the El Niño effect. However, it is scientifically agreed that the El Niño will be more frequent and intense because of global warming.

BOX 2.5

AMAZONIA: CLIMATE REGULATOR

Amazonia has great influence in bringing heat and water vapour to regions at higher latitudes. It also has a very important role in atmospheric carbon sequestration and, therefore, contributes to reducing global warming.

As a consequence of deforestation, the forest will no longer function as a climate regulator. The increase in temperature and the reduction in precipitation in the dry months could mean the transformation of Amazonia into a savannah. According to Marengo and others (2007), the maps of future climate scenarios provided by different IPCC models show that there will be systematic warming in different regions of South America, including Amazonia, although different models with equal concentrations of greenhouse gases give different regional climate projections, especially in relation to rainfall.

THESE THREATS PRESENT GREAT CHALLENGES THAT WILL BE CLOSELY ASSOCIATED TO THE CREATIVITY AND INITIATIVE OF THE SCIENTIFIC BODY AND TO DECISION MAKING OF THE POLITICAL BODY.

Marengo and others (2007) also mention the more sensitive forest areas that will cover Tocantins and Guyana crossing the Santarém region that show precipitation patterns more similar to those of the Cerrado. This dry Amazonia would have savannah-type vegetation and show greater indexes of evapotranspiration, so that its soils would tend to be drier during the months of the dry season. This region would be much more vulnerable to forest fires, the main cause of the conversion of the the forest into savannah.

These threats present great challenges that will be closely associated to the creativity and initiative of the scientific body and the decision making of the political body, and will demand great multi-institutional and interdisciplinary articulations to find technically innovative solutions that guarantee sustainability.

Source: Marengo and others (2007)
Prepared by Leonardo de Sá, INPE/MPEG/MCT.

A reduction in the rainfall cycle in Amazonia is already causing serious droughts that have a severe impact on icthic species and on soil characteristics.

DANIEL BELTRA / GREENPEACE

Amazonian rivers play an important role in the region's water cycle and balance. Changes in this regime affects the habitat and the behaviour of many plant and animal species.

All these changes threaten Amazonia's terrestrial and aquatic ecosystem. The latter, in particular, is affected by the increase in temperature that results in more surface water evaporation and more transpiration of plants, thus producing a more intense water cycle. If the reduction in precipitation during the dry season occurs, the impacts on the Amazonian water pattern will become exacerbated (Nijssen and others 2001).

Climate change threatens aquatic Amazonian ecosystems in different ways, some of which are: (i) increased temperature in waters with an impact on some fish and animal species; (ii) reduced precipitation during dry months that affects many Amazonian water systems: (iii) changes in river nutrients due to changes in forest productivity and affecting aquatic organisms; and (iv) higher levels of sedimentation and colmatation in courses of rivers that rise in the Andean foothills.

Rivers in Amazonia play an important role in the region's water cycle and balance. Changes in this regime (quantity, quality and temporality) affect the habitat and behaviour of many plant and animal species. It can already be seen how some plant and animal species are adapting to change.

Another effect of droughts in Amazonia due to climate change has been the increase in frequency, and possibly also the intensity, of forest fires (for more details see Chapter 3.2 on Forests). Every year both deforestation and forest fires send hundreds of millions of tonnes of carbonic gas into the atmosphere contributing to global warming. Fires are particularly harmful because they fragment habitats and have very extreme impacts (Nepstad 2007, Laurance and Williamson 2001, Cochrane and Laurance 2002).

A study by an international team of scientists at Oxford University, the Potsdam Institute and others concluded in February 2008, that the Amazonian forest is the planet's second most vulnerable area after the Arctic; the accelerated deforestation of the Amazonia is leading it towards gradual desertification, which could in turn bring about a vicious circle in planetary climate behaviour, besides being seriously affected by global climate change. Amazonian societies recognize that proper precautions must be taken on the problems caused by disasters that come with climate change, worsening health problems, as well as a rise in existing poverty levels.

THE PAICHE OR PIRARUCÚ *(ARAPAIMA GIGAS)*, IS THE LARGEST FISH IN AMAZONIAN RIVERS.

DANIEL SILVA / EL COMERCIO

WATER IN AMAZONIA

The water supply in the Amazonian watershed is the result of the combination of six rivers with their headwaters in the Andean Cordillera, gathering waters from their snow-covered peaks and from rainfall, plus another six that originate in the Amazonian plains. Between 12,000 and 16,000 km³/year of water is captured by the Amazonian basin, coming from these twelve principal affluents.

Major rivers of the world. There is no unanimous consensus on the length of the principal rivers of the world, whose length is difficult to establish due to the fact that they drain enormous water basins, and they run partially through very broken terrain, making exceptionally complex the task of establishing their origins with precision.

- AMAZON RIVER AT 6,992.06 km
- NILE RIVER AT 6,671 km
- YANGTZE RIVER AT 6,380 km
- MISSOURI RIVER AT 6,270 km
- YELLOW RIVER OR HUANG HE AT 5,464 km

The five great contaminants.
- Gold mining (washing sand with pumps and draglines in the rivers, and seams), using mercury as amalgamation medium
- Oil extraction
- Illegal crops
- Industrial crops that use agrochemicals
- Urban waste

CONTAMINATION BY HYDROCARBONS

When hydrocarbons, goldmine tailings or other contaminating wastes enter into contact with the soil, a process of evaporation and penetration begins which alters the gaseous exchange of the vegetation with the atmosphere.

1 On the surface, invertebrate animals, such as spiders and centipedes, and vertebrates, such as mammals or reptiles, can more easily escape.

2 Microscopic creatures that participate in the formation and oxygenation of the soil die instantly.

3 In the river, the first biological community affected are the plankton that die by asphyxiation.

4 Plants, responsible for producing food and oxygen for other animals, also die.

5 In aquatic mammals, Petroleum destroys the natural thermal insulation of aquatic mammals. It also affects their ability to float which leads them to die by drowning.

6 In fish, pollutants block their respiratory structures, and those that manage to survive are highly contaminated.

7 Contaminated fish affect the health of the animals or humans that eat them.

Residual waters. Volume of brines originated by Amazonian petroleum industry.

	Production of brines (barrels / year)
ECUADOR	496,030,437
BRAZIL	41,883,750
PERU	41,251,537
COLOMBIA	11,529,465

Drainage area. Part of the territory of each country whose runoffs drain into the Amazon basin.

PERU	66.5 %
BOLIVIA	66 %
BRAZIL	57.7 %
ECUADOR	46 %
COLOMBIA	38.5 %

PROBLEMS

Gold extraction. One to three grams of mercury is used to obtain one gram of gold, in addition to cyanide and detergents. This implies that approximately 24 kg of mercury are dumped into every square kilometre of river.

Potable water. Only 46% of the population has access to this service. The water for human consumption is contaminated in part due to the fact that almost 70% of the solid waste dumps are open air. It is calculated that 1,700,000 tons/year of solid waste and 600 litre/ second of leachate enter the rivers.

Chemical agents. Nitrate concentration is increasing, which fosters algal growth and the eutrophication of lakes and flooded areas, which affects the organisms in the aquatic ecosystems.

Cocaine production. The production of basic cocaine paste uses an average of two tons of chemical precursors (sulphuric acid, quicklime, gasoline, kerosene, potassium permanganate and ammonia) per hectare of coca processed. These toxic elements, once used, are dumped into Amazonian rivers.

Logging. Deforestation constitutes a growing threat to the availability of water, given that it affects the water cycle.

Coverage of potable water and sanitation services (Andean - Amazonian countries)

	Piped water	Sanitation
BOLIVIA	45.2%	24.4%
COLOMBIA	33.5%	26.0%
ECUADOR	29.0%	21.1%
PERU	40.3%	33.7%
VENEZUELA	20.0%	15.0%

Sewage. Most Amazonian localities have no sewerage system. Raw sewage is dumped into rivers without prior treatment, making them sources of contamination for the fauna, flora and human beings.

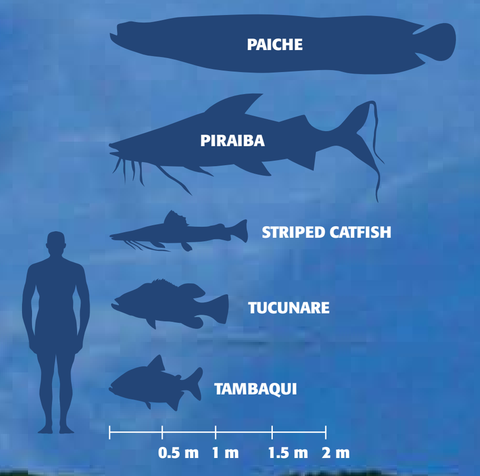
Lack of fish. Reduction in some fish species has already provoked famine in some parts of the region. Their mortality, caused by contamination and later decomposition, is a source of disease. Fisheries are not yet in grave danger, but there is over fishing of certain species, causing reductions in their natural supply.

Amazonian fisheries

Fish are the main direct food source for the populations along the Amazon river banks, where the world's highest consumption values are recorded for fresh water ecosystems.

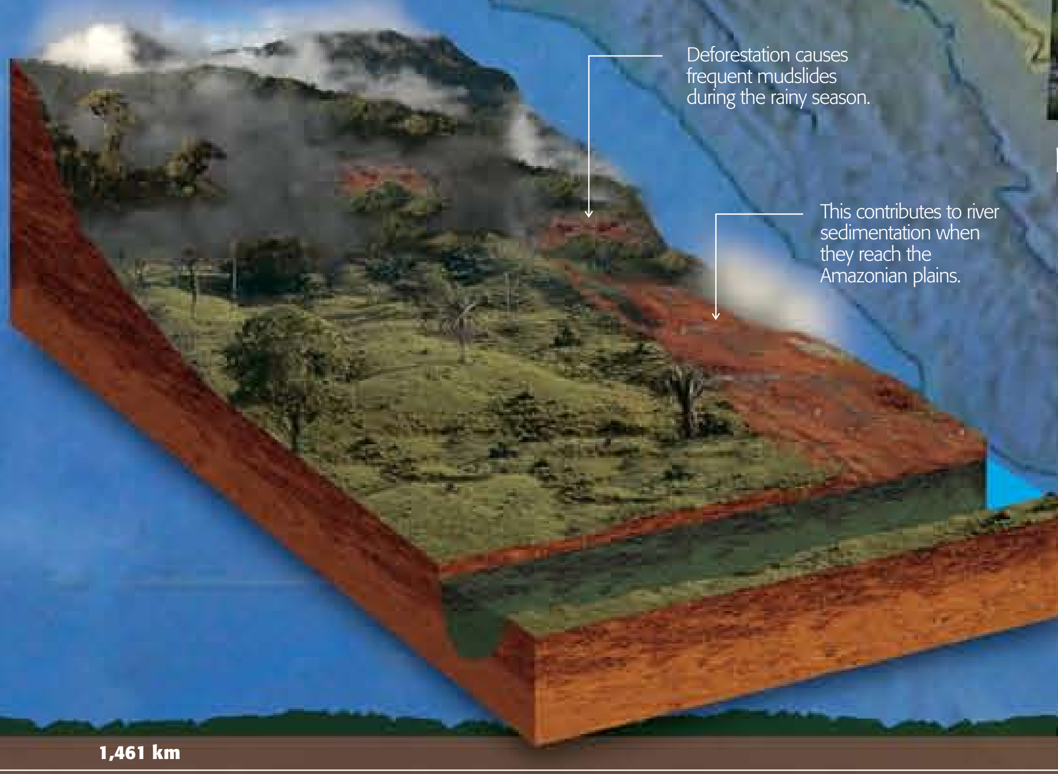
Daily consumption
(grams/person/day)

Middle Amazon	369
Lower Amazon	490-600
Upper Amazon	500-800
Upper and middle Putumayo	246



SEDIMENTATION

Due to the intense deforestation, mainly in the slopes of the Andean piedmont, sedimentation is accelerating in the rivers of the Amazonian plains, causing overflows as well as altering courses and river dynamics.



RIVER COURSES AND TYPES OF WATER

River courses and water bodies located under different geological, topographical and geomorphologic conditions that generate varied aquatic environments.

White waters

These are very productive waters full of nutrients. They have a neutral pH between 6.2 and 7. Their high turbidity is caused by inorganic sediments, illite and montmorillionite clays, carried from the Andes to the alluvial plains.

Várzeas (flood plains)

Bodies of water formed during river flood stages in the Amazonian plains. Its rich aquatic flora and fauna constitute a source of life for an important part of the Amazonian riverside population.

Rapids

On their journeys through the Cordillera, the rivers short run in canyons and become rapids as a consequence of the predominant topographical and geological conditions.

Waterfalls

Known as cachoeiras in Brazil, these are geological formations, present in the course of a river when it crosses a terrain that is resistant to water erosion. There are many in the Andean foothills and the Guyanese Shield.

Clear waters

These waters originate in the most ancient areas of the watershed (shields dating to the pre-Cambrian and Paleozoic eras), which, as the name implies are systems with a high degree of transparency, low pH and low productivity, due to the characteristics of the soils, which are generally sandy.

Meanders

Pronounced curves in the course of the rivers when they reach the Amazonian plains. They have varied forms and development; but, generally, they are characterized by eroding the banks in the concave parts and accumulating sediment in the convex sectors.

Black waters

Originate in the Amazonian plains; they have low pH, greater transparency and high concentrations of organic acids such as humic acids, giving them their colour. These conditions cause the black water ecosystems to have lower productivity. Zones flooded by these rivers are known as igarapés in Brazil.

NAVIGATION

In spite of being the most important natural communication route in South America, the Amazon river registers modest international traffic, owing to its paucity of commercial and industrial centres along its banks and the lack of transit facilities.

Iquitos and Yurimaguas. These are floating-type ports that have docking facilities, storage and sufficient equipment for cargo handling.

Leticia. Located on the left bank of the Amazon river. Being a border town, it possesses special characteristics for river commerce.

Tabatinga. A port with great commercial activity, at the border with Colombia and Peru, 1,600 km upriver from Manaus.

Manaus. Located on the banks of the Rio Negro, principal affluent of the Amazon on its left margin. Most of Brazil's river trade goes through its docks.

Santarém. Has a private port with a gigantic silo, capable of storing 60,000 tons of grain. From here soya is exported to European markets. It is connected to southern Amazonia by the BR 163 Cuiabá – Santarém highway.

Belén. Its river port is the gateway to Brazilian Amazonia and is considered the most dynamic city in northern Brazil. Belén is the starting point for visiting beaches and eco-tourism attractions.

IQUITOS — 370 km — LETICIA / TABATINGA — 1,461 km — MANAUS — 427 km — SANTARÉM — 321 km — BELÉM

3

AMAZONIA TODAY

3.1 BIODIVERSITY

3.2 FORESTS

3.3 WATER RESOURSES AND AQUATIC ECOSYSTEMS

3.4 AGROPRODUCTIVE SYSTEMS

3.5 HUMAN SETTLEMENTS

RAISING A TARICAYA TURTLE ALLOWS SUSTAINABLE DEVELOPMENT OF A PRODUCTIVE ACTIVITY THAT BENEFITS THE POPULATION.

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3.1 | BIODIVERSITY

Amazonia is an area with an extraordinary concentration of biodiversity of worldwide importance as to both species and ecosystems, as well as in genetic variation. As a whole, it is a region of great economic potential for mankind. Preventing the reduction of this biological diversity through loss and transformation of habitats and ecosystems, species extinction, reduction of genetic diversity and introduction of exotic species, among other causes, is one of the greatest environmental challenges facing the countries with territory in this region.

Throughout Amazonia, in spite of the zone's vast heterogeneity, there are similarities in many of its patterns of biodiversity, in the wealth of species and in endemism. In a similar manner, the causes of environmental changes, as well as their impact and opportunities to protect and use the environment, are identified as having similar origins.

AMAZONIAN BIODIVERSITY

Amazonian biodiversity is synonymous with ecosystem abundance and complexity and has developed over a vast territory, without its functional patterns having been affected by political boundaries. Amazonia has contributed diverse products of great importance to the world (e.g., rubber and cacao). However, signs of deteriorating biodiversity -understood not only as a set of ecosystems and species, but also as genetic and cultural diversity - are beginning to appear.

Indigenous peoples are knowledgeable users and conservers of genetic diversity and of their traditional knowledge with its ancestral value. Several studies indicate that the indigenous peoples of Amazonia use approximately 1,600 species of medicinal plants to cure different diseases, although the figure may be greater, owing to

Amazonian biodiversity is synonymous with ecosystem abundance and complexity, and has developed over a vast territory.

Exotic and uniquely beautiful biodiversity surprises the world.

TABLE 3.1
Types of floodplain forests in Amazonia

TYPE OF FLOODING	TYPE OF CYCLE	TYPE OF WATER	TYPE OF FLOODED FOREST
SEASONALLY FLOODED	Regular annual river floods	White	Seasonal várzea
		Black and clear	Seasonal igapó
	Tidal movements	Salt water	Mangrove swamps
		Recirculation of fresh water	Tidal várzea
	Torrential events (rainfall)		Flooded forests
PERMANENTLY FLOODED		White water	Permanent swampland forests
		Black and clear water	Permanent igapó

Source: Prance (1979).

The Amazonian region is fundamental for maintaining global climatic equilibrium, conservation and use of biological and cultural diversity, and traditional knowledge.

the high degree of endemism of Amazonian plants. Sadly, a large part of this ethno-botanical knowledge is disappearing with the acculturation or disappearance of some of the indigenous peoples (Álvarez 2005).

BIODIVERSITY PATTERNS

Generally speaking, ecosystems follow a global latitudinal pattern: tropical ecosystems are richer in species than the colder ecosystems at higher latitudes (Walter 1985, Gaston and Williams 1996). A similar pattern can be observed for higher taxonomic groups (genera, families) (Blackburn and Gastón 1996), which is attributed to physical factors (e.g., climate, geology, soil science, geographical barriers, etc.) as well as the capacity of species to occupy and adapt to abiotic and biotic environmental conditions.

Amazonia has been considered as one of the planet's most biologically diverse areas, and it is estimated that around 10% of all species of plants are found in this region. (Prance and others 2000). The Amazonian region is fundamental for maintaining global climatic equilibrium, conservation and use of biological and cultural diversity, and traditional knowledge. Although for many years the region was considered to be a relatively homogenous area, recent studies have documented spatial heterogeneity and floral differences between sites that were previously thought to be similar (Tuomisto and Ruokolainen 1997).

Different explanations, such as climatic and historical factors, have been put forward for the great diversity of Amazonia's species and bio-geographical patterns (Simpson and Haffer 1978; Josse and others 2007). The spatial heterogeneity found in Amazonia has been explained by differences in geology and geomorphology, producing environments with a wide diversity of drainage systems and soil qualities that lead to important differences in ecosystem composition and structure. Josse and others (2007) emphasize the importance of specifically defining criteria by zones, especially when these present significant comparative differences, such as in Amazonia. For example, they indicate that, in the case of the mountainous zone, altitudinal floors and the bio-climate are key criteria, while in the alluvial plain, the topography, hydrography and dynamics of flooding are factors that explain the spatial distribution of vegetal communities.

The great diversity of flora and fauna species in Amazonia has facilitated its traditional use as a source of food (agriculture or gathering of natural products), in handicrafts or traditional medicine. There are more than 2,000 species identified as plants that are useful for nutritional and medicinal purposes, and for producing oils, greases, waxes, etc. *(Secretaría Pro Tempore del Tratado de Cooperación Amazónica 1995)*. Fishing, far more than hunting, is the main source of proteins for local populations in Amazonia.

TABLE 3.2
Number of species by group reported in the Amazonian countries

COUNTRY	PLANTS TOTAL / AMAZONIA	MAMMALS TOTAL / AMAZONIA	BIRDS TOTAL / AMAZONIA	REPTILES TOTAL / AMAZONIA	AMPHIBIANS TOTAL / AMAZONIA
BOLIVIA	20,000 / n.a.	398 / n.a.	1,400 / n.a.	266 / n.a.	204 / n.a.
BRAZIL	55,000 / 30.000	428 / 311	1,622 / 1,300	684 / 273	814 / 232
COLOMBIA	45,000 / 5.950	456 / 85	1,875 / 868	520 / 147	733 / n.a.
ECUADOR	15,855 / 6249	368 / 197	1,644 / 773	390 / 165	420 / 167
GUYANA	8,000	198	728	137	105
PERU	35,000 / n.a.	513 / 293	1,800 / 806	375 / 180	332 / 262
SURINAME	4,500	200	670	131	99
VENEZUELA	21,000 / n.a.	305 / n.a.	1,296 / n.a.	246 / n.a.	183 / n.a.

n.a.: no data available for Amazonia in those countries having territory beyond this region.

Sources: Castaño (1993); Rueda-Almonacid and others (2004); Mojica and others (2002); Ecuador: Ecociencia, *Ministerio del Ambiente* (2005); Ibisch and Mérida (2004); *Fundación Amigos de la Naturaleza* (FAN, undated); Brazil: *Sociedad Brasileña de Herpetología* <http://www.SBherpetología.org.br> (for all of Brazil); Ávila-Pires and others (2007); Peru: Information System on Biological and Environmental Diversity of Peruvian Amazonia (Sistema de Información de la Diversidad Biológica y Ambiental de la Amazonía Peruana (Siamazonía), <http://www.siamazonia.org.pe>.

Amazonian wildlife is mainly used by the local populations for hunting and fishing for food; it is used less frequently for medicinal or traditional artisan purposes. Furthermore, the large mammals, such as peccaries, tapirs, rodents, deer, large primates, and river and land turtles, provide the main volume of bush meat *(Secretaría Pro Tempore del Tratado de Cooperación Amazónica 1995)*. Another use for Amazonian fauna is the capture of wild animals as pets, a limited commercial activity regulated by the norms of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in all Amazonian countries.

The ample biodiversity of the region has also favoured development of economic activities based on that biodiversity, such as: aquaculture, ecotourism, animal breeding, agroindustry, hunting or forest extraction (of timber-yielding or non-timber-yielding species) (see Sections 3.2 and 3.4).

The forest is the significant characteristic of this region (see Section 3.2 of this chapter). Five major categories of vegetation can be found in Amazonia (Kalliola, and others 1993; Domínguez 1987; Prance 1979, 1985; Huber 1981; Sierra 1999):

- Floodplain forests: sub-classified into seven sub-categories in function of the flooding regime and the type of water (Prance 1979)
- Dry land forests: these include the hillside forests (campinarana) and the highland forest complexes (piedemonte, sierra)
- Tepuies and Pantepuies
- Montane savannahs
- Wet and dry savannahs: found together with several types of aquatic and swamp vegetation along the river system.


MUSUK NOLTE/ EL COMERCIO

The rich aquatic ecosystems provide the Amazonian people with many species of fishes for food.

BIODIVERSITY:
a great variety of animal and plant species / endemism / gradients of diversity

Plants show a clear gradient of diversity from east to west, so that the abundance of species is greater in the foothills of the Andes (Gentry 1988), which also occurs with many animal species (Brown 1999). Gentry (1988) attributes this phenomenon to the presence of more fertile soils, greater rainfall and a lesser degree of seasonality in the climates of the upper Amazon river.

In the case of plant species, many might also be soil considered as belonging to specific types of soils, and their geographic distribution is correlated to the distribution of certain particular types of vegetation, as is the case in Amazonia (De Oliveira and Daly 1999). Nevertheless, it often occurs that an area with the same type or little variety of vegetation has different patterns of geographical distribution, generally attributed to historic events and evolutionary divergence of populations (Prance 1982; De Oliveira and Daly 1999).

SPECIES DIVERSITY

In the Amazonian region six of the eight ACTO members belong to a group of mega-diverse countries. To mention a single biological group, a third of the world's known vascular plants are found in Brazil, Colombia and Peru (Mittermeier and others 1999; Peru: The Biological Diversity and Environment Information System of Peruvian Amazonia [Siamazonía] 2007).

Brazil not only has the greatest territorial extension of the continent; of the eight countries analyzed, it is the one with the greatest total number of plant, mammal, bird, reptile and amphibian species numbering a little more than 58,000 species. Colombia follows Brazil in its wealth of biological diversity, with almost 49,000 species; Peru, with 38,020 species; and Bolivia, with 22,268 species, of the five biological groups mentioned (Table 3.2).

Brazilian Amazonia boasts a concentration of 54% of the plant species, 73% of the mammal species and 80% of the country's bird species. Peru is renowned for the concentration in its national territory of reptile species (48%), and amphibians (79%) of the total number of species in the respective groups. Ecuadorean Amazonia sustains a concentration of 53.3% of the nation's total mammal species, while Colombian Amazonia is the habitat for 46% of the avian species registered.

Dinerstein (1995) recognizes the western arch of Amazonia, and especially the areas close to the Andean foothills, as a zone of well-known and extraordinary diversity in species and endemism. At any rate, it is widely accepted that both Amazonian flora and fauna are not only lacking complete documentation, but that there is no total biological count for Amazonia and new collections constantly incorporate new species into the inventories of Amazonian flora and fauna (Da Silva and others 2005; Prance and others 2000).

Lewinsohn (2005) affirms that in Brazilian Amazonia there are 30,000 species of higher plants, 300 ferns (only in the lowlands), 311 mammals, 1,300 bird species and more than 163 species of amphibians as well as 1,800 continental fish.

Specifically in Colombian Amazonia, the Amazonian Institute for Scientific Research


CONSERVACIÓN INTERNACIONAL

AMAZONIAN PEOPLE USE APPROXIMATELY

1,600

SPECIES OF MEDICINAL PLANTS TO CURE DIFFERENT DISEASES.

(SINCHI), through its Colombian Amazonian Herbarium (COAH), reports a total of 214 botanical families with 5,950 species, of which 226 are non-vascular plants and 5,274 are vascular (*Instituto de Hidrología, Meteorología y Estudios Ambientales* [Ideam] 2004). While the country's Information System on Biodiversity indicates a total of 868 avian species, 140 amphibians, 85 mammals and 147 reptiles for this river basin.

In Ecuador, Ecociencia y el Ministerio del Ambiente (2005) differentiates between two major Amazonian ecosystems: that of the Amazonian rainforest and the Amazonian flooded forest. In the rainforest they recognize a total of 8,042 species, represented by plants (6,249), birds (773), fish (491), mammals (197), amphibians (167) and reptiles (165). The flooded forest has a slightly lesser wealth of species, with a total of 1,060; of these 425 correspond are fish, 366 birds, 139 reptiles, 83 amphibians and 47 mammals. It should be made clear that many of these species probably share both ecosystems.

Peru has the world record for the largest number of butterfly species (4,200) and 20% of the world's avian species (Information System on Biological and Environmental Diversity of Peruvian Amazonia (Siamazonía), at <http://www.siamazonia.org.pe>; Brack 2004). Evidence of this wealth of biodiversity came to the fore in the Bi-national Project, "Peace and Conservation of Peruvian–Ecuadorean Biodiversity" ("Paz y Conservation de

There are more than 30,000 plants, many of them arboreal species, in Brazilian Amazonia

The lepidopters (butterflies), with multiple colour combinations, are among Amazonia's most beautiful and varied insects.

CONSERVACIÓN INTERNACIONAL

4,200

SPECIES OF BUTTERFLIES HAN BEEN REGISTERED IN PERU, CONSIDERED TO BE A WORLD RECORD

la Biodiversidad, Perú-Ecuador"), backed by Conservation International (Perú: Instituto Nacional de Recursos Naturales [Inrena] – Conservación Internacional 1997), which showed the world that in the Condor Mountain Range in the Amazonas Department, in a period of only three weeks 800 plant species were collected, belonging to 94 families of which one of the most outstanding families was that of orchids, with 26 species. Many of the species found were new to science. However, it was also shown that in this highly diversified floral area, there are many endangered animal species, such as the spider monkey *(Ateles bezelbuth)*, the spectacled bear *(Tremarctos omatus)*, the neo-tropical otter *(Lontra longicaudis)*, to name a few. On the Ecuadorean side, 2,030 plant species were found, 613 avian species, 56 toad and frog species among others.

On the other hand, Amazonian aquatic biodiversity is also very rich and like the chemistry of its waters, is diverse and complex. Different studies reveal around 3,000 registered species of algae (Ehrenberg 1843; Forsberg and others 1993; Putz and Junk 1997; Sant'Anna and Martins 1982; Scott and others 1965; Thomasson 1971; Uherkovich 1976, 1984; Uherkovich and Rai 1979; Uherkovich and Franken 1980). In contrast to this wealth, micro-algae densities are very low, owing to the reduced mineralization of Amazonian waters.

Aquatic plants (macrophytes) are those with the highest annual primary production and represent 65% of the total aquatic food network, followed by the flooded forests with 28%. However, due to the large trees, forests have the highest biomass content followed by the periphytons and the phytoplankton with 5% and 2%, respectively (Barthem and Goulding 2007).

Approximately 2,500 species of fish have been identified in Amazonia; a number greater than that registered in the Atlantic Ocean. It is also well known that most of the ichthyic biomass, and especially that of detritopha-

TABLE 3.3
Strictly Protected Areas in the Amazonian Basin

COUNTRY	CATEGORY	N°	PROTECTED AREA (ha)
BOLIVIA	National Parks	9	2,865,656
	National Reserves	6	3,990,900
	Biological Stations	1	135,000
	Wildlife Refuges	3	270,000
	Sanctuaries	1	1,500
	TOTAL	**20**	**7,263,056**
BRAZIL	National Parks	21	19,101,420
	Biological Reserves	9	3,638,184
	Ecological Stations	15	6,765,915
	Ecological Stations of the federal states	8	4,590,225
	Parks administered by the federal states	42	6,623,239
	Biological Reserves under the responsibility of the Amazonian states	5	1,284,513
	TOTAL	**100**	**42,003,496**
COLOMBIA	National Natural Parks	11	4,904,768
	National Natural Reserves	2	1.947.500
	Sanctuaries for Fauna and Flora	1	8
	TOTAL	14	6,852,276
ECUADOR	National Parks	3	1,098,435
	Ecological Reserves	1	403,103
	Reserve for Fauna production	1	655,781
	Biological Reserve	1	4,613
	TOTAL	**6**	**2,161,932**
GUYANA	National Parks	2	7,870,000
	TOTAL	**2**	**7,870,000**
PERU	National Parks	9	7,467243
	National Reserves	3	2,412,759
	National Sanctuaries	2	131,609
	Historic Sanctuary	1	32,592
	TOTAL	**15**	**10,044,203**
SURINAME	National Parks	1	8,400
	Natural Reserves	5	544,170
	TOTAL	6	552,570
VENEZUELA	National Parks	1	1,360,000
	Natural Monuments	4	300,015
	TOTAL	**5**	**1,660,015**
TOTAL BASIN		**168**	**78,407,518**

Source: adapted and updated from the *Iniciativa Amazónica*, with original sources in: The Amazonian Cooperation Treaty (TCA) - Special Commission on the Environment for Amazonia. Brasil: *Ministerio de Medio Ambiente* (2008). Colombia: *Unidad de Parques Nacionales Naturales* (UAESPNN). Perú: *Instituto Nacional de Recursos Naturales* (Inrena) (2007a).

CONSERVACIÓN INTERNACIONAL

Acquatic and land turtles abound in Amazonian rivers and lagoons, but their habitat faces growing threats.

214

BOTANIC FAMILIES WITH 5,950 SPECIES HAVE BEEN REPORTED IN COLOMBIAN AMAZONIA.

2,500

SPECIES OF FISH HAVE BEEN IDENTIFIED IN AMAZONIA, MORE THAN IN THE ATLANTIC OCEAN.

gous fish (that feed on decomposed organic material) is related to the primary productivity of lakes and floodplains (Araujo-Lima, Forsberg, Victoria and Martinelli 1986; Forsberg and others 1993).

Outstanding among the fish species are pirarucu or paiche or *(Arapaima gigas)*, measuring over 2.5 m and weighing up to 200 kilos. Elsewhere, several types of boa constrictor, anaconda *(Eunectes murinus)* and caiman *(Alligatoridae)* are found in swampy areas or tranquil backwaters. And aquatic turtles, known as charapas *(Podocnemis expanda)*, the largest fresh water turtles in the world, weighing up to 45 kilos, are found in backwaters and lagoons, where the taricayas turtles *(Podocnernis unifilis)*, as well as frogs and amphibians are also prevalent (Alvárez 2005).

ENDEMISM CENTRES

Endemic areas, with concentrations of species that occupy a delimited and very specific region in unique and irreplaceable assemblies, are particularly important in Amazonia; they contribute elements for reconstructing the processes of biota formation in the region (Da Silva and others 2005). These authors have identified eight major areas of land mammal endemism for Amazonia: Napo, Imeri, Guyana, Inambari, Rondonia, Tapajos, Xingú and Belem. Of these eight, four are completely in Brazil and the rest of the endemic areas also occupy areas of the other Amazonian countries.

These areas vary considerably in size within the eight countries studied and show threats of habitat loss, degradation and fragmentation whose origins lie mainly in deforestation, cattle ranching, illicit crops and lumber extraction (Gascon and others 2001; Sierra 1999; Armenteras and others 2006). These processes are far from homogeneously distributed among the eight major areas; for example, the areas of Rondonia and Xingú have lost 10 to 50% of their original forest cover. An extreme case is that of Belem, in Brazil, a zone having less than a third of its original coverage, while Napo, Inambari, Guyana and Tapajós have lost less than 10% of their forests (Da Silva and others 2005).

Some bi-national studies provide specificities for endemism in Amazonia. For example, in the Condor Range, the bi-national Ecuadorean–Peruvian project mentioned earlier shows that there is a high level of endemism in that region, owing to its proximity to the region known as the "Huancabamba depression" or the Porculla Pass, which is the distribution limit for many species of northern and central Andean flora (PERÚ: *Instituto Nacional de Recursos Naturales* [Irena] and *Conservación Internacional* [CI] 1997). Furthermore, in the bi-national study NatureServe (2007) on the ecological systems in the Amazon basin of Peru and Bolivia, 84 ecological systems were identified in 1,249,281 km^2. It indicates that 15 ecological systems are shared between the two countries; while 7 systems are unique to Bolivia and 10 occur only in Peru (Josse 2007).

CONSERVATION AREAS

All Amazonian countries have national systems of protected areas and some categories of conservation and sustainable natural resource usage. Conservation areas have increased in number and extension, especially since the 1990's. The protected areas cover more than 700,000 square kilometres which is 12% of the Amazon basin's area. The countries with the most protected area are Brazil and Peru, or 54% and 13% of the total Amazonian protected area respectively (Table 3.3). On the other hand, this protected area is 4% of the total area of the eight ACTO member countries.

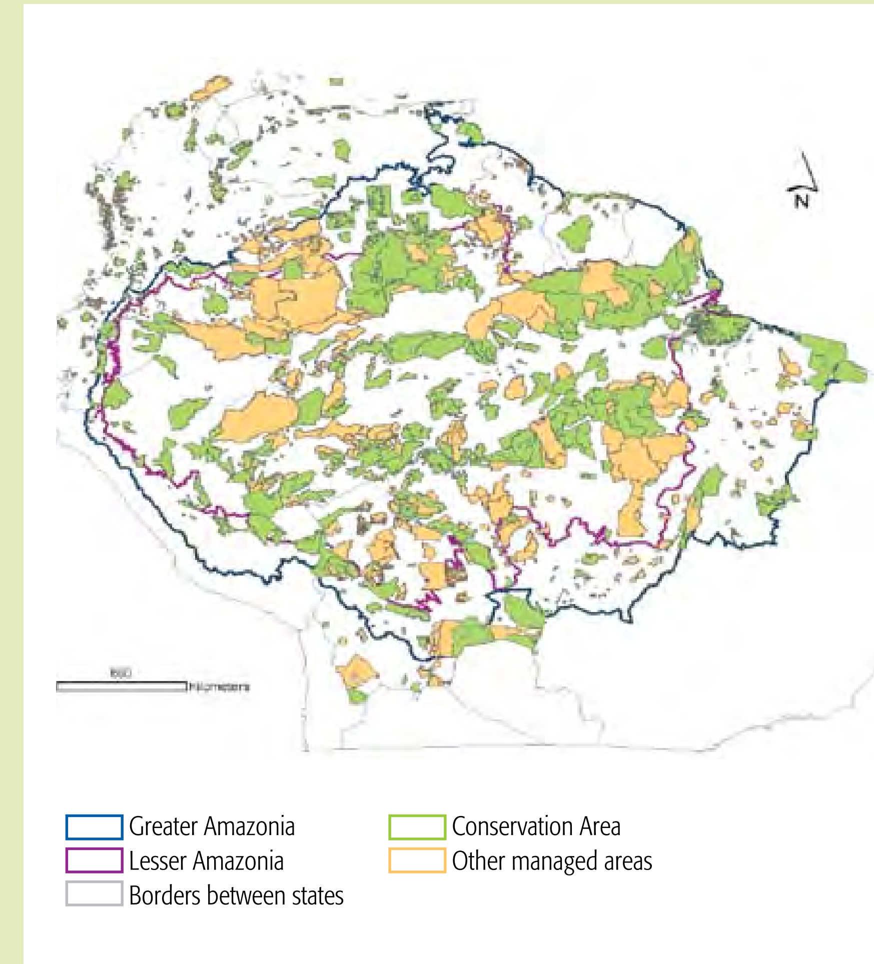
BOX 3.1

AMAZONIAN MANAGED AREAS

This map includes "Conservation Areas" as well as other managed areas that contribute to the conservation of biodiversity, at least partially. **The "Conservation Areas" are those having as their primordial function the protection and maintenance of biodiversity, as well as natural and associated resources. These areas are also managed on the basis of legal instruments and are compatible with the IUCN categories I – VI.**

The areas included by country are as follows:

- Bolivia: Conservation Area: National Park, Wildlife Reserves and Integrally Managed Natural Area (includes Cotapata, Aguaragüe e Iñao Protected Areas that do not yet have Management Plans and whose operation is based on Annual Operational Plans); other areas: Indigenous Lands (includes areas under litigation).
- Brazil: Conservation Area: National Parks, Biological Reserves, Ecological Stations, State Parks, State Ecological Stations and State Biological Reserves. Other areas: Indigenous Lands.
- Colombia: Conservation Area: National Natural Parks, National Natural Reserves, Unique Natural Areas, Flora Sanctuaries, Fauna Sanctuaries, Vías parques (similar to Natural Monuments). Other areas: Indigenous Reserves (constituted by INCORA and the more recent ones by INCODER. Established in Decree 1320 of 1998)
- Ecuador: Conservation Area: National Parks, Ecological Reserves, Reserves for Fauna Production, Biological Reserves.
- Guyana: Conservation Area: National Parks (e.g. Kaieteur National Park and the Iwokrama Tropical Rainforest, each of which has its own legislation – Acts of Parliament) and the Moraballi Reserve, protected under the framework of the Forestry Law, Other areas: Indigenous Lands.



- Peru: Conservation Area: National Parks, National Reserves, National Sanctuaries, Historical Sanctuaries.
- Suriname: Conservation Areas: National Parks, National Reserves. Other areas: Forest Reserves, Multiple usage areas.
- Venezuela: Conservation Area: National Parks, Natural Monuments

Source: Original production of GEO Amazonia, with the technical collaboration of UNEP/GRID - Sioux Falls with data received from: Conservation International (for Bolivia); IBGE and MMA (for Brazil); the *Unidad Administrativa Especial del Sistema de Parques Nacionales Naturales* (Special Administrative Unit for the National Natural Parks System) and CIAT Colombia (for Colombia); Environmental Protection Agency (for Guyana); IIAP (for Peru); Suriname Forest Service, Ministry of Labour, and ACTO (for Ecuador, Suriname, and Venezuela).

MAP 3.1
Priorities border area for illegal traffic

Source: Rivera (2007) (The document referred to is still a working document, not endorsed by the countries)

The management categories for the protected areas vary by country. Some sources indicate that there are at least twenty-three distinct categories in the Amazonian region involving not only biodiversity protection, research, education and ecotourism, but also management of forestry resources, as is the case of the Brazilian conservation units. In the case of Guyana, a strategy was designed in 2001 to to establish a system of protected areas; and, in spite of the lack of an established system, there are two legally declared protected areas: the Kaieteur National Park and the Iwokrama Rainforest Reserve (Environmental Protection Agency [EPA] 2007). Although the conservation areas are a valuable instrument, some studies indicate that insufficient resources and limited regional coordination affect the efficiency and efficacy of the management process in these areas (OTCA 2007).

In addition to having a national system of areas protected by the State, the countries can have alternative forms of biodiversity conservation. For example, a Regional System of Protected Areas for the Region of Loreto (Procrel) was designed in Peru in 2007; it is backed by the Regional Government of Loreto and is promoted within the framework of the decentralization process as an innovative programme for Peruvian Amazonia. Forms of conservation have also been promoted by the private sector, such as *servidumbre ecológica*, private conservation areas, concessions for conservation, ecotourism, and other types.

In spite of the national efforts, the limited availability of economic resources and reduced regional coordination condition the scope of conservation through systems of protected areas or conservation units (ACTO 2007).

84
ECOLOGICAL SYSTEMS HAVE BEEN IDENTIFIED ON 1,249,281 KM² OF THE AMAZON BASIN OF PERU AND BOLIVIA.

LOSS OF BIODIVERSITY

Amazonian biodiversity is suffering a gradually increasing pressure that is causing its reduction. The pressure is derived from the direct destruction of Amazonian ecosystems and their indirect destruction through unsustainable use and exploitation and by the introduction of exotic species. In addition, global warming and the higher incidence of forest fires alter the conditions for adequate ecosystem functioning.

Public policies promoted settlement processes and development of productive activities without considering an orderly land occupation. Thus, the various countries developed programmes to expand the agricultural frontier, for which deforestation (whether by clear-cutting or burning) is a necessary prior activity. To this can be added mining and petroleum activities as well as the construction of infrastructural works.

The over-exploitation of renewable natural Amazonian resources, mainly timber, and diverse components of biodiversity, responds to the incentives faced by the participating social players. The lack of definition of property rights and an effective system guaranteeing the application of those rights stimulates a predatory behaviour for obtaining short term benefits, without considering the environmental, social and inter-generational economic costs. Similarly, limited knowledge of ecosystem services and their respective values reduces the incentive for use of sustainable management practices. For example, in the case of timber exploitation, extraction was initially on a selective basis, however, over the medium term this generally translates into clear-cutting and conversion of the land to other uses. In some countries, such as Peru and Bolivia, migratory agricultural development is responsible for accelerated forest removal and, therefore, the change in biodiversity habitat conditions (see Section 3.4). Unsustainable use is also associated with the extraction of specimens from the biodiversity or part of them, which generally constitute part of illegal commerce. The introduction of species is principally associated with the agricultural and livestock systems. Logically, all of this results in the modification and / or loss of Amazonian habitats.

Generally speaking, illegal trafficking in species is the third most important illicit activity on the planet, and Amazonian diversity is no stranger to the dynamism of that market. For example there is illegal trafficking of timber

SEBASTIÁN CASTAÑEDA/ EL COMERCIO

Amazonian flowers: Demonstration of biodiversity and great natural beauty

SEBASTIÁN CASTAÑEDA / EL COMERCIO

CONSERVACIÓN INTERNACIONAL

SEBASTIÁN CASTAÑEDA / EL COMERCIO

and non-timber species (like orchids) and wild fauna (especially avifauna) (Map 3.1). In spite of the efforts of CITES, this type of commerce is facilitated, in some cases, by the development of infrastructure projects and human settlements in the project's areas of influence (Rivera 2007). Of the twenty-one countries that permit the legal sale of species, five are part of the Amazon basin, (Brazil, Bolivia, Colombia, Peru, and Venezuela,) and they sell to eleven countries, among them the United States, the greatest consumer of wild animals in the world. According to the estimations of the Brazil's herbarium, 38 million wild animals are smuggled across Brazil's borders.

HABITAT REDUCTION, FRAGMENTATION AND TRANSFORMATION OF ECOSYSTEMS

Doubtless, natural ecosystems provide essential goods and services for mankind (Millennium Ecosystem Assessment [MEA] 2006). However, its unsustainable exploitation has brought the reduction of great natural extensions, which has generated deforestation and habitat fragmentation. The destruction of tropical forests has received worldwide attention since these ecosystems are fundamental elements for the stability of global processes, such as the carbon cycle, water regulation, biodiversity conservation and maintenance and the potential effects on global climate (Fearnside 1995; Fearnside an others 2001).

AMAZONIAN NATURE IS SO ABUNDANT, DIVERSE AND SURPRISING THAT IT IS NOT RARE TO FIND THE MIMETISM IN SOME SPECIES, SUCH AS THIS ORCHID.

Land occupation of Amazonia generally takes place in three stages: the first comprises typical activities of timber, firewood and fibre extraction, with the consequent reduction in the number of adult trees (Nepstad and others 1999). The second stage includes burning processes that tend, on the one hand, to reduce the seed bank in the soil, and on the other, to raise the indices of seed and seedling mortality, due to competition from pioneer species and vines (Cochrane and Schulze 1999; Gascon and others 2000, Perez-Salicrup 2001). The third stage consists of hunting and habitat loss, activities that eliminate the seed dispersers (Laurance 2001; Silva and Tabarelli 2000, 2001). This process leads to a loss of, in many cases irreplaceable, species in the Amazonian ecosystems.

The fragmentation of natural ecosystems ("fragmentation" understood as the division of continuous fragments into smaller patches that are partially or totally disconnected) originated by the development of infrastructure, human settlements or agricultural practices of greater or lesser scale (monoculture) (see Section 2.2). To a great extent, this process affects the quality of habitats and causes a significant loss in species wealth (Laurance 1998; Laurance, Delamônica, Laurance, Vasconcelos and Lovejoy 2000). These impacts are related to the "border" effects that cause physical and biotic changes in the remaining fragments that translate into an abundance of pioneer species and alterations in germ plasm banks. This greatly affects the demography and the community's attributes, and puts the "natural" regeneration and forest function at risk (Laurance and others1997; Gascon and others 2000, Benítez and Martínez 2003).

Infrastructure development (either by the government or illegal incentive) unleashes a series of events that affect biodiversity and ecosystems and causes more destruction, than even forestry plantations (Fearnside 2005; Soares-Filho and others 2004). The trails that facilitate timber extraction usually precede highways and expand the frontiers for agricultural and livestock exploitation (see Section 2.2). Timber extraction itself has stimulated ecosystem degradation and has also made some areas more susceptible to fires because of: (i) an increase in flammability of the forest and (ii) the reduction in the number of days without rain, an event that facilitates the sotobosques (the group of

The destruction of tropical forests has received worldwide attention because these ecosystems are fundamental for the stability of global processes such as the carbon cycle, water regulation, bhiodiversity conservation and maintenance, and the potential effects on the global climate.

IN 2007 DEFORESTATION INCREASED BY

15%

COMPARED TO THE PREVIOUS YEAR.

FROM 2000-2005

27,151

KM² OF FORESTS WERE LOST IN AMAZONIA ANNUALY.

bushes found beneath or close to a forest) becoming inflammable (Fearnside 2005; Nepstad and others 2004).

Conversion and loss of habitat have been severe and the rate of deforestation is growing in Amazonia. This is associated with international prices of agricultural and livestock products that allow for growing profits in these sectors, as well as public policies developed to confront deforestation (Soares-Filho, Nepstad, Curran, Cerqueira, García, Azevedo Ramos, Voll, McDonald,Lefebvre and Schlesinkger 2006) (see Section 3.4). The rate of deforestation in Brazilian Amazonia increased during the period 1988-2004 (Fearnside 2005), primordially due to the expansion of livestock exploitation. Medium and large-sized ranches are principally responsible for more than half of that growth (Laurance, Albernaz, Schroth, Fearnside, Bergen, Venticinque and Da Costa 2002). In contrast, during the period 2005-2006 the deforestation rates fell significantly: in 2006 there was a reduction of 25%, which can be explained by the effectiveness of public programmes and projects for reducing deforestation, based on the participation of local populations (Brazil: Ministry of Foreign Relations, Ministry of Science and Technology, Ministry of the Environment, Ministry of Mines and Energy and Ministry of Development, Industry and Foreign Trade 2007). However, 2007 registered a new increase in the rate of deforestation with a growth of 15% over the previous year, due to the accelerated increase in international food prices, which stimulated the expansion of agriculture and livestock production (Brazil: Instituto Nacional de Pesquisas Espaciales [INPE] 2008).

In spite of the fact that Amazonia contains more than half of the world's remaining tropical forests, it continues to show rapid deforestation with the consequent changes in patterns of ecosystem loss (Malhi and others 1999; Laurance 1998; Whitmore 1997; Brazil: INPE 2008; Lima and Gascon 1999). This process inevitably leads to loss of species habitat, greater fragmentation and increased isolation of the fragments of the remaining ecosystems, which can affect their ecological processes, their structure, dynamics and operation, both at the ecosystems levels and those of species and genes (Carvalho and Vasconcelos 1999; Gascon and others 1999; Davies and Margules 1998; Laurence and others 1998; Laurance, Delamônica, Laurance, Vasconcelos and Lovejoy 2000; Nepstad and others1999).

Variations in forest cover cause local and regional climate change altering water cycles and even accelerating desertification. In Amazonia, during the period 2000-2005, annual deforestation was 27,151 km² (see Section 3.2).

Laurance and others (2002) identify another factor, in addition to transportation infrastructure and human population density, causing deforestation and habitat loss in Brazilian Amazonia: the severity of the dry season. There is evidence showing that tropical deforestation in Brazilian and Bolivian Amazonia are most frequently found in the driest ecosystems that are the most vulnerable to fire (Laurence and others 2002; Steininger and others 2001). Moreover, CO2 emissions, nitrogen fixation, air pollution and climate change are not yet completely understood, although preliminary evidence suggests that they can cause enormous changes in the composition of species and the structure of the Amazonian forest (Clark and others 2003; Lewis and others 2004).

On the other hand, extreme events, (e.g., floods, storms and seismic activity), which are generally increasing in frequency and intensity all over the world and notably in the Amazonia region, alter the characteristics of the habitat and therefore affect its biodiversity. This implies that the vulnerability of biodiversity increases, not only due to anthropic action, but also as a result of extreme natural events.

THREATENED SPECIES AND SPECIES LOSS

The largest number of extinct species is reported in Brazil, one of the countries having the greatest biological wealth of the eight being analyzed (Table 3.4), as pointed out earlier. Regarding the other endangered categories, according to the "red lists" of the International Union for the Conservation of Nature (IUCN), Colombia and Ecuador report the largest numbers, followed closely by

ERNESTO ARIAS/ EL COMERCIO

Opening roads affects the condition of the forest, including the fauna it shelters.

Peru. However it is important to clarify that the way threat levels are determined varies greatly from country to country, and between different groups of living organisms. It should be mentioned that some species at risk are not included in the Red List.

Upon analyzing the threatened categories: "in critical danger", "in danger", and "vulnerable", by biological group (Table 3.5), Ecuador is identified as the country with most reported species, followed by Brazil. The latter turns out to be the territory with the highest levels of threat for mammals, birds, reptiles, fish and invertebrates other than molluscs, in categories of intermediate and high risk. Colombia holds first place among the eight nations in the number of endangered amphibians. Finally, regarding the groups of molluscs and plants, Ecuador has the highest number of species considered to be vulnerable, endangered and in critical danger.

To date, there is not enough information available to prepare a list of endangered Amazonian species, except for Guyana and Suriname both of which consider their entire territory to be part of Amazonia. Brazil, through its Ministry of the Environment (Biodiversitas Foundation) reports that this part of the country registers 60 endangered species between mammals (19), birds (16), other invertebrates (5) and plants (20).

The Amazonian ecosystem's services and, in particular, its biodiversity reveal a process of discernable deterioration: the number of extinct, threatened and critically endangered species is growing. Furthermore, there is also evidence of a lack of knowledge about these complex ecosystems and their respective value, which in turn offers no incentive for their care or conservation. One must add to this a reduced valorization placed on the traditional wisdom of the indigenous peoples, who are the most affected by this accelerated change in habitat and reduction of biodiversity.

Even though programmes and projects have been launched to stimulate the conservation of biodiversity, these still have limited scope in relation to the magnitude of the deterioration.

Ecosystem services and biodiversity show a process of deterioration: more species extinct, endangered and in critical danger.

TABLE 3.4

Number of extinct, threatened and other species in each category of the “Red List”, by country (2006)

COUNTRY	EXTINCT	EXTINCT IN NATURE	IN CRITICAL DANGER	IN DANGER	VULNERABLE	AT RISK / DEPENDS ON CONSERVATION	CLOSE TO BEING THREATENED	DEFICIENT DATA	OF LESSER CONCERN
BOLIVIA	1	0	14	32	108	5	65	47	1,611
BRAZIL*	10	2	125	163	342	**	**	**	**
COLOMBIA	6	0	106	210	298	7	133	204	2,049
ECUADOR	6	0	311	778	1,091	6	347	367	1,859
GUYANA	0	0	6	10	55	4	21	53	922
PERU	2	0	45	90	389	11	105	197	1,912
SURINAME	0	0	7	9	49	1	17	39	823
VENEZUELA	1	0	30	52	151	6	52	135	1,497

*Brazil does not officially adopt the IUCN classification. The NGOs committed to conservation of biodiversity use the IUCN classification and because of that, the totals presented here do not coincide with the totals of the following table.
** no information.
Source: International Union for Conservation of Nature (IUCN) (2006) for all countries except Brazil. Brazil: *Informe técnico - Revisión de la lista de especies de la fauna brasileña amenazada de extinción. Conservation International.* Diciembre/2002.

TABLE 3.5

Number of threatened species, by group of organisms, by country

COUNTRY	MAMMALS	BIRDS	REPTILES	AMPHIB-IANS	FISH	MOLLUSCS	OTHER INVERTEBRATES	PLANTS	TOTAL
BOLIVIA	24	32	3	23	0	0	1	71	154
BRAZIL	69	160	20	16	154	40	163	108**	622
COLOMBIA	38	88	16	217	28	0	2	225	614
ECUADOR	34	76	11	165	14	48	0	1,832	2,180
GUYANA	11	3	6	9	18	0	1	23	71
PERU	46	98	8	86	8	0	2	276	524
SURINAME	11	0	6	2	19	0	0	27	65
VENEZUELA	26	25	13	71	26	0	3	69	233

Source: IN MMA N° 3 of 05/27/2003; IN MMA N° 5 of 05/21/2004 and IN N° 52 of 11/08/05; IN MMA N° 5 of 05/21/2004, IN N° 52 of 11/08/05 and IN No 3 of 05/27/2003 – includes aquatic and land based invertebrates; Ordinance N° 37-N of 3 April 1992, however, the MMA is updating the list of flora in extinction with a current forecast that the number of flora threatened by extinction could be as many as 1,500 species.
Brazil: The list of fauna species threatened by extinction is found in the Normative Instructions of the Ministry of the Environment (MMA). IN N° 5 of 21/05/04, presents two annexes: the first, with a list of fish and aquatic invertebrate species, and the second with a list of over-exploited or threatened by over-exploitation fish and aquatic invertebrate species. Some of these species, presented in the Conservation International report, have since left the list of threatened species and been incorporated in the list of species over-exploited or threatened by over-exploitation.

CONSERVACIÓN INTERNACIONAL

There are multiple species of different forms and sizes of frogs and toads including some with striking skin colourations.

MILLIONS OF WILD ANIMALS ARE SMUGGLED EACH YEAR. DEFICIENCIES IN DEFINING PROPERTY RIGHTS ENCOURAGE PILLAGING BIODIVERSITY FOR SHORT-TERM PROFIT.

CONSERVACIÓN INTERNACIONAL

SERGIO AMARAL / OTCA

A large variety of monkey species are sheltered in Amazonia.

CONSERVACIÓN INTERNACIONAL

The cock of the rocks

CONSERVACIÓN INTERNACIONAL

CONSERVACIÓN INTERNACIONAL

BOX 3.2

BOLIVIA: USE AND EXPLOITATION OF NON-TIMBER FORESTRY RESOURCES: BRAZIL NUTS *(BERTHOLLETIA EXCELSA H.B.K.)*

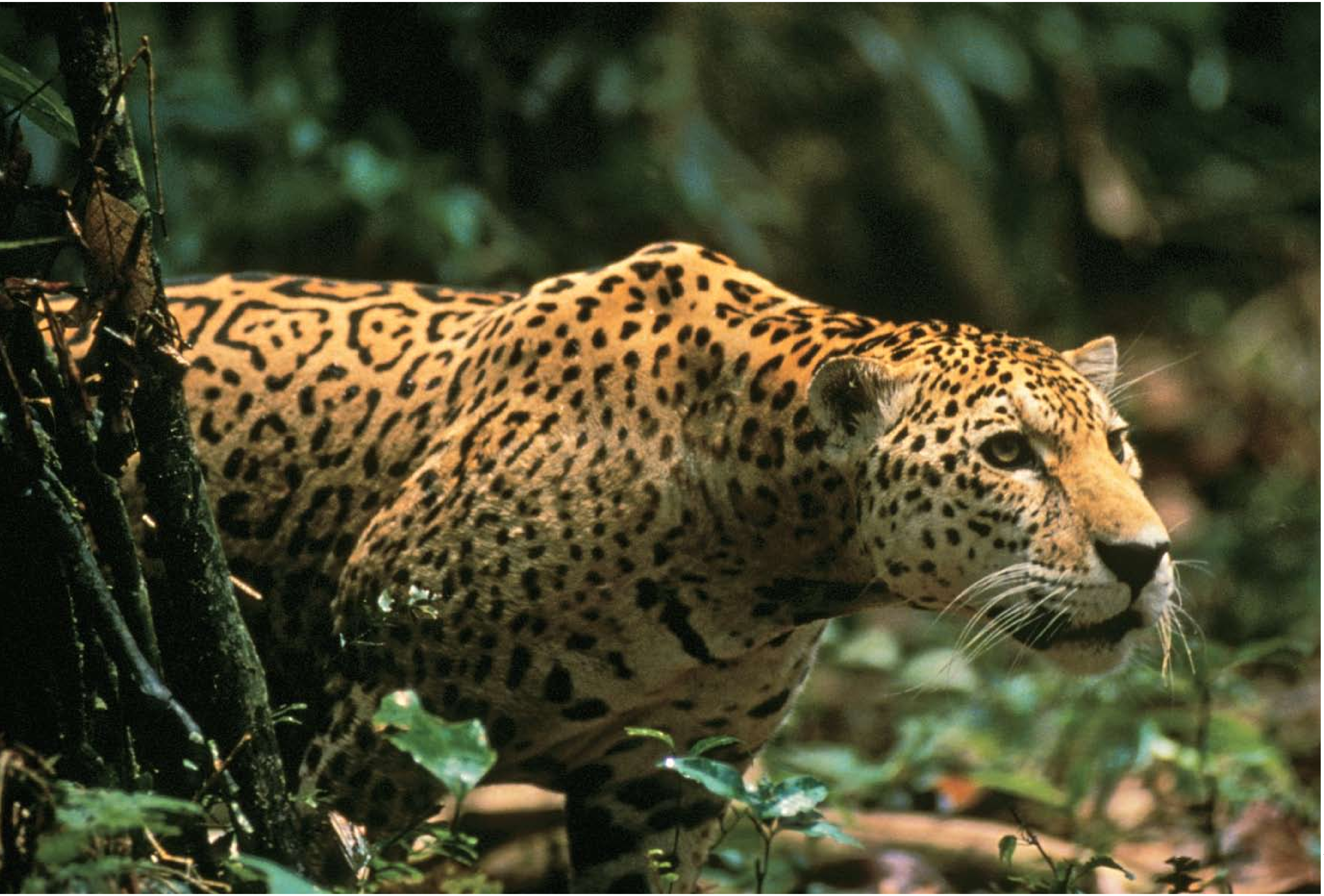
The *Bertholletia excelsa HBK (Lecythidaceae family)* is one of the dominant species in the dry land forest canopy of Amazonia, especially in Brazil, Peru and Bolivia, distributed over an area estimated at 325 million hectares. At times it can reach 50 m in height, and its fruits of a considerable size hold between 15 and 25 seeds covered with a hard, woody shell. These seeds are known as *castañas* or Brazil nuts, and although it is one of the most widely commercialized dry fruits in the world (1 or 2% of the total volume of international trade), it is considered to be one of the most viable alternatives for the sustainable use of the Amazonian forest, due to the self-sustaining ecological characteristics of the species and the fact that the vast majority of fruit collection is done in natural forests with minimum levels of alteration.

In the North of Bolivia this species is specifically concentrated in the departments Pando, Beni and La Paz, areas where castaña collection, processing and commercialization activities are also prevalent. And although some debate the impact of this product in improving the living standards of the Amazonian rural populations, some 170,000 persons currently obtain their sustenance from some activity connected to the production of castaña. It even forms a visible part of Bolivian exports, as a non-traditional product, especially since the significant reduction in natural rubber production.

Castaña is considered by many to be one of the flagship species for conservation of the Amazonian forest, although, when it comes to calculating the area that would be effectively preserved through extraction of this seed, it only amounts to 6% of the total area of potential distribution of the species.

If we add to this the growing interest in initiatives like organic certification, bio-commerce and fair trade, it would appear that all of the conditions are met for the castaña to become the standard bearer for sustainable use of the Amazonian forest.

Source: Stoian (2004).



CONSERVACIÓN INTERNACIONAL

THE JAGUARS, ONZA OR OTORONGO *(PANTHERA ONCA)* IS THE BIGGEST FELINE IN AMAZONIA AND THE THIRD BIGGEST IN THE WORLD.

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3.2 | FORESTS

The Amazonian forest comprises several natural ecosystems and is considered to be one of the planet's most important (Foley and others 2007). Its importance lies in its vast remaining tropical forest area, which offers several valuable environmental products and services (pharmaceuticals, enzymes, gene bank, among others). Prominent among its environmental services is that it is the depository of a very broad biological diversity (Fearnside 1999; Dirzo and Raven 2003), its capacity to absorb and store carbon (DeFries and others 2004), and its continental and global scale of its energy balance and water regulation (Foley and others 2007).

The Amazonian forest is subject to strong pressure, both from natural phenomena (drought and fire), as well as from man-made phenomena (mainly productive activities). Diverse economic activities, such as migratory agriculture, extensive ranching, agro-industry, un-regulated timber exploitation and accelerated urbanization, among others, generate the degradation and/or loss of forest cover, which in many cases causes irreversible impacts on the ecosystems.

CONSERVACIÓN INTERNACIONAL

THE AGUAJE, BURITI OR MORICHE *(MAURITIA FLEXUOSA)* IS A TYPICAL PALM THAT PROLIFERATE IN AMAZONIAN FLOODED FORESTS.

THE AMAZONIAN FOREST

There are multiple proposals for classification of the Amazonian forests (Moran 1993; Whitmore 2001; Stone and others 1994; Saatchi and others 2008). According to one of the most recent (Saatchi and others 2008), sixteen classes of vegetal coverage can be distinguished, which in aggregate terms, fall into four categories: dense forests, open forests, flooded forests and non-forest vegetation. Ayres (1993) refers to the fact that several different types of vegetation complexes can be found in the tropical Amazonian forest such as, highland forests,

The importance of the Amazonian forest is in extensive area of remaining tropical forest and the valuable environmental services and products it offers.

BOX 3.3

COVERAGE IN COLOMBIAN AMAZONIA

It is noteworthy that in 2001 95% of the Colombian Amazonia was considered natural or minimally transformed. The coverage was distributed as follows: Natural forests, 43,311,755 ha. (90.75%); cultivated pasturelands, 2,186,524 ha (4.58%); natural grasslands, 833,232 ha (1.75%); bodies of water, 535,614 ha (1.12%); and the remaining area, with less than 1% was divided into: scrublands (44,050 ha), secondary vegetation (328,755 ha), annual or transitional crops (12,698 ha), heterogeneous agricultural areas (72,475 ha) and urban zones (5,178 ha).

Source: Colombia: Instituto Amazónico de Investigaciones Científicas - SINCHI (2007)

Aspect of the arbustive-arboreal forest, a product of seasonal flooding

SERGIO AMARAL / OTCA

Dense forest predominates in Amazonia, and is distributed over an area of 3,936 million km². Most dense forests are found in Brazil, followed by Peru and Colombia.

dense forest, floodplains and flooded forest. Beyond the limits of the Amazonian forest, the Amazon basin is covered by a broad savannah and enclosed in the basin's headlands by the Brazilian and Guyanese shields. The cloud forest is a special type of vegetation that grows between 1,500 and 3,000 meters in the eastern foothills of the Andes, exposed to constant moisture-bearing winds. The vegetation can change abruptly at altitudes greater than 3,000 meters (Goulding and others 2003a).

The estimated amount of Amazonian forest cover varies according to the source, but it fluctuates around 6 million km² (Saatchi and others 2008). The dense forest comprises tropical humid ombrophilous, dry land forests and transitional forests. Here the trees are predominantly very large with high commercial value for lumber production (Lentini and others 2005), which makes these forests susceptible to pressure from timber activities (Uhl and Vieira 1989; Asner and others 2005) and in some regions to fires (Cochrane and Laurance 2002). Dense forest predominates in Amazonia and is distributed over an area of 3,938 million km². Most of the dense forests are found in Brazil, with 2,513 million km², followed by Peru with 446,600 km² and Colombia with 324,600 km². The rest of the countries together contain from 1 to 3% of the total Amazonian dense forest.

Open forests are predominantly made up of palm trees, vines and bamboo, with a canopy that is more open than that of the dense forest. This type of forest is concentrated in eastern Amazonia in Brazil; in the southwest, along the borders of Brazil, Bolivia and Peru; and in the northwest, in Colombia. There are also small areas of open forest in the north, on the Guyanese Shield. It is estimated that open forests occupy approximately 610,000 km².

The flooded forests or várzeas represent an important environment, because of their diversity and aquatic productivity (Goulding 1980; Goulding 1988; Forsberg and others

BOX 3.4

DIVERSITY OF VEGETATION IN PERUVIAN AMAZONIA

The classification of the diverse vegetation in Peruvian Amazonia was prepared by the Peruvian Amazonian Research Institute through the BIODAMAZ Project (Biological Diversity Project for Peruvian Amazonia; Peru-Finland Agreement) in 2004; it is based on the composition of a mosaic of Landsat TM images and the identification of twenty-four vegetal units.

I. NATURAL VEGETATION

1. AMAZONIAN PLAINS

a. Vegetation of the floodplain. Exposed to seasonal flooding by the flow of the rising rivers; in lowland terraces of recent and sub-recent origin

- Successional scrub-arboreal forest (riverbank complex vegetation)
- Herbaceous marshes with predominance of grasses
- Herbaceous- scrub marshes, associated with spiny palms
- Dense swamps or pure *Mauritia flexuosa* communities
- Mixed swamps or mixed associations with the renacos *(Ficus sp. and Coussapoa sp.)*
- Mixed swamps or disperse *Mauritia flexuosa* communities
- Scrub-arboreal marshlands and swamps in the Pastaza river delta sector
- Savannah-type vegetation with grassland dominance and disperse palms *(pampas del Heath)*
- Terraced forests, floodable by black water from the Nanay river
- Dense Pacal or pure guadua *spp.* communities (see group B)
- Mixed Pacal or guadua spp. communities and other tree species (see group B)
- White sand (Varillales) forests (along the banks of the Nanay, Pintoyacu and Chambira rivers) (see group B)

b. Vegetation of highlands or "dry land". Non-floodable by rising rivers, except for those lands with poor drainage, due to the accumulation of rainwater, in undulating lands, high terraces and hills.

- Dense Pacal or pure guadua spp. communities (see group A)
- Mixed Pacal or communities of guadua and other tree species (see group A)
- Highland swamps or *Mauritia flexuosa* palm groves in the highland plains with poor drainage (see group C)
- White sand (Varillales) forests (Allpahuayo – Mishana sector) (see group A)
- High humid colluvial terrace forests or forests on Andean foothill delta lands
- High colluvial terrace forests on glacis-type terrains in the Andean foothills
- Hilly forests on the Amazonian plains
- Hilly forests dissected in a dendritic drainage pattern, in the Pucacuro – Nanay – Chambira sector *(Hoja Seca del Nanay)*

2. MOUNTAINS

c. Low mountain forests

- Highland swamps or *Mauritia flexuosa* palm groves in high inter-montane terraces with poor drainage (see group B)
- High-hill plains forests or forests of low mountains cut-off from the *Divisory Sierra*
- Tropical dry forests
- Andean mountain cloud forests (see group D)

d. High mountain forests

- Andean mountain cloud forests (see group C)

II. ANTHROPIC VEGETATION

e. Complexes of successional vegetation more than three centuries old

- Grasslands

f. Complexes of successional vegetation less than three centuries old

- Deforested areas (populated centres and complexes of farms and secondary forests on dry land)
- Deforested areas with plantations of palms (e.g. El Espino Palm)
- Deforested areas of dry tropical forest.

Source: Peru: *Instituto de Investigaciones de la Amazonía Peruana* (IIAP) (2004a)

682,124

KM² IS THE ACCUMULATED AREA DEFORESTED IN BRAZIL BETWEEN 2000 AND 2006, SUPPOSEDLY 79.5% OF THE TOTAL DEFORESTATION IN THAT PERIOD.

1993; Araújo-Lima and others 1986; Junk 1983 and 1997). These areas extend all along the rivers and are almost completely flooded during the rainy season, although it is difficult to determine exactly which areas, due to the complexity of the flooding system that can be influenced by local rains, flood periodically due to overflowing rivers and incoming tides (Goulding and others 2003a). The *várzeas* of white-water rivers are relatively well conserved in zones upriver from the confluence of the Purús and Amazon rivers in Brazil, where the impact of ranching or agriculture is still very slight. On the other hand, the várzeas of the Amazon river are significantly altered in the lower reaches of the Purús river, especially in Santarem, in the state of Pará. There is a special type of *várzea*, influenced by floods and river overflow in the area where the Tapajós and Xingú rivers flow into the lower Amazon (Barthem 2001). In Brazil, tidal várzeas can be seen along the entire length of the area between the confluence of the Xingú, the Amazon and the mangrove swamps. This vegetation is intensely exploited by lumber companies and small-scale farmers (Anderson 1999; Barros and Uhl 1995). According to Saatchi and others (2008), the area occupied by this type of forest covers 527,000 km² and Brazil has 64% of the total of floodplains, followed by Bolivia with 11%, and Peru and Colombia with 7% each.

Non-forest vegetation can be found in several types of savannahs with small trees, frequently with twisted trunks, dispersed across the land. This class of vegetation also includes deforested areas or secondary forests. It is estimated that this type of vegetation covers 1,131 million km² of Amazonia (Saatchi and others 2008).

DEFORESTATION IN AMAZONIA

Several investigations have been carried out in each of the constituent countries, regarding the tempo of deforestation in Amazonia; however, their results differ from one study to another, because of the absence of precise monitoring systems, the use of different methodologies or simply because the figures are not accessible or are outdated. In spite of this, one can affirm that the tropical Amazonian rainforest has been seriously affected in recent years and has suffered a reduction in vegetal coverage.

Table 3.6 shows that by 2005 accumulated deforestation in Amazonia reached 857,666 km² (85.8 million hectares), which means that the total vegetation coverage of the region was reduced by approximately 17%. This is almost equivalent to 67% of Peru's total land area or 94% of that of Venezuela.

The causes of deforestation are varied and affect each country with differing intensity. The Amazonian forest, in general, is being affected by the pressures of agriculture and ranching (Hecht 2005) and timber extraction (both legal and illegal) (Asner and others 2005); by the exploitation of its natural resources in general (mining, non-timber-yielding forest resources) (Peres and others 2006); by government policies, such as highway building (Nepstad and others 2001; Soares-Filho and others 2004) and other infrastructure works; by demographic growth (Fearnside 1993; Kaimowitz 1997), to name the principal culprits. By the same token, natural events have also affected the forests; for example, extended droughts have caused an intensification of forest fires.

ENRIQUE CÚNEO / EL COMERCIO

Deforestion of tropical forests causes the loss of global biodiversity, especially in areas with a high degree of endemism.

Deforestation in tropical forests leads to the global loss of biodiversity, especially in areas with fewer remaining natural ecosystems, and a high degree of endemism (Capobianco 2001, quoted by Fearnside 2005). In addition to erosion, deforestation generates soil compaction and loss of nutrients (Fearnside 2005), as mentioned in Section 3.1.

Brazil has the largest area of accumulated deforestation, 682,124 km², meaning that, of the total deforested up to the period 2000-2005, 79.5% corresponds to that country, followed by Peru with 8.2% of the total deforestation for the period, and Bolivia and Colombia, with 5.3 and 3.4%, respectively. The other the countries account for percentages below 2% of the total. It should be clarified that these interpretations should be understood as being preliminary, since the data are not homogenous for all of the countries during the period under analysis.

Estimates for the annually deforested area between the decades of 1980 and 1990 reveal a reduction of 13%, from 23,619 km² to 20,550 km², basically in function of Brazil's reduction of deforested area by 16,503 km² per annum, and that of Peru to 783 km² annually. However, during that same period, the rates of annual deforestation for Bolivia and Ecuador increased by 8.7% and 78%, respectively (see Table 3.6).

Deforestation of slopes encourages erosion with soil loss and sedimentation of Amazonian rivers.

BOX 3.5

DEFORESTATION IN AMAZONIA

PADRO MAYOR / GABEL SOTIL / RED AMBIENTAL

It is a well-known fact that deforestation is concentrated in transitional areas between forests and the *"cerrado"* (tropical savannah), along the highways and on the boundary between Acre and Rondonia (Houghton and others 2000; Cardille and Foley 2003; Soares-Filho and others 2004). However, there are still gaps in the understanding of Amazonian deforestation. Until recently, the characterizing deforestation from a satellite's view was concentrated on estimating changes in "forest" and "non-forest" areas over time. Today the Amazonian landscape is much more dynamic and complex: it has undergone cycles of clear-cutting, cultivation, pasture land and growth of secondary forests, which has resulted in a complex mosaic of interaction between the tropical forest, lands under varied management regimens and recuperation of secondary forest, (Fearnside 1993; Nepstad and others 1999; Cardille and Foley 2003). It is particularly important to distinguish between the regions where secondary forest is regenerating, given the fact that it provides important areas for carbon capture, (Houghton and others 2000), temporary reservoirs of genetic diversity and some degree of recuperation and/or soil conservation.

Source: Foley and others (2007).

Laurance and others (2002) suggest that Brazilian Amazonia has the highest absolute indices of deforestation and forest fragmentation in the world. That perception was confirmed in 2004, when annual deforestation reached the second highest figure in its history, with 27,379 km², according to the National Institute for Space Research (INPE)/ the Programme of Monitoring the Brazilian Amazon Deforestation (PRODES) data. The highest annual deforestation in Brazil's history was recorded in 1995, with 29,059 km² (Lentini and others 2005). The Brazilian states most affected by deforestation are Mato Grosso and Rondonia. They registered a strong expansion of agricultural and ranching activity, primordially for the establishment of soya cultivation and for extensive cattle raising. In Brazilian Amazonia, for example, there was an increase from 5 million hectares of cultivated areas in 1990 to 8 million hectares in 2002, according to the Brazilian Institute of Geography and Statistics (IBGE). The Amazonian Institute of People and Environment (Instituto do Homem e Meio Ambiente da Amazônia) (IMAZON) indicates that the attack on the forests is mainly associated with illegal occupation of public lands and the construction of clandestine highways, which have been opened through Amazonia by miners, in search of gold and diamonds, as well as by timber companies.

For 2000-2005 deforestation of the Amazonian forest grew to 27,218 km² per year, mainly as a result of the surprising increase of deforestation in Brazil, which averages 22,513 km² per year. This growth of annual deforestation in Brazil represents an increase of 16% of the overall rate for the decade of 1980, and 36.4% of that for the 1990's. In spite of that, it should be noted that between the years 2005 and 2007 there was a significant deceleration in the rhythm of deforestation; in 2007 annual deforestation was 11,224 km², that is, 59% less than at the 2004 peak. Annual deforestation for 2000-2005 also grew in Bolivia, Colombia, and Ecuador, but decreased significantly in Peru and Venezuela (see Table 3.6).

In Peruvian Amazonia, migratory agriculture and the cultivation of coca leaves are the two main causes for deforestation. The first utilizes the technique of slash-and-burn on

TABLE 3.6

Deforestation of the Amazonian Forest during the decades of 1980, 1990 and 2000-2005.

COUNTRY	ACCUMULATED DEFORESTED AREA (km²)				ANNUAL DEFORESTATION (km²/YEAR)		
	1980-1989	1990-1999	2000-2005	% OF TOTAL DEFORESTED BY 2005	1980-1989	1990-1999	2000-2005
BOLIVIA[1]	15,500	24,700	45,735[2]	5.3%	1.386[2]	1.506[2]	2.247[2]
BRAZIL[3]	377,500	551.782	682,124	79.5%	19.410	16.503	22.513
COLOMBIA[4]	19,973	27,942	29,302[5]	3.4%	n.a.	664	942
ECUADOR[5]	n.a.	3,784	8,540	1.0%	212[5]	378	388[4]
GUYANA[5]	n.a.	n.a.	7,390	0.9%	n.a.	n.a.	210[5]
PERU[5]	56,424	64,252	69,713	8.2%	2.611	783	123[5]
SURINAME[5]	n.a.	n.a.	2,086	0.2%	n.a.	n.a.	242[5]
VENEZUELA[5]	n.a.	7,158	12,776	1.5%	n.a.	716	553[5]
TOTAL	**451,924**	**666,076**	**857,666**	**100%**	**23.619**	**20.550**	**27.218**

Source:
1 Steininger, Tucker, Townshend, Killeen, Desch, Bell and Ersts (2001).
2 Killeen, Calderón, Soria, Quezada, Steininger and Harper (2007).
3 *Programa de Cálculo do Desflorestamento da Amazônia* (PRODES). (2007)
4 Colombia: *Instituto Amazonico de Investigaciones Cientificas* (SINCHI) (2007).
5 Soares-Filho, Nepstad, Curran, Cerqueira, Garcia, Azevedo Ramos, Voll, Mcdonald, Lefebvre and Schlesinger (2006).

a small scale, for the inhabitants to carry out rudimentary agriculture, generally on soils of limited agricultural quality. For that reason they only occupy the land during a short period of time, which causes the cycle to be constantly repeated. The second involves the use of improved techniques for coca cultivation; however, this also leads to land being abandoned due to Government pressures to combat the expansion of this crop for illicit ends.

Clearing for illegal purposes, together with the expansion of the agricultural frontier, new settlements and extensive cattle ranching are the main causes of deforestation in Colombian Amazonia. Deforestation rates vary from 0.97% to 3.73% in highly populated areas and up to 0.23% in sparsely populated areas (Armenteras and others 2006).

In Bolivia, the advance of the agricultural and ranching frontier over the last decade has been the cause of the increased rate of illegal deforestation of lands with forest usage potential (there are permits for changing land usage, granted according to technical criteria established by the authorities); however, the underlying causes for the increase are inse-

Attacks on forests is associated with illegal appropriation of public land and clandestine highway contruction

TABLE 3.7
Principal causes of deforestation and forest degradation

COUNTRY	PRINCIPAL CAUSES OF DEFORESTATION AND FOREST DEGRADATION
BOLIVIA	Subsistence agriculture due to migration of landless individuals (Killeen, Calderón, Soria, Quezada, Steininger and Harper 2007) Soya cultivation, ranching activity (Steininger, Tucker, Townshend, Killeen, Desch, Bell and Ersts 2001) Pasture lands for ranching activity (Pacheco 1998) Timber extraction
BRAZIL	Pasture lands for ranching activity (Arima, Barreto and Brito 2005) Mechanized agriculture (Nepstad, Moutinho and Soares-Filho 2006) Infrastructure: highways and hydroelectric dams (Fearnside and Laurance 2002) Agrarian reform settlements (Brandão and Souza 2006) Timber activity (Lentini, Sabogal, Pokorny, Silva, Zweede, Veríssimo and Boscolo 2005) Appropriation of public lands
COLOMBIA	Spontaneous settlement (Armenteras, Rudas, Rodríguez, Sua and Romero 2006) Pasture lands for ranching activity (Armenteras, Rudas, Rodríguez, Sua and Romero 2006) Cultivation of illegal plantations (Armenteras, Rudas, Rodríguez, Sua and Romero 2006)
ECUADOR	Policies of settlement and shifting borders, subsistence agriculture (Wunder 2003) Infrastructure associated with petroleum production
GUYANA	Agriculture (EPA 2007) Bauxite mining (EPA 2007) Artisan mining *(garimpo)* (EPA 2007)
PERU	Highways (Maki, Kalliola and Vuorinen 2001) Agrarian reform (Álvarez 2003) Timber activity
SURINAME	Artisan mining, *(garimpo)* (Peterson and Heemskerk 2001)
VENEZUELA	Agriculture and ranching activity Gold mining

curity in property ownership, the comparative economic advantage of agricultural and ranching activities, as against forestry activities, insufficient mechanisms of control and supervision of deforestation, and the lacunae in the legislation, to mention a few. Also, the number of forest fires has increased, in many cases, as a consequence of deforestation itself. The department of Santa Cruz is where 75% of the deforestation is concentrated, and Pando and Beni constitute 20% *(Unidad de Control de Desmontes e Incendios Forestales* [Ucdif] 2007).

Deforestation in Ecuador started with the opening of roads to build pipelines for the petroleum industry, making it easier to colonize Amazonian land. For decades the policies for state land settlement, strongly influenced by the need to maintain its presence in border areas, were an incentive to change soil usage from forest to rudimentary agriculture and ranching. This generated a flow of migrants, and with them came very significant pressures on the Amazonian region (Wunder 2003). The lumber industry, responsible for approximately a third of the deforestation, builds most of the roads and promotes the advance of the forest's colonizers. Land traffickers and road builders encourage colonization and the fragmentation of ecosystems.

ANTONIO ESCALANTE/ EL COMERCIO

Illegal crops are an important deforestation vector in some Andean-Amazonian countries.

In Guyana Asian timber companies have arrived and were given important forestry concessions on 25-40% of the territory.

In Venezuela, converting forests for agriculture has helped to transfer a large amount of public forest land to private owners, even within forest reserves.

Although Guyana does not register high levels of deforestation, the growth of lumber exports and the growing interest in bio-fuels are cause for concern that deforestation will increase in that country. The same applies to Suriname, which has a low level of deforestation, caused almost exclusively by lumber extraction. This, however, situation changed recently with the entry of Asian timber companies, which have obtained important forest concessions for 25 to 40% of the territory (from 7 to 12 million hectares) for lumber extraction (World Rainforest Movement [WRM] 2000).

Venezuela has part of the world's largest extension of virgin, or not significantly affected, tropical forests. The highest rates of deforestation were reached during the 1980s, when public and multilateral development banking investments were made in iron ore and bauxite exploration, steel and aluminium factories, dams and a multitude of light industries, all linked by a network of roads and high tension lines that crossed the new cities founded to supply labour for the industries. Another cause of deforestation in Venezuela is the increase in the agricultural frontier between 1980 and 1990, which grew from 24 to 32 million hectares) (WRM 2000). The conversion of forests to agricultural lands has not helped much to solving the food deficit in this country, but it has facilitated the transfer of large quantities of public lands, that were originally forest, to private ownership, even within forest reserves.

Industrial mining also has a direct and indirect impact on the forest. Deforestation and contamination of the forest with chemical residues and mine tailings are direct impact examples (Uhl and others 1993). Indirect impact occurs when mining attracts large flows of migrants who help to increase deforestation in areas adjacent to the mining projects. The impact of industrial mining occurs mainly in Brazil, but artisan mining attracts thousands of people mainly in search of gold. These activities have been documented in Suriname, Guyana and Brazil. Artisan miners or *garimpeiros* generate impacts on the rivers through contamination with mercury and sodium cyanide (Muezzinoglu 2003).

FOREST DEGRADATION

Deforestation and its associated impacts are not the only threats to the integrity of the Amazonian forests. Extensive forested areas are also being impoverished by the degradation caused by different activities including lumber extraction (Nepstad and others 1999), forest fires (Cochrane and Schulze 1999) and forest fragmentation (Laurance and others 2000). Hydroelectric dams also generate direct impacts, such as flooding extensive areas of forest, and indirect impacts, such as population migrations (Junk and Mello 1999; Fearnside and Laurance 2002). Forest degradation generates partial, temporary or permanent alterations in the composition and structure of the forests (Lambim and others 2000). Other elements that can lead to forest degradation include hunting, the extraction of non-timber resources and the invasion of exotic species (Peres and others 2006); however, these disturbances are not detected by remote sensors and therefore there is no information as to their localization and extension.

Selective forest exploitation or skimming ("descreme") is also considered a forest degrading activity. It consists of extracting various commercially valuable tree species per hectare, without applying techniques for low impact forest exploitation. This practice has proven to be extremely destructive, since it is not regulated. On average, for each tree removed, up to thirty more trees are seriously damaged by the operation itself, since when trees are felled, the vines binding them together pull down neighbouring trees, causing severe damage to the surroundings. This practice can also cause the forest floor and undergrowth to dry out, making it much more vulnerable to forest fires (Asner and others 2006). Unregulated skimming can generate severe impacts on the soil, caused by heavy machinery. The forest penetration roads, constructed by these illegal timber merchants, frequently are used by colonizers to go even further into the forest and convert it to migratory agriculture.

Illegal timber extraction in Peru, especially mahogany, is produced by the action of small-scale loggers, who invade forest concessions or native communities and selectively extract the trees. The National Institute of Natural Resources (INRENA) calculates that in 2006, the value of timber illegally extracted was about US$44.5 million, equivalent to 221,000 m^3 of timber (World Bank 2006). In the now emblematic case of the Yasuní National Park in Ecuador, a protected area where tribes live in voluntary isolation but which, nevertheless, is having its cedar trees illegally extracted.

MIGUEL BELLIDO / EL COMERCIO

Much of the timber commercialized in Amazonia is illegal and taken from land that belongs to native communities or from forestry concessions.

In contrast to deforestation, which completely eliminates the forests, non-sustainable timber extraction partially affects their structure and composition. Logging activity is one of the principal causes of forest degradation and leads to a reduction of forestry stock as well as of commercially valuable forest species (Cochrane and Schulze 1999; Gerwing and Farias 2000; Fredericksen and Fredericksen 2002) and creates a fire-prone environment (Holdsworth and Uhl 1997), in addition to increasing the risk of extinction of native species (Martini and others 1994).

Although it is more visible than skimming, the expansion of infrastructure, mainly highways, is also a cause of Amazonian forest fragmentation, which particularly affects Brazil (Fearnside and Laurance

TABLE 3.8
Number of fire hot spots in Amazonia

COUNTRIES	# HOT SPOTS							
	2003		2004		2005		2006	
	N°	%	N°	%	N°	%	N°	%
BOLIVIA	1.764	9	4.291	14	4.532	16	2.855	16
BRAZIL	17.941	88	26.742	85	23.723	83	14.316	83
OTHER COUNTRIES	611	3	275	1	260	1	144	1
TOTAL	**20.316**		**31.308**		**28.515**		**17.315**	

Note: A hot spot indicates the existence of fire in the element of resolution (pixel) that varies from 1 km x 1 km to 5 km x 4 km. There may be one or various fires in one pixel.
Source: <http://www.dpi.inpe.br/proarco/bdqueimadas/>.

ON AVERAGE THERE WERE 24,000 FOREST FIRE HOT SPOTS IN THE REGION IN THE 2003-2006 PERIOD.

2002; Nepstad and others 2001), Peru (Maki and others 2001) and Ecuador, in this case, associated with petroleum activities. In Peru, for example, between 1981 and 1996, deforestation saw an explosive increase along the Inter-Oceanic Highway (Naughton-Treves 2004). In Brazil, 80% of deforestation is concentrated in a radius of 50 km from the official highways (Asner and others 2006). To this we add the opening of illegal roads for access to natural resources (timber and gold) and to public lands, by squatters (Brandão and Souza 2006). Through satellite mapping imagery in 2003, it was possible to identify nearly 173,000 km of illegal roads through the Amazonian forest. Similarly, the growth of urban centres also leads to increased pressure on the remaining forests within a 20 km radius of those centres (Barreto and others 2006), due to the rise in forest fragmentation and degradation through timber exploitation and forest fires, as well as the impoverishment of fauna and flora from hunting and collecting non-forest timber products (Peres and others 2006).

FOREST FIRES IN AMAZONIA

Forest fires are a huge threat to the integrity of tropical forests (Rudel 2005). Fire has been used as a tool for clearing pasturelands and agricultural plots in the Amazonian forest (Kato and others 1999) and for burning the forest after clear-cutting (Fearnside 2005). Uncontrolled fires in pasturelands and farming areas generally extend into (and burn) the edges of adjacent forests (Nepstad and others 1999; Cochrane and Schulze 1999). When the adjacent forests have already been exploited by timber cutting activities, the fires penetrate into the forest with greater ease and cause a more significant impact. This occurs because of the higher incidence of solar radiation and the accumulation of residue generated by exploitation (Holdsworth and Uhl 1997). Once an area is burnt, its vulnerability to new fires increases and the damages caused are far more extensive (Cochrane and Schulze 1999).

Maps show the localization and extension of forests degraded by fires. Local studies, based on remote sensing and field data collection, show that the area affected by forest fires far exceeds that affected by logging activities. One way to understand the dimensions of this problem and the risks of forest fires is through data on localized burning (hot spots, active fires).

From 2003-2006 there were, on average, 24,000 fire hot spots per year. The year with the most fires was 2004, reaching 31,308 recorded hot spots, while 2006 reported the smallest number: 17,315. Brazil is the Amazonian country reporting most fires during the period 2003-2006, averaging 85% of the total. Bolivia holds second place with an annual average of 14% of total fires for the same period. The other countries, on average, had 1% of the total number of fires.


CONSERVACIÓN INTERNACIONAL

Most of the hot spots are concentrated in the southern limits of the Amazonian forest, along the so-called “deforestation arch” in Brazil and the central zone of Bolivia (Figure 3.1). A concentration of fires can also be seen along the highways that cut the central zone of the Brazilian forest, along the length of the Trans-Amazonian Highway (BR-230), Santarem-Cuiabá (BR-163) and highway BR-317, that connects western Brazilian Amazonia to the Pacific Ocean. These areas are all have recently deforested frontiers.

During the last half of the 20th century one of the principal ecological transformations in the Amazonian region was a short lapse of time between forest fires. Instead of centuries between events, some fires are now burning with lapses of five to fifteen years (Cochrane and Schulze 1999; Alencar and others 2006), which makes the forest even more susceptible to subsequent burning. The critical ecological point of the Amazonian forest is reached when the forest becomes so inflammable that frequent periodic burning is virtually inevitable.

According to Nepstad (2007), over great extensions of Amazonia, unregulated skimming, drought and fire are thinning the forest canopy, allowing more and more sunlight to penetrate the thin combustible forest substrate. Trees that die or are extracted by loggers (Nepstad and others 1999), trees that die from drought and trees

Deforestation and selective extraction make Amazonian forests much more prone to fires.

Before fields are ready for crops, the forest is cleared and burnt.

ENRIQUE CÚNEO / EL COMERCIO

400

MILLIONS OF TONNES OF CARBON ARE RELEASED EACH YEAR INTO THE ATMOSPHERE AS A RESULT OF TRADITIONAL FOREST CLEARING AND BURNING IN AMAZONIA.

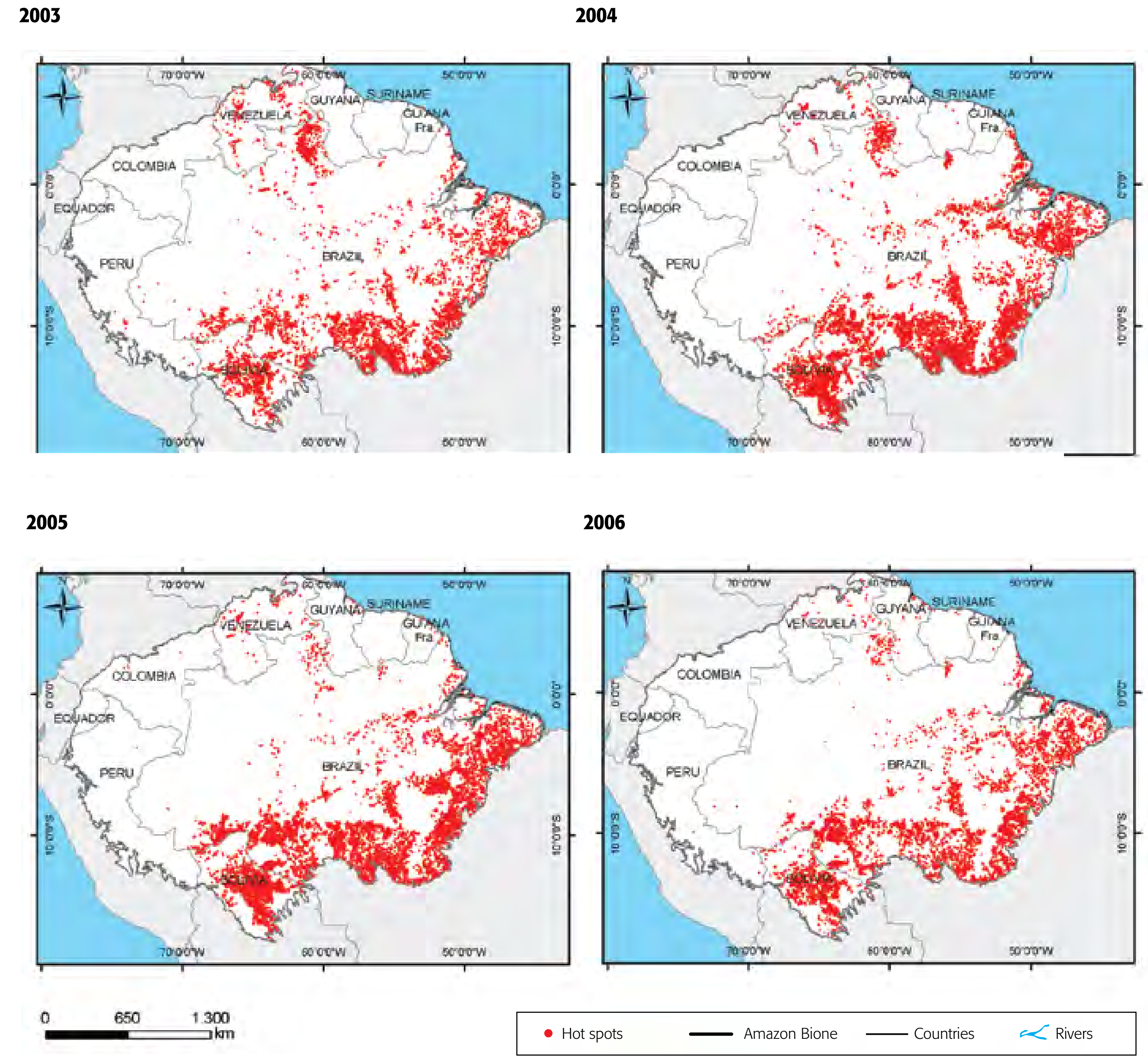
that die from fire, open the forest canopy to the powerful rays of the equatorial sun, which dries the fine layer of kindling on the ground. As more sunlight that penetrates inside the forest, more light demanding plants, and that increase the inflammable nature of the forest, are able to establish themselves. Although they are still rare in Amazonia, grasses, ferns and highly inflammable bamboos can establish themselves in the undergrowth, which considerably increases its susceptibility to fire. When these damaged forests catch fire, more trees die and the invasion of grasses, ferns and bamboos continues in a vicious circle.

Finally, as mentioned in Chapter 2, Section 2.5, global warming is another type of environmental pressure that can lead to turning extensive areas of Amazonian forest into savannahs (Nobre and others 2007). Deforestation, followed by burning forests, contributes to carbon emissions. In Brazilian Amazonia alone, emissions can reach 0.2 gigatonnes of carbon per year (Nobre and Nobre 2002). Projections made by climate models for South America for the year 2100 show, in the worst case scenario, that the mean temperature of Amazonia may increase by up to 8 degrees Celsius and produce heavy rainfall (Marengo and others 2007).

In addition to this environmental concern, the fact that, while an estimated 400 million tonnes of carbon are released into the atmosphere every year, as a result of traditional clear-and-burn agriculture in the forest in Amazonia, Asner and others (2005) estimate that another 100 million tonnes are produced by selective logging, in other words, 25% more greenhouse gases than were previously assumed; which could drastically alter the predictions for global climate change.

FIGURE 3.1

Distribution of the fire spots in the Amazonian forest (2003-2006)



Source: MODIS sensor data base

During the last half of the 20th Century, one of the principal ecological transformations in the Amazonian region was a shorter lapse of time between forest fires.

ANTONIO ESCALANTE / EL COMERCIO

THE AMAZONIAN LANDSCAPE INCLUDES GREAT RIVERS AS ONE OF ITS ESSENTIAL COMPONENTS.

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3.3 | WATER RESOURCES AND AQUATIC ECOSYSTEMS

As set out in Chapter 1, the Amazon watershed is the largest in the world and occupies more than a third of the surface of the South American subcontinent. The most important tributary basins of the Amazon river originate in the Cordillera of the Andes, and other tributaries find their source in the Guyanese and Brazilian shields and other areas neighbouring the Orinoco basin (Colombia).

Amazonia has a vast supply of water resources that by far exceed the demand for their use; however, deforestation constitutes a growing threat to the availability of water, given that it affects the water cycle. By the same token, economic activities carried out in the region (agriculture and mining, among others), as well as the accelerated rate of urbanisation, are forces having a negative impact on the water quality.

The water resources of Amazonia have a variety of characteristics and, as a result, contain a great wealth of fish species. Although fishery resources are generally not being over-exploited, there is evidence that the reduction in volume of certain species in determined zones is as much due to the change in water quality as to fishery pressure to satisfy nutritional requirements.

WATER RESOURCES IN THE AMAZON BASIN

The Amazon Basin water supply is due to a combination of several elements. The headwaters of six of the 12 principal rivers that flow directly into the Amazon are in some way linked with the Andes mountain range, since they gather waters from its snow-covered peaks (e.g., the Mismi, in Peru) and from the rains which, in some sectors of the high Andes, can reach 8,000 mm of rainfall per year; rainfall in the strip of piedmont varies between 2,500 and 5,000 mm/year. These rainfall patterns, added to those of the

Six of the 12 principal rivers that flow directly into the Amazon are in some way linked with the Andes mountain range.

FIGURE 3.2
Percentage contribution of the principal Amazonian hydrographic sub-basins to total basin discharge

Source: Goulding and others (2003a).

Climate change could alter availability of water in Amazonia, although there is no scientific evidence that this is hapenning.

drainage areas of the other six affluents and of the rest of the lesser tributaries that originate on the Amazonian lowlands (where rainfall varies between 1,500 and 3,000 mm/year), result in a total liquid water accumulation in the Amazon Basin of between 12,000 and 16,000 km3/year (Salati 1983, Goulding and others 2003b, Barthem and others 2004).

However, it has been estimated that the outflow of water through the different river channels oscillates between 5,500 and 6,700 km3/year, which means that the remaining 60% of the water returns to the atmosphere through evapotranspiration by the Amazonian forest (Salati 1983; Sioli 1984; Goulding and others 2003; Calasans and others 2005, Cadavid undated), a process that has become a fundamental support for ensuring the water balance between the terrestrial and aquatic ecosystems. Furthermore, climate change may also alter the water availability in Amazonia, although there is no current scientific evidence that this is happening (see more detail in Chapter 4).

Surface water

Depending on different studies, the drainage area that gathers the waters from the Amazonian water network for each of the countries of the basin corresponds to approximately 38.5% of Colombia's national territory; 46% for Ecuador; 46.5% for Brazil (or 57.5%, if you consider the sub-basin of the Tocantins river); 66.5% for Peru; and 66% for Bolivia. In the cases of Venezuela, Guyana and Suriname, they generally do not drain water into the Amazonian basin; however, during periods of heavy rainfall and floods, small sectors are able to mix the waters of separate basins, such as those of the Orinoco with those of the Negro river in what is known in Venezuela as the "Casiquiare Branch"; or, in Guyana, the Río Negro mixes with the Takutu river (Barthem and others 1995; Barthem 2001; Brasil: Ministerio del Medio Ambiente - Agencia Nacional de Aguas [ANA] 2002a; Colombia: Instituto Amazónico de Investigaciones Científicas [SINCHI] 2002; Goulding and others 2003b and 2003b; Barthem and others 2004; Cummings 2006; Perú: Instituto de Investigaciones de la Amazonía Peruana [IIAP] 2006).

SERGIO AMARAL / OTCA

The "meeting of the waters" is the name given to the confluence of the Negro river with the Amazon, each one bringing waters of different quality, origin and coloration.

If the contributions of water from each country into the Amazon Basin are considered, Colombia, Ecuador and Peru are the source of 30% of the flows that reach the main channel of the Amazon. The Madeira river (Peru, Bolivia and Brazil) and the Negro river (Brazil) contribute another 30%, and the rest is all captured in Brazilian territory (Figure 3.2) (Brasil: Ministerio del Medio Ambiente - Agencia Nacional de Aguas [ANA] 2002a, Goulding and others 2003a).

As a consequence, the availability of surface water for each Amazonian country depends, to a great extent, on adequate water management by its "upstream" neighbouring country, not only in respect of its particular aquatic situation, but that of the entire Amazonian ecosystem.

The disappearance of natural vegetation cover, which now encompasses approximately 17% of the size of the original forest cover (see Section 3.2), is the principal factor affecting water availability. The high levels of deforestation attributed to expanding agricultural, ranching and logging activities, together with the deforested areas of Bolivian, Colombian and Peruvian Amazonia, due to the effects of illegal crops, have led to changes in soil usage affecting the water supply and ecosystem services.

The total liquid water captured by the Amazonian basin is between 12,000 and 16,000 km3 / year.

TABLE 3.9
Coverage of aqueduct and sanitation services for the Amazonian region

COUNTRY	PERCENTAGE COVERAGE (%)	
	AQUEDUCT	SANITATION
BOLIVIA	45.2	24.4
BRAZIL	63.0	9.0
COLOMBIA	33.5	26.0
ECUADOR	29.0	21.1
GUYANA	n.a.	n.a.
SURINAME	92.0	n.a.
PERU	40.3	33.7
VENEZUELA	20.0	15.0

Note: n.a. = no data available.
Sources: Gutiérrez and others (2004); Nippon Koei Lac Co. and the General Secretariat of the Andean Community (2005); Brazil: Instituto Brasileño de Geografía y Estadística (IBGE) (2006); Peru: Instituto Nacional de Estadística e Informática (INEI) (2006); Supelano (2006); Brazil: Ministerio do Medio Ambiente and others (2007); Suriname: Análisis Sectorial de la Oferta de Agua Potable y Saneamiento en Suriname (2002); World Bank(2005).

"Amazonia needs to be preserved to study it, to explore the forest without extracting from it but in a totally new way. Brazil should lead the development of the new forest economy".

CARLOS NOBRE, SCIENTIST - NATIONAL SPACE RESEARCH INSTITUTE (INPE), BRAZIL

The environmental effect of reduced vegetal coverage is cumulative for the basin as a whole, since it has been proven that the volume of water a given region ceases to receive after being deforested will be proportional to the intensity and frequency of rainfall, as well as to the amount of fresh biomass removed (United States Agency for International Development [USAID] 2005; Marengo and others 2006; Troncoso and others 2007). To wit, having less forest coverage reduces evapotranspiration while promoting soil erosion and increased surface drainage, because of the rain falling directly on the unprotected ground. This increase in surface drainage, in turn, generates an increase in the volume of the basin's flow, accelerating the egress of water from the system. Therefore, the environmental service provided by the Amazonian basin, as regulator of the water cycle, not only for the basin itself, but also for the water balance of the countries of South America, is being lost in ever-increasing proportions (Nepstad and Campos 2006; Troncoso and others 2007).

Subterranean waters

If the potential of subterranean waters, for which there are no known statistics for any of the Amazonian countries, is added to the panorama described above, the hydrological potential may possibly be multiplied several times over. Bolivia and Colombia have identified hydrogeological provinces, among them Amazonia, to which they attribute a huge potential (García and others 2001; Van Damme 2002; Colombia: *Instituto Colombiano de Minería Y Geología* [Ingeominas] 2004). Brazil also confirms this potential and indicates that the system for recharging aquifers is facilitated by the high pluviometric index and the abundance of surface water (Pedrosa and Caetano 2002).

Although there is no certain knowledge on subterranean water supply, its usage has been identified for a variety of activities. For example, Pedrosa and Caetano (2002) estimate a series of uses for Brazilian Amazonia that could be the general trend for other countries:


CONSERVACIÓN INTERNACIONAL

All Amazonian inhabitants has a right to clean and health water.

- Most subterranean water is destined to human consumption and the percentage of water used in other activities (irrigation, livestock production, industry, etc.) is less than 10%.

- The contribution of subterranean water to public services is relatively small as against its tremendous possibilities; for example the State of Amazonas in Brazil uses 25% of available subterranean water sources to supply public service.

- There is a large number of shallow wells in household patios in the region, which, due to deficient construction and a lack of conservation measures, are focal points for aquifer contamination; for example in Belén, Brazil, there are a total of 20,000 wells, used by residences, hotels, hospitals and small industries, among others.

In Peru, INRENA indicates that the city of Pucallpa, in the Ucayali basin, has 2,802 domestic wells, 7 for agricultural, 20 for livestock and 10 for industrial use (Peru: Instituto Nacional de Recursos Naturales [INRENA] 2006). In the city of Leticia's area of influence (the tripartite border: Brazil-Colombia-Peru), it is well known that among the indigenous communities, along the banks of the Amazon and in urban family groups, the practice of constructing shallow wells, to insure a clean, continuous and abundant water supply, has become customary. (Nippon Koei Lac Co. and the General Spell Check of the Andean Community 2005).

In coastal Amazonian countries (Guyana and Suriname) the coastal aquifer system is the most important source for generating subterranean water; in the case of Guyana it supplies 90% of the population, residing in low-lying areas (US Army Corps of Engineers Mobile District and Topographic Engineering Centre 2001, Guyana Environmental Protection Agency [EPA] 2007).

SUBTERRANEAN WATER PRODUCTION IN SOME AREAS WOULD ALLOW CITIES WITH POPULATIONS OF 20,000 TO 70,000 INHABITANTS TO BE SUPPLIED FROM A SINGLE WELL.

Diverse studies in Latin America indicate that subterranean water production in some areas is between 200 and 700 m^3/hour; sufficient for supplying cities with populations of 20,000 to 70,000 inhabitants from a single well (UNESCO 1996, cited in Global Water Partnership – South American Technical Advisory Committee 2000). The preceding information suggests the expedience of regionally evaluating the supply of subterranean aquifers and defining the minimum parameters for their appropriate use, in conjunction with all the countries of the basin, depending on the origin, depth and destination of the volumes of water that are extracted from these reservoirs.

MULTIPLE USES AND QUALITY OF WATER RESOURCES

The principal use of water resources in Amazonia is for agricultural and livestock activities, followed by other industrial uses. They all generate impacts on the quality of the resource to a greater or lesser extent. On the other hand, coverage of water for consumption by the Amazonian population is still very limited, in spite of the fact that the supply is very ample, from which we can gather that there is a problem of service management.

Water for domestic purposes

The average consumption of water for the population, depending on socio-economic strata and the needs of urban or rural zones, varies between 100 and 200 litres/person/day (Lopes and others 1998; Colombia: *Instituto de Hidrología, Meteorología y Estudios Ambientales* [Ideam] 2002; Brasil: *Ministerio del Medio Ambiente* - Agencia Nacional de Aguas [ANA] 2002a; Ecuador: *Consejo Nacional de Recursos Hídricos* 2002). Considering the upper value of 200 litres/person/day and an Amazonian population, estimated for the eight countries, of 33.485,981 inhabitants, it turns out that the per capita consumption of the Amazonian basin is 77.51 m^3/s of water to generously satisfy their domestic needs, which is 0.036% of the surface water that the system discharges into the sea.

In spite of the existence of a surfeit of water supply, when one analyzes the coverage of public services that have to do with the use of water (drinking water, waste water – sewerage) for each of the ACTO countries, in none of these cases, does it exceed 60% (Table 3.9). Most of the communities, distant from major urban centres, have few or none of these services, although they are subsumed under the average indicators (Nippon Koei Lac Co. and the General Secretariat of the Andean Community 2005, Supelano 2006) (for greater detail on certain cities see Section 3.5). In this sense, Brazil presents the best global indicators, followed by Bolivia and Peru.

The conditions of water use and services in rural areas of Amazonia can vary widely. It was reported that almost 80% of the population along the central axis of the Amazon river have their water supplied through local aqueducts (with serious limitations in service hours); the main problem is the quality of basic sanitation services (toilets and latrines), which gets worse as one approaches the border between Colombia and Peru. This means that sewage and residual waters from most population centres are drained directly into the aquatic ecosystems close to dwellings, with no treatment whatsoever, converting them into the principal vectors for diseases such as dengue and malaria.

One of the threats to water utilised near populated centres is related to basic sanitation, since nearly 70% of solid waste disposal takes place in open air. It is calculated that 1,700,000 tonnes of waste reach the Amazon river system and 600 l/s of leachate enters the environment (Table 3.10) (Nadalutti 2002; Brazil: *Instituto Brasileño de Geografía y Estadística* [IBGE] 2006; GEO Brazil – Water Resources 2007).

Water for productive processes

The greatest demand for water comes from agricultural and ranching activities, and Brazil leads the field by far over the other countries of the Amazonian basin: its demand is somewhere between 60 and 250 m^3/s, depending on the source consulted (Brazil: ANA 2002a and 2002b; Brazil: Ministerio do Meio Ambiente and others 2007), and is mainly a function of the extensive plantings in the south and southeast of its Amazonian territory, with a tendency to continue increasing the area that must be irrigated, with projections that go from the current 92,000 to 300,000 hectares for the year 2020 (Brazil: Instituto

ALMOST
80%
OF THE POPULATION ALONG THE CENTRAL AXIS OF THE AMAZON RIVER HAVE THEIR WATER SUPPLIED THROUGH LOCAL AQUEDUCTS.

Sewage and residual water of most populated centres go directly into aquatic ecosystems near dwellings, without any type of treatment.

TABLE 3.10
Estimate of solid waste and leachate produced in the Amazon basin

COUNTRY	SOLID WASTE (T)*	CALCULATION OF LIXIVIATE (L/S)**	SOLID WASTE ENTERING THE RIVERS (T)
BOLIVIA	94,275	5	18,855
BRAZIL	5,438,584	388	1,087,716
COLOMBIA	254,802	24	50,960
ECUADOR	47,654	6	9,530
GUYANA	-	-	-
PERU	2,445,906	155	489,181
SURINAME	90,000	7	18,000
VENEZUELA	37,000	3	7,400
TOTAL AMAZONIA	**8,408,224**	**589**	**1,681,644**

* The solid waste estimate was made by multiplying the per capita rate of production in the basin (0.2 – 0.4 t/year) by the population data per country in the region.

** The formula for estimating the flow of lixiviates is Q = K x NT x RY x 1 litre. Where Q = flow in l/sec. K = is a constant of permeability. If the site is protected with a covering material, we use el K = 0.1. If the site is completely uncovered, with the waste in the open air, K = 0.6 is used. NT = is the total quantity, in tons, of solid waste placed in the site. RY = average yearly rainfall in mm/year. To develop the formula, the constant of 0.6 is taken tighter with an existence for the waste deposit as 10 years. Adapted from: "Guide for developing an integral solid waste management plan" from the UNICEF Integral Solid Waste Management Plan (ISWMP), Municipality of Mirafores, Department of Guaviare, Colombia.

del Medio Ambiente y de los Recursos Naturales Renovables 2006). Regarding the other countries for which there is information on water used for agricultural activities, Colombia uses 76 m^3/s; Peru, 61.70 m^3/s; and Suriname, 61.13 m^3/s (Goulding and others 2003a; Peru: Instituto Nacional de Recursos Naturales [INRENA] 2006; Supelano 2006; US Army Corps of Engineers Mobile District and Topographic Engineering Centre 2001).

Although the dimensions of the areas deforested due to agriculture and livestock activities begin to be significant, the main threat lies in the sectors of each sub-basin where these productive processes have been established. In Brazil, for example, the headlands of the Xingú and Tapajós Rivers are worked intensively. (Puty, Almeida and Rivero 2007; Troncoso and others 2007), while in Bolivia, Colombia and Peru there is intense agriculture and livestock activity in the Andean foothill sectors, in the precise vicinity of the headwaters of the larger tributaries of the Amazon River (Goulding and others 2003; Barthem and others 2004; Peru: *Instituto Nacional de Recursos Naturales* [INRENA] 2006; Supelano 2006).

Thus, the impact generated is doubly negative: that coming from deforestation itself and that caused by the use of fertilizers, pesticides, weed killers and products of mechanisation. The first of these increase the concentrations of nitrates, which propitiate algal growth and eutrophication of lakes and flood areas, while the second have bio-accumulable compounds (e.g., organochlorines), which affect the rest of the organisms in the aquatic ecosystems, especially fish which, in most of Amazonia, are the base of the diet for local populations (Global Water Partnership – South American Technical Advisory Committee 2000; *Centro Latinoamericano de Ecología Social* [CLAES] 2008; Pasquis 2006; Barthem and Goulding 2007).

Furthermore, if one considers illegal crops and the production of basic cocaine paste, which uses around two metric tonnes

Most of the communities far from the principal urban centre have few or none of the public services related to water use, although they are hidden in average figures of indicators.

BOX 3.6
GLYPHOSATE AND ITS MIXTURES: IMPACT ON NATIVE FISH

Toxicity experiments (lethal concentration 50 - LC50) were conducted at the Aquaculture Institute of Los Llanos (IALL) in Colombia, using glyphosate (120 mg/l-1) on the *gamitana (Piaractus brachypomus; Red-bellied Pacu)*. As a result they found toxic action in the gills, liver, kidneys, skin and brain; a reduction in swimming and in respiratory frequency; as well as a delay in response to stimuli. The authors recommend evaluating the concentrations of glyphosate present in the bodies of water near areas of fumigation to define the susceptibility of the species found therein.

Source: Eslava and others (2007).

of chemical precursors (sulphuric acid, quicklime, gasoline, kerosene, potassium permanganate and ammonia) per hectare of processed coca, one can imagine the magnitude of the problem (United States Embassy 2001, *Oficina de las Naciones Unidas Contra la Droga y el Delito* [ONUDD] 2005; Salazar and Benites 2006). Glyphosate is used to control these plantations, particularly in Colombia. Glyphosate is a herbicide, whose spray rate is between 17 and 30 l/ha, which has demonstrated adverse effects on organisms inhabiting aquatic ecosystem (Eslava and others 2007).

Notwithstanding, the water resources used by the industrial sector do not exceed 4.0 m^3/s per country and are more closely related to large urban centres. This figure must be underestimated, since most of the industrial centres use water from underground wells, which has not been adequately quantified (Pedrosa and Caetano 2002). Furthermore, mining processes demand large quantities of water for their operation, as is the case of gold exploitation through dredging that processes thousands of litres per second, but mixed with sediment from the deforested areas or from the riverbeds where the gold is found. This activity causes an increase of suspended solids in the bodies of water and alters the functioning of natural habitats for aquatic species (Goulding and others 2003a, Barthem and others 2004).

However, the most dramatic problem is related to spillage of chemicals used for gold extraction. It is estimated that to obtain one gramme of gold, one to three grammes of mercury must be used as well as cyanide and detergents. That implies that nearly 24 kilogrammes of mercury are fed into each square kilometre of river (Gómez 1995b; Sweeting and Clark 2000; Global Water Partnership – South American Technical Advisory Committee 2000; Mann 2001; Franco and Valdés 2005; Ibish and Mérida 2004; Fobomade 2005). It is estimated that Brazilian Amazonia incorporated 2,300 tonnes of mercury into the environment as of 1994, a rate that continues today at 150 tonnes/year (Mann 2001; Commission on Development and Environment for Amazonia 1992).

In this regard, recent research has demonstrated that there is also a certain amount of mercury found in nature, and it is estimated that the contribution from gold extraction activities only reaches 3% of the total mercury found in the basin. Therefore, careful analysis should also be done on the problem of bioaccumulation of mercury in migratory fish that arrive in zones where there are no mining operations, but which will be consumed by the population and converting it into a regional problem (Sweeting and Clark 2000; Crossa and Alonso 2001; Goulding and others 2003a; Barthem and others 2004). At any rate, the total effect of the process in a given region of Amazonia causes changes in the pH (<4), acidifying receiving waters, limiting the presence of aquatic flora and fauna, and in certain cases, contaminating underground water supplies (Van Damme 2002, Osava 2005, Salazar and Benites 2006).

Petroleum extraction also uses significant volumes of water. For each barrel of petroleum extracted, an average of 2.5 barrels of water are used and becomes enriched as a brine (sulphates, bicarbonates and chlorides / ± 200,000 ppm). It is estimated that as much as 590 million barrels of residual waters are produced per year (table 3.13). To dilute these salts to concentrations close to those of the Amazonian waters (± 7 ppm) requires at least 3.75 m^3/s for each 1,000 barrels processed per day (Gómez 1995a; Global Water Partnership – South American Technical Advisory Committee 2000; Martínez 2005). In the particular case of Colombia, the constant attacks against the petroleum infrastructure have led to oil spills, estimated at 5,000 barrels per day, that have affected surrounding soils and waters (Ecopetrol 2003).

ON AVERAGE
2,5
BARRELS OF WATER ARE USED FOR EACH BARREL OF PETROLEUM EXTRACTED IN AMAZONIA.

To obtain a gramme of gold one to three grammes of mercury are used, as well as cyanide and detergents. This implies that close to 24 kilos of mercury are dumped per square kilometre of river.

Due to their great volume of flow, the Amazonian river systems would have a high capacity for diluting brine concentrations and oil spills. In addition to the strategies of biosecurity and prior treatment, to which the petroleum companies should adhere, this would lead one to suppose that the negative effects can be more effectively minimised (Global Water Partnership – South American Technical Advisory Committee 2000).

Of all the uses that have been given to the water resource in the Amazonian basin, hydroelectric generation definitely demands the greatest volumes of water, and generates the greatest impacts. In this sense, while the Andean– Amazonian countries have yet to take advantage of its full potential, Brazil currently has 24 hydroelectric dams, which have flooded more than 11,700 km^2 of Amazonian territory (Brazil: *Ministerio de Minas Y Energía* 2006; Lopes and Cardoso 2006; Brazil: Ministerio do Meio Ambiente and others 2007).

The direct problems linked to these flooded areas include sedimentation, the exaggerated growth of macrophytes, the reduction of fisheries downstream from the dams, and the increase of diseases whose vectors are aquatic organisms (Goulding and others 2003; Oliveira 2003). However, it has been proven that the construction of dams does not alter the volume of water currents in the region, and although it may change the discharge cycle, there is no proof of an annual reduction in volumes of flow of Amazonian rivers (Oliveira 2003). The example of the Afobaka Dam in Suriname illustrates a part of the drawbacks that can arise from hydroelectric infrastructure projects.

STATUS OF AQUATIC ECOSYSTEMS

The types and quality of water are two widely studied aspects in the Amazonian basin (Salati 1983; Sioli 1984; Junk 1997; McClain and others 2001). The most thoroughly studied aspect is the physicochemical characterisation of Amazonian waters, followed by the taxonomy and ecology of phytoplankton, zooplankton, macro-invertebrates and productivity. This set of references illustrates the mosaic of Amazonian aquatic environments that give origin to the significant diversity of aquatic organisms and sustain extraction activities as important as fishing.

TABLE 3.11
Volume of wastewater (brines) originating from petroleum extraction activities in Amazonia

COUNTRY	BRINE PRODUCTION (BARRELS/YEAR)
COLOMBIA	11,529,465
BOLIVIA	n.a.
BRAZIL	41,883,750
ECUADOR	496,030,437
GUYANA	n.a.
PERU	41,251,537
SURINAME	n.a.
VENEZUELA	n.a.
TOTAL	**590,695,189**

Source: Ministry of Mines and Energy of Colombia; Ministry of Mines and Energy of Brazil <http://www.mme.gov.br>; Ministry of Mines and Energy of Ecuador <http://www.menergia.gov.ec>; National Statistics and Informatics Institute <http://www.inei.gob.pe>.

BOX 3.7
SOCIO-ENVIRONMENTAL EFFECTS CAUSED BY HYDROELECTRIC PROJECTS: AFOBAKA DAM IN SURINAME

The 1963 construction of the Afobaka (Brokopondo) Dam by Suralco, a subsidiary of the United States', Alcoa Corporation, primordially to supply electricity to its aluminium plants, implied the flooding of half the territory of the Saramacca (1,560 km^2) and displacing 6,000 inhabitants. The submerged vegetation decomposed and produced sulphuric gas in large quantities, and the water became acid, due to the lack of oxygen, resulting in the death of the basin's flora and fauna.

Source: World Rainforest Movement (2000)

Hydroelectric generation demands enormous volumes of water and causes major environmental impacts.

SERGIO AMARAL / OTCA

The rivers are "highways" that make communication possible among Amazonian populations.

A good part of the Amazonian economy and its inhabitants nutrition sustenance is based on the use of the diversity of aquatic organisms, especially fish.

Types of water

Water characteristics in the Amazonian region can be classified into three groups, according to their origins and locations.

Andean, pre-Andean and alluvial formation regions: the waters coming from this sector are muddy, yellowish (white waters) and are fed by material from recent geological formations within the Andean mountain range. They transport huge quantities of sediments, which are deposited in banks and floodplains or form islands (Furch 1984). The mineralization (60 - 200 $\mu S.cm^{-1}$)and pH levels (6.0 – 8.0) of these environments are higher than those of the other two regions. The rivers that originate in these formations present a decreasing gradient in their mineralization (McClain and others 2001), as they get further from their origins; as examples of there are: in Bolivia: Mamoré and Ichilo; in Brazil: Amazon-Solimoes; in Colombia: Caquetá/Japurá and Putumayo/Izá; in Ecuador: Napo and Pastaza; in Peru: Tambopata, Marañón, Yuruá, Ucayali and Madre de Dios. These rivers produce a yearly flood pulse of rising and falling water levels (Junk and others 1989) that propitiates changes in river and lake dynamics, affecting their hydrology as well as the physical, chemical and biological condition of their waters.

Region of the Guyanese Shield and the Central Brazilian Massif: these are very ancient geological areas, where black and clear waters originate. The former environments are characterised by having a low mineralization, expressed in terms of low conductivity (8 - 60 $\mu S.cm^{-1}$)and acidic environments (4.0 - 6.0). In this zone we find, among others, the headwaters of the Negro and Urubú rivers (Brazil), Madeira (Bolivia), Yavarí (Peru) and Igaraparaná (Colombia). On the other hand, the clear waters traverse zones with sandy soils and, therefore, lose most of the material in suspension; the chemical conditions are similar to those of the black waters, but their transparency is greater. Examples of the rivers that are classified among this group are Trombetas, Xingú and Tapajós. Each of the clear and black water tributaries contributes minerals or dilutes the waters of the greater Amazon river, generating an East – West gradient.

Region of central Amazonia: found in this province are rivers of a smaller order known as *igarapés* (streams) that run through the forests, and some lakes that are fed by both the Amazon and small tributaries. This is an area of extreme geochemical poverty, reflected in low levels of conductivity. This is even seen in the lakes of the Amazon valley that present a paucity of nutrients in certain seasons and thus influence the development of life strategies by aquatic biota.

Diversity of fish as a source of food and income

A good part of the Amazonian economy, and the nutritional sustenance of its inhabitants, is based on the diversity of aquatic organisms, especially fish, that are important factors for the region's economic, social and cultural movement. Since the 1990s, ichthyic resources have generated commercial flows, oscillating between US$100 million and US$200 million per year (Bayley and Petrere 1989; Petrere 1989; Almeida, Lorenzen, McGrath and Amaral 2006; Barthem and Goulding 2007). These yields are due, precisely, to the high ichthyic diversity of Amazonia, estimated as between 1,200 and 2,500 species, of which commercial and subsistence fisheries utilise an average of 200 species, and of these, 30 represent the basin's most important landings (Géry 1984; Barthem and others 1995; Barthem and Goulding 2007).

BOX 3.8

SEDIMENTS IN AMAZONIAN RIVERS

Due to the heavy rainfall it receives and to the strong topographic gradient varying from north to south, **the Andean mountain range undergoes intense erosive phenomena to enrich the Andean rivers of the Amazonian basin with huge quantities of materials in particulate (sediments) and dissolved form.**

Laraque, Guyot and Filizola (in press) coincide that it is difficult to evaluate the comparative yearly variability of the sediment flows in Amazonia due to the lack of long sampling series. When these exist, they generally refer to small basins, as in the case of the Piray River near Santa Cruz de la Sierra, in Bolivia. Analysing these sedimentary series in small basins reveals an extreme inter-annual variability of erosion in the mountainous region, where, for example, an exceptional flood caused by El Niño in 1982-1983, lasting for several days, modified the average inter-annual value.

IN THE MADEIRA RIVER BASIN, ONLY 40% OF THE MATERIAL ERODED IN THE ANDES REACHES THE AMAZON.

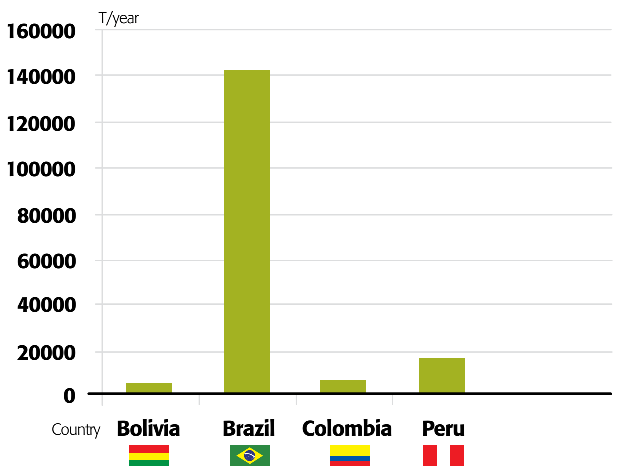
As it leaves the Andes, owing to diverse factors (a violent change in the topographical slope, different geodynamic processes, lithological variations), the transportation capacity of the water currents varies rapidly and the phenomena observed vary from one point of the mountain range to the next. In Ecuador, for example, the first data obtained suggest that half of the sedimentary flow of the Napo river, flowing into Peru, comes from Andean basins and the other half, from the erosion of Ecuadorian sediments. In Bolivia, to the contrary of what is seen in Ecuador, one sees an abundant sedimentation in the Andean piedmonts and much weaker slopes. In the Madeira river basin, only 40% of the material eroded in the Andes arrives in the Amazon. The total flow of sedimentary material exported by the Amazon to the Atlantic Ocean is estimated to be between 600 and 800 x 106 tonnes/year^{-1} (Filizola 2003). It is worth noting that the complex processes of erosion and sedimentary transfer, seen in different parts of the basin, are currently being studied and quantified.

Source: Laraque, Guyot and Filizola (in press).

FIGURE 3.3

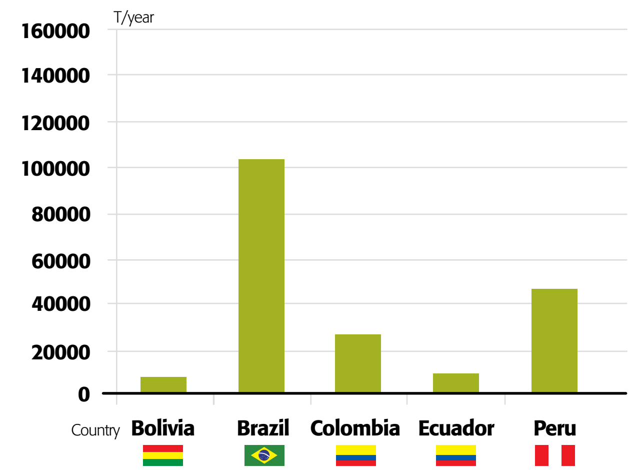
Average annual fisheries landings per country during the period 1988-1998 (a) and estimate of fish consumed by rural and riverside populations in Amazonia (b)

(a)



Source: adapted from Barthem and others (1995); Tello (1998); Peru: Ministerio de la Produccion – Dirección Regional de Pesquería de Loreto (2001); Barthem (2004); Batista (2004); Batista and others (2004); Isaac and others (2004); Viana (2004); Junior and Almeida (2006); Colombia: Instituto Colombiano de Desarrollo Rural [INCODER] (2006).

(b)



Source: adapted from Cerdeira and others (1997); Batista and others (1998); Fabré and Alonso (1998); Agudelo and others (2006).

In 1988, 166,000 tonnes were recorded as coming from the basin's principal fishing ports: Bolivia (3,000), Brazil (150,000), Colombia (3,000) and Peru (10,000) (Tratado de Cooperación Amazónica [TCA] y Organización de las Naciones Unidas para la Agricultura y la Alimentación [FAO] 1991). Ten years later, merging available statistics for the same countries, the calculation yielded 170,000 tonnes/year, which demonstrates a certain stability, at least regarding the volumes extracted (Barthem and others 1995; Tello 1998; Peru: *Ministerio de la Produccion* – Dirección Regional de Pesquería de Loreto 2001; Barthem 2004; Batista 2004; Batista and others 2004; Isaac and others 2004; Viana 2004; Junior and Almeida 2006; Colombia: *Instituto Colombiano de Desarrollo Rural* [INCODER] 2006).

The other side of the story concerns the fish consumed by the local populations, which implies no commercial exchange, and as a consequence does not appear in any official statistics. In this regard, it has been calculated that fish consumption per capita, for rural and riverside families in different regions of the basin, varies from 250 to 800 grammes/person/day (Cerdeira and others 1997; Batista and others 1998; Fabré and Alonso 1998; Agudelo and others 2006). Therefore, it is estimated that the aquatic ecosystems offer the inhabitants of Amazonia 200,000 tonnes of fish per year (Figure 3.3).

Adding these commercial production estimates to those destined to self-consumption gives values of nearly 400,000 tonnes/year that Bayley and Petrere (1989) calculated for Amazonia, and they are a long way from the potential of 900,000 tonnes/year, suggested by Merona (1993) for the entire basin. Therefore, one can conclude that fisheries activities are not in grave danger; however, there is excessive use of certain resources that are causing a decline in their natural supply.

This behaviour is evident when we analyze the data available from Brazil, Colombia and Peru for the years 1994, 1995, 1996 and 2000 (Figure 3.4) (Isaac and others 1996; Tello 1998, Peru: Ministerio de la Produccion – Dirección Regional de Pesquería de Loreto 2001; Barthem 2004; Batista 2004; Isaac and others 2004; Viana 2004; Colombia: Instituto Colombiano de Desarrollo Rural [INCODER] 2006; Almeida and others 2006; Barthem and Goulding 2007): (i) pirabutón, bocachico or curimatá, yaraquí, palometa, garopa or pacu and dorado, have always been the most commercialised species in the different years; (ii) B. *vaillantii* decreased to 13,000 tonnes/year in 2000; (iii) P. nigricans tended to increase greatly towards the year 2000, reaching 32,600 tonnes/year; (iv) pintadillo, doncella or Tiger shovelnose catfish (surubim) and B. *rousseauxii* surpassed 10,000 tonnes/year in 2000, and the first of these began to take on importance in the statistics of the three countries.

Fish consumption per capita, for rural and riverside families in different regions of the basin, varies from 250 to 800 grammes/person/day.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

Most food eaten by Amazonian inhabitants is river fish.

Similar cases were recorded in central Amazonia when, during the 1980s, the Manaus fishing fleet found it necessary to extend its fishing efforts to distances of over 500 km to maintain its production of the *gamitana* (Red bellied pacu). However, the species never regained its original yields (Bayley and Petrere 1989; Tratado de Cooperación Amazónica [TCA] y Organización de las Naciones Unidas para la Agricultura y la Alimentación [FAO] 1991; Barthem and others 1995; Isaac and others 1996). Recently, towards Upper Amazonia, the species popularly known as *lechero* is no longer commercially important and is being replaced by another, known as *mota* (Petrere 2001; Petrere and others 2004). In the case of other countries of the basin, Guyana and Suriname, Amazonian fishing is strictly a subsistence activity, and therefore has no recorded data, and in the case of Suriname, its only fisheries are in the coastal zone (Tratado de Cooperación Amazónica [TCA] y Organización de las Naciones Unidas para la Agricultura y la Alimentación [FAO] 1991).

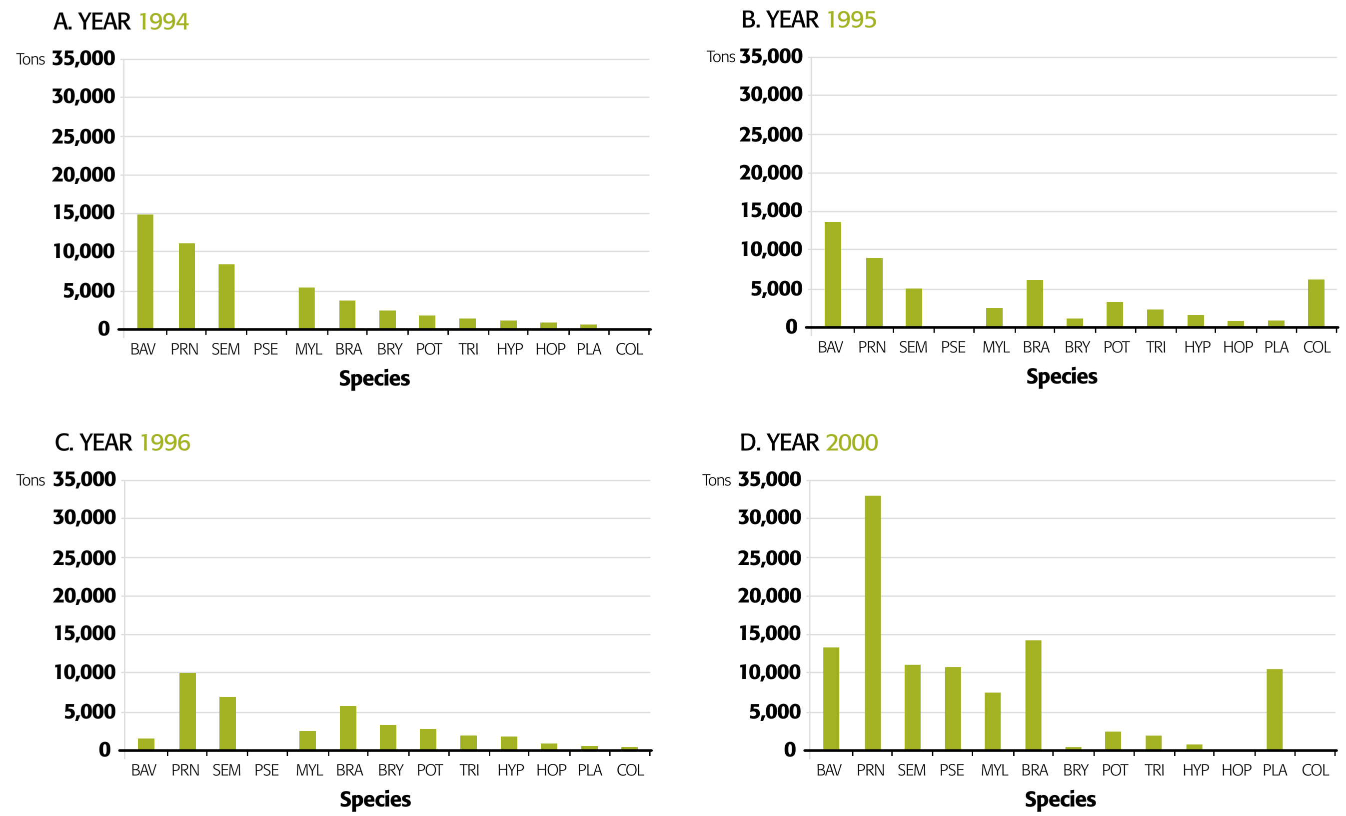
BOX 3.9

ALERT ON THE OVER-EXPLOITATION OF DORADO *(BRACHYPLATYSTOMA ROUSSEAUXII)* AND PIRABUTÓN *(BRACHYPLATYSTOMA VAILLANTII)*

Adults and pre-adults of Dorado are captured all along the Amazon river's main channel and major tributaries, while juveniles are heavily fished in the estuaries. Similarly, a significant number of pirabutón juveniles are also captured in trawl nets. In the first case, the first signs of over-fishing are being seen, while in the second, the situation has already been confirmed. Posting an early alert on the threat of a collapse of these fisheries should create an incentive for the governments of the Amazonian countries to consider plans for macro-regional management, in which definite measures can be applied and monitored in conjunction on either side of the borders.

Source: Adapted from Bayley and Petrere (1989); Ruffino and Barthem (1996); Barthem and Goulding (1997); Japan International Cooperation Agency (1998); Fabré and Alonso (1998); Agudelo and others (2000); Petrere (2001); Petrere and others (2004); Alonso and Pirker (2005); Fabré and others (2005); Almeida (2006); Food and Agriculture Organisation (FAO) (2006); Barthem and Goulding (2007).

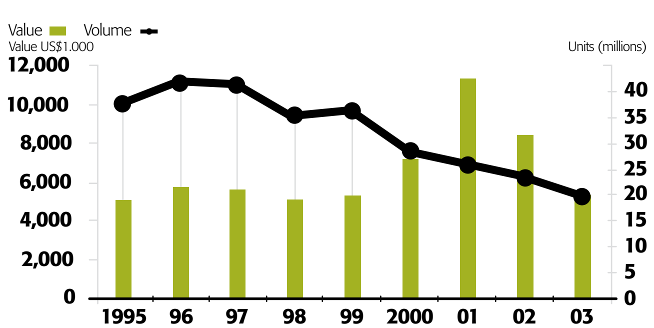
FIGURE 3.4
Principal species landed in Brazil, Colombia and Peru* in the period 1994-1996 and 2000



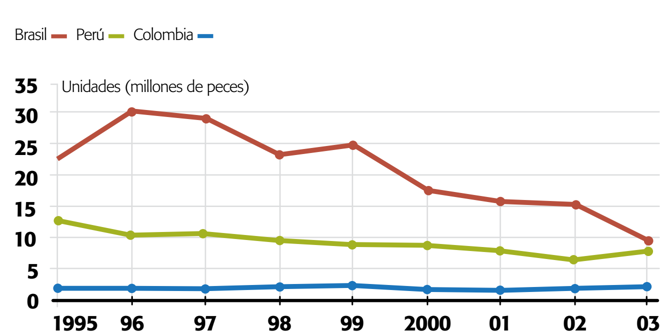
BAV: *Brachyplatystoma vaillantii* (pirabutón, piramutaba, manitoa), **PRN:** *Prochilodus nigricans* (bocachico, curimatá), **SEM:** *Semaprochilodus spp.* (yaraquí, jaraqui), **PSE:** *Pseudoplatystoma spp.* (pintadillo, surubim, doncella), **MYL:** *Mylossoma spp.* (palometa, garopa), **BRA:** *Brachyplatystoma rousseauxii* (dorado, dourada), **BRY:** *Brycon cephalus* (sábalo, matrinxa), **POT:** *Potamorrhina spp.* (branquinha), **TRI:** *Triportheus spp.* (sardina, sardinha), **HYP:** *Hypophthalmus edentatus* (mapará, maparate), **HOP:** *Hoplias malabaricus* (traira), **PLA:** *Plagioscion spp.* (curvinata, pescada), **COL:** *Colossoma macropomum* (gamitana, tambaqui).

Source: Adapted from: Isaac and others (1996); Tello (1998); Peru: Ministerio de la Produccion – Dirección Regional de Pesquería de Loreto (2001); Barthem (2004); Batista (2004); Isaac and others (2004); Viana (2004); Colombia: Instituto Colombiano de Desarrollo Rural (INCODER) (2006), Almeida and others (2006); Barthem and Goulding (2007).
** Brazil during the period 1994-1996 includes fisheries from Belén, Santarém and Manaus (with the exception of 1996, when there was no information on the refrigeration facilities in Belén). Brazil in 2000 includes the continental fisheries for the states of Pará and Amazonas. For Colombia data refer to landings in Leticia and Peru in the Loreto region.*

FIGURE 3.5
Annual fisheries exports from the Amazonian basin in the period 1995-2003 (Brazil, Colombia, Peru)



FICGURE 3.6
Live fish (units) exported by Brazil, Colombia and Peru from the Amazonian basin



150 ORNAMENTAL SPECIES ARE REGISTERED FOR EXPORT IN COLOMBIA AND PERU INCLUDING THE OTOCINCLUS CATFISH AND THE AROWANAS.

Aquaculture cannot be seen as a substitute for traditional fisheries, but rather as a viable alternative in Amazonia.

Due to the migratory and cross-border nature shown by the principal species that sustain Amazonian fisheries, it would be appropriate to integrate each country's basic knowledge of these species, as well as the initiatives among the countries for fishery management and administration. This will allow international agreements to be made to control fishing, define which equipment has the least impact and include strategic areas for the preservation of different stages of the species' development (i.e. spawning, breeding, and growth) (Ruffino and Barthem 1996; Barthem and Goulding 1997; Agudelo and others 2000; Ruffino 2000; Petrere 2001; Alonso and Pirker 2005; Fabré and others 2005; Alonso, Agudelo and others 2006; Barthem and Goulding 2007). Therefore the migration routes used by the fish during their life cycles must be safeguarded to ensure the dispersion and repopulation of these aquatic environments. In this sense, infrastructural mega-projects become the principal threats to the connectivity and environmental continuum of the Amazonian basin (Barthem and Goulding 1997; Petrere 2001; Alonso and Pirker 2005; Barthem and Goulding 2007).

Since the 1980s, aquaculture has been mentioned as a viable alternative in Amazonia; it could contribute to minimising the impact caused by overfishing of certain species, while allowing for the maintenance or improvement of the supply during the off-season within the natural milieu. In this sense, the supposition that aquaculture is an absurd activity or that it is anti-economic, in the face of the basin's vocation to fisheries, should be reoriented towards its outstanding strengths, due the excellent availability of water of different types and qualities (Junk 1983; Barthem and others 1995; Val, Ramos and Rabelo 2000).

Definitely, this productive alternative cannot be conceived as a substitute for traditional fisheries, but as an opportunity for development, which some governments are already supporting, with emphasis on areas near to the larger urban centres (Belén, Manaus and Iquitos) (Barthem and Goulding 2007). It is possible that the perspective of Amazonian aquaculture will be to supply local markets at low cost, while wild catch fishing could be directed toward export at higher market prices. (Almeida and others 2006).

Ornamental fish are also an example of Amazonian biodiversity in the fisheries. In the worldwide context, ornamental fish represent annual exports in excess of US$ 200 million, of which Amazonia contributes, depending on the year, between US$6 million and US$11.5 million per year, representing between 20 and 25 million live units per year of the 30 to 50 most utilised species (Figure 3.5). Brazil is the leading marketer, with an average volume of 16 million units, followed by Peru with 9 million and Colombia with 1.9 million (Figure 3.6) (Food and Agriculture Organisation [FAO] 2002; Perdomo 2004; Pereira 2005; Junior and Almeida 2006; Prang 2006).

In Brazilian Amazonia some 180 ornamental species are commercialised, of which the most frequently captured are the cardinal and the neon tetra (Pereira 2005; Brasil: Ministerio de Minas y Energia – Petrobras 2005; Freitas and Rivas 2007). In the case of Colombia and Peru, there are 150 species registered for export, of which the most representative are the otocinclus catfish and the *arowanas* (Perdomo 2004; Campos-Baca 2005; Sanabria 2005; Rodríguez-Sierra 2007). The last named species presents a certain degree of threat, since it is a medium-sized fish and also suitable for consumption; however, given its exotic characteristics, its larvae and fry are commercialised (Junior and Almeida 2006; Rodríguez-Sierra, 2007). The combined exports of Guyana, Venezuela and Ecuador amount to less than 2% of the total sold by the Amazonian countries (Cabrera 2005; Prang 2006).

Arowana trade, as with other ornamental species, presents conflicts in usage and legislation at the borders between Brazil, Colombia and Peru. Therefore, a strategic initiative is needed to administer the activity through management plans coordinated between the countries involved so that, by sharing responsibilities, a commitment between users and institutions would have greater effect (Food and Agriculture Organisation [FAO] 2002; Colombian Rural Development Institute / Traffic – South America / WWF – Colombia 2005).

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3.4 | AGROPRODUCTIVE SYSTEMS

The term "Agroproductive systems" refers to the set of biological and natural resources, managed by the population, to produce food and other non-food goods, as well as to conserve ecosystem services that society values. A variety of agricultural productive systems have been developed in Amazonia, taking advantage of the wealth of its ecosystem services. However, the development and operation of those systems varies between and within each of the Amazonian countries

AMAZONIAN AGROPRODUCTIVE SYSTEMS

Soil quality is fundamental to sustaining the production of agricultural productive systems. Amazonian soils are generally poor, due to their thin layer of organic material. Because of its wealth of micro-organisms, the organic material is the source of nutrients for plants. This microbial diversity is fundamental to ecosystem function, owing to the varied processes those micro-organisms control, such as decomposition, nutrient recycling and soil aggregation, among others (Peña and Cardona 2007). Furthermore, organic material acts as a protective layer for the soil against erosive agents or processes.

Amazonian soil has different characteristics, according to its development in alluvial or non-alluvial zones. In alluvial flood zones, the soil has greater natural fertility, since it is fertilized annually by mud and clay sedimentation left by floods; however, it has poor drainage. Generally speaking it is covered by water during most of the year. River bank lands have their own particularities, according to the cycle of flooding and its wealth of nutrients, and there is an identifiable classification into: mires, islands, beaches, swamps, shoals and floodplains. These soils are sensitive to hydrological erosion, and therefore, to loss of fertility; thus, when the forest is cleared for agricultural development, the fragile natural equilibrium of the ecosystem is broken, and the rains cause its rapid impoverishment. Soils in non-alluvial zones are those found in the shoals, high terraces, hills, and mountains, which have been enriched by the biomass they support (Rodríguez 1995). It should be pointed out that there is limited knowledge about the characteristics of these soils and their use potential, as well as relating to the species or varieties that are suitable for development thereon.


INSTITUTO IMAZON

Unsustainable productive systems advance in Amazonia.

Amazonian agroproductive systems are heterogeneous, both in their production modes and scale, as well as their access to natural resources and the destination of their production, among other factors. In this sense, traditional production systems exist alongside their modern, high technology counterparts. The development of agroproductive systems is conditioned by the process of land usage in Amazonia (see Chapter 1, Section 1.2.), as well as by the socio-economic dynamics of the areas neighbouring the Amazonian region of each country.

Agroproductive systems in Amazonia include: agrosilvopastoral, agroforestal, forest grazing, agricultural systems for forest enrichment, simple agriculture (i.e. monocultures) and extensive livestock production. The agrosilvopastoral system consists of integrated crop management, pasturelands for livestock production and forestry activities involving timber-yielding and non-timber yielding products. The agroforestal system concentrates on managing associated crops and developing synergies with appropriate forest species; this system helps to improve crop yields and soil

The fragile fertility of Amazonian soil means low crop yields compared to other productive zones.

conservation, and to reduce agrochemical usage. Forest grazing systems associate livestock production with managing pasturelands and forest resources. Agricultural systems for forest enrichment involve managing timber-yielding and non-timber-yielding forest species. All of these systems assume integrated management of the productive unit, not only to guarantee the conservation of ecosystem services, but also to consider economic profitability and improving the quality of life of the population.

In contrast, there are also monoculture and livestock production systems that concentrate on using natural resources to attend to the growing demands of the food market and on maximising earnings, without considering ecosystem functions.

Agroproductive systems are managed by growers with a wide variety of profiles and differing interests:

- In **production by indigenous populations**, the property regimen is communal. They manage integrated production systems that include agriculture and extraction (hunting, fishing, forest crops). Productive management is traditional, to wit, in agriculture, no agrochemicals are used and forest management is a community activity. The environmental impact from these productive activities is minimal.

- In the genre of **production by settled small-scale farmers**, the growers generally own the land they work. They carry out a variety of productive activities: diversified agriculture, livestock production, forest exploitation and artisan mining. Frequently the settler comes from a different ecological environment, and is therefore not familiar with the Amazonian forest. For this reason and because he has no training, he employs agricultural techniques that are inappropriate or inadequate for the Amazonian physical milieu.

- In the **entrepreneurial production** mode, access to natural resources (e.g. land) can be attained through concessions, forced occupation of the land or by obtaining illegal property titles, among others. Productive activities are specialised and highly technical. The main productive activities are: monoculture agriculture articulated under an agro-business chain (e.g. soya), livestock production (e.g. dairy and zebu cattle), selective extraction of timber-yielding species, management of oil palms (e.g. dendé and babazú), production of sugarcane to produce biofuels, among others.

BOX 3.10

BABAZÚ: OPPORTUNITIES AND LIMITATIONS

Characteristics

- Native palm from the northern and north-eastern regions of Brazil.
- Extends over 13 to 18 million hectares.
- States of Marañón, Piauí, Tocantins, Goiás, Mato Grosso, Amazonas and Pará.
- Marañón accounts for 55% of the babazú growth area.
- Babazú provides around 64 sub-products (oil, ethanol, methanol, cellulose, handicraft products, flours, glycerine, among others).
- Possibility of obtaining carbon credit for substitution of coal for babazú charcoal, a non-lumber yielding forest product, which allows for the palm trees to remain standing.

MARKET CHARACTERISTICS			
	RELATIVE SIZE	RELATIVE IMPORTANCE TONS/YEAR	PRICE RANGE US$/TON
PHARMACEUTICAL	VERY SMALL	< 105	> 2,000
CHEMICAL	MODERATE	< 106	700 - 2,000
NUTRITIONAL	LARGE	< 107	450 - 700
ENERGETIC	UNLIMITED	> 107	< 450

Source: *Secretaría de Extractivismo y Desenvolvimiento Rural Sustentable*. Ministry of the Environment.
Information supplied by Muriel Saragoussi (Ministry of the Environment, Brazil).

Reduced labour costs, low land prices, tax exemptions or evasion and the opening of communication routes sustain the competitive advantages of entrepreneurial agriculture in the region. Furthermore, international market forces, interested in expanding crops (e.g. sugar cane and soya) provide incentives for expanding the agricultural frontier into tropical forest ecosystems (Killeen and Da Fonseca 2006).

During the historical process of land occupation, Amazonia was considered an empty space with tremendous productive potential (see Chapter 1). Therefore, public policies applied since 1960 considered investments in infrastructure and promoted colonisation processes and the expansion of the agricultural frontier over this region. It should be clarified that in Amazonian agricultural development, there is a difference between riverside growers that cultivate the floodplains *(várzeas)* or riverbanks, and those growers who carry out their agriculture in the forest itself.

Production by indigenous populations is on communal property. Their integrated production systems include agriculture and extractive activities.

BOX 3.11

AMAZONIAN RIVERSIDE AGRICULTURE ON THE UCAYALI RIVER (PERU)

"The banks of the Ucayali river were the sites of the first indigenous and colonist settlements in Peruvian Amazonia, Those riverside populations developed diverse productive activities, such as fisheries, agriculture and others.

The complexity and diversity of the Ucayali agro-ecological system determines the agricultural activities employed during the different seasons of the year (Bergman 1990, De Jong 1995). One important element of the Ucayali agro-ecological system is the diverse variety of soil types, suitable for agriculture, that appear and disappear along the riverbanks, according to changes in the river.

Riverside crops include: plantain, cassava, rice, maize, beans, peanuts, soya, and many others. Rice is concentrated mainly in the mud flats *(barrizales)*, while maize gets better yields in the shoals (restingas). Once the crops are chosen, the production system becomes very simple; monocultures are predominant. There are few riverside growers involved in associated crop cultivation. The few that do exist are located on the shoals, and their production limited to self-consumption (Padoch and De Jong 1991).

Agricultural activity on the banks of the Ucayali can have high yields. However, this does not guarantee profitability for the crops nor for the farm managing them. To wit, both the yields and the earnings are susceptible to variations in the conditions for producing and marketing the products. The risks of early flooding, the high cost of river transportation and price instability all affect the profitability of their agriculture."

Source: Labarta and others (2007).

The expansion of soya cultivation is a response to the growing international market demand and the availability of relatively low-cost land.

In the case of the riverside or alluvial zone growers, they take advantage of the mud deposited during the flood stages of the river, allowing them to obtain better yields. Furthermore, there is a culture and method of production, typical of riverside dwellers, characterised by managing a variety of activities, such as extraction, which includes collecting fruits, vines, honey, latex, bark, flowers, gums and resins and ornamental fish, among others, in addition to farming. However economic feasibility studies evaluating these types of productive units are limited.

To cultivate the dry land or in the forest, the swidden technique is used (cut, fell and burn the forest) in order to clear the land and form a layer of ash, which contributes to soil fertility. On that prepared ground they produce diverse agricultural products (e.g. sugar cane, coffee, maize, grains and fruits, among others) (Rodríguez 1995).

The fragile fertility of Amazonian soil generates low crop yields in comparison to those of other productive zones. For example, in Peru, rice cultivation yields differ according to the area of production, depending on whether it is on the northern coast (8.5 MT/ha), the southern coast (11 MT/ha), the high forest (6,5 MT/ha) or the low forest (3 MT/ha) (Peru: *Ministerio de Agricultura* 2002; *Centro Peruano de Estudios Sociales* 2006). The limited fertility of Amazonian soil forces growers to move to a new zone every three to five years and generating migratory agriculture.

Soya is a monoculture that has begun expansion in Amazonia, although the production of this crop has traditionally been concentrated in other biomes, such as the Cerrado (in Brazil) and the Chaco and Chiquitano forest (in Bolivia). Expansion of soya cultivation responds to the growing demand on international markets and takes advantage of the availability of relatively low-cost land. The accelerated growth of soya cultivation has generated socio-productive changes, both in the productive zones and in their zone of influence.

Soya production is a monoculture that has begun expansion in Amazonia, although the production of this crop has traditionally been concentrated in other biomes, such as the Cerrado (in Brazil) and the El Chaco and the Chiquitano forest (in Bolivia). Expansion of soya cultivation responds to the growing demand on

TABLE 3.12
Amazonia: Crops and livestock production

	BOLIVIA	BRAZIL	COLOMBIA	ECUADOR	GUYANA	PERU	SURINAME	VENEZUELA
AGRICULTURE								
RICE	●	●			●	●	●	
COFFEE	●	●	●	●		●		
CACAO	●	●	●	●		●		●
SUGARCANE	●	●		●	●			
COCA	●		●			●		
CASSAVA	●	●	●	●		●		●
MAIZE	●			●		●		
PEPPERS		●						
SOYA	●	●						
TROPICAL FRUITS (BANANAS, CITRUS, COCONUT)	●	●	●	●	●	●	●	
FORESTRY								
DENDÉ NATIVE OIL PALM		●		●				
	●	●				●		●
EXOTIC FORESTRY	●	●						●
EXTRACTIVE FORESTRY	●	●	●	●	●	●		●
NON-TIMBER YIELDING FOREST EXTRACTION (E.G., BRAZIL NUTS)	●	●	●	●	●	●	●	
LIVESTOCK								
LIVESTOCK-PASTURES	●	●	●	●	●	●		●

Source: Original production; Programa de las Naciones Unidas para el Medio Ambiente (PNUMA) and others (2006 and 2007)..

international markets and takes advantage of the availability of relatively low-cost land. The accelerated growth of soya cultivation has generated socio-productive changes, both in the productive zones and in their zone of influence.

The mechanised nature of soya cultivation makes the flatlands suitable for this crop. Large-scale soya production has smaller manpower requirements (one worker for each 170–200 ha) compared to other crops. The extensive areas of cultivation require the use of crop dusting aircraft for applying herbicides, which favours the dispersion of these chemicals into the environment.

Beginning in 1984, soya cultivation in Bolivia was the main cause of deforestation. Between 1997 and 2006, the area of soya cultivation expanded by 411%, which meant 1,420,000 hectares of deforestation. Soya production is concentrated in the department of Santa Cruz. Eighteen percent of the deforested area is tropical rainforest, while 37% is in the wooded savannahs of the Gran Chaco and 30% in the Chiquitano forest. Some studies indicate that, in the case of San Julián - Santa Cruz, one of the main soya production centres, at the current rate, the forests will disappear within nine years. Soya management implies the use of an intensive technological package of agro-chemicals, to which is added the initiation of trans-genetic soya production. Thus, depending on the type of seed used, production costs will vary; with conventional seed they are approximately US$229/ha, while in the case of trans-genetic seed these costs rise to US$351/ha (*Asociación Internacional por la Salud* 2006).

Soya cultivation in Brazil is also advancing into rainforest areas (e.g. Rondonia, Pará and Amazonas) (Pasquis 2006). This expansion of production affects habitats with high conservation value and the way of life of the local population, because it leads to erosion and soil exhaustion and obliges the locals to either substitute their productive activities or abandon their lands. Furthermore, it fosters exhaustion and eutrophication of the rivers and the loss of ecosystem supportive services; in particular, it reduces soil fertility.

ENRIQUE CÚNEO / EL COMERCIO

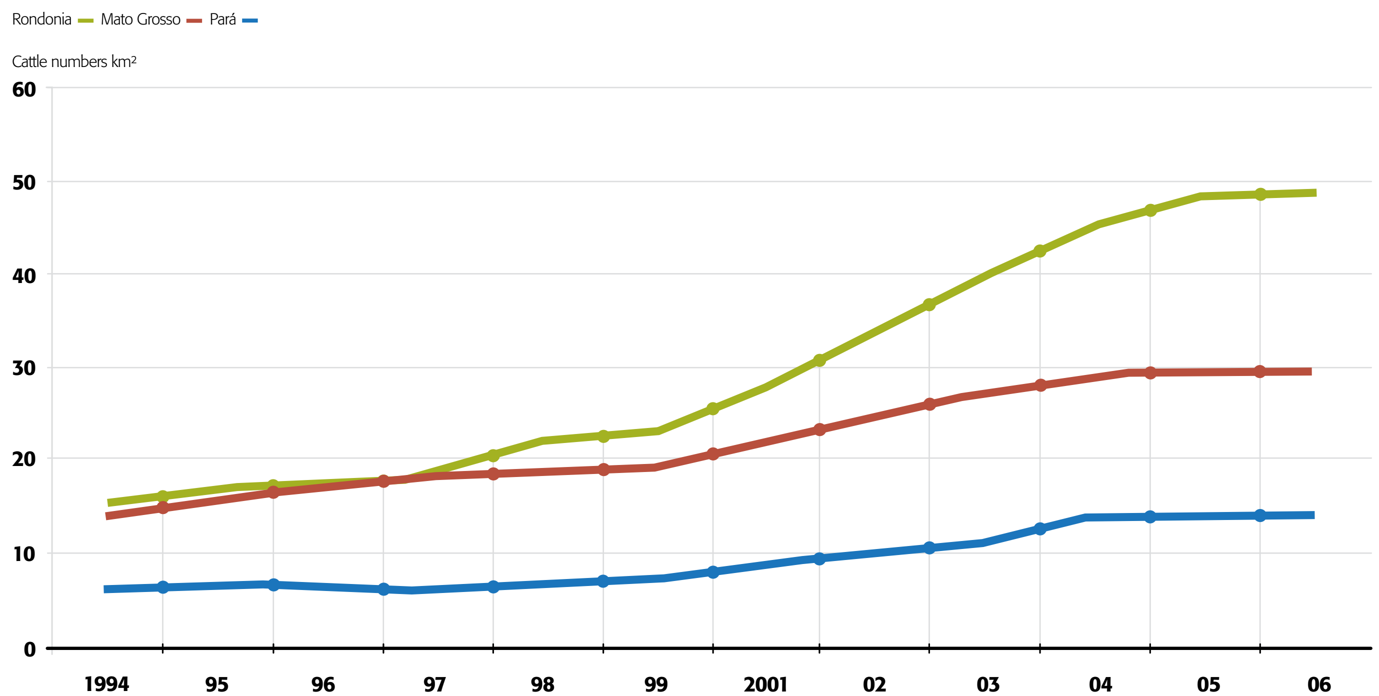
In remote sectors of the Bolivian and Peruvian Andean foothills poor *campesinos* produce coca leaf both for traditional consumption and for the illegal market.

Coca is a crop concentrated in the Andean-Amazonian zone and the region contains 98% of the world coca production. Production moves from one producing country to another, according to the risks faced. Thus, after 1998 when eradication programmes became aggressive and effective in Bolivia and Peru, production moved to Colombia. The coca harvesting area reached its maximum level in the year 2000, with 221,300 ha and its minimum level in the year 2003, with 153,800 ha. In 2006 there was a slight reduction of 2% compared to the previous year, when 156,554 ha were recorded (*Oficina de las Naciones Unidas Contra la Droga y el Delito* [ONUDD] 2007).

Coca growing areas are located in remote zones with difficult access and generally on steep slopes, so that land preparation for planting frequently provokes intensive erosion of the slopes. The incentive for planting coca is the significant short-term income that can be earned and that is higher than any other crop. For example, the average price for coca leaf in 2005 showed an increase of 3.6% over the previous year, reaching US$2.90/kg. The expectation of higher income attracts migrants from other regions. In Peru and Bolivia, as against Colombia, coca leaf cultivation for traditional consumption *(chaccheo)* is legal (Durand 2005).

FIGURE 3.7

Livestock density in the States of Rondonia, Mato Grosso and Pará (Brazil) 1996 – 2006



Source: Brazil: Instituto Brasileño de Geografía y Estadística (IBGE) (2007)

The use of agro-chemicals (fertilisers and pesticides) in the Amazonian region has increased, due to the need to improve soil fertility and control pests. This increase is due principally to the expansion of monocultures, such as soya or coca. In Brazilian Amazonia, for example, the states leading in consumption of agrotoxic substances are Mato Grosso (208 kg/ha), Tocantins (112 kg/ha) and Amapá (105 kg/ha) (Brazil: *Ministerio del Medio Ambiente* 2005).

In Guyana, agricultural development is concentrated along the coast, and the principal crops are sugarcane and rice. The Guyanese coast is between 0.5 and 1 m below sea level and has natural defences like mangrove swamps and concrete infrastructure, which protect it from incoming salt water, making it inhabitable and suitable for growing crops. In contrast, the soils of the country's interior are fragile and clayey, which allows certain crops to grow (cereals, peanuts, coconuts, tomatoes; fruits like coconut, mango, star fruit, pear, bananas, and others) as well as livestock. In general, the National Development Strategy indicates that agricultural expansion in the country assumes the use of good agricultural practices that include the elimination of aerial fumigation, an increased use of bio-insecticides, and the revision of agro-chemical use, among other measures (Guyana: National Development Strategy Secretariat 2006).

In Venezuela, expansion of the agricultural frontier was carried out by assigning forest-covered public lands to landless *campesinos* and they began by commercialising the most valuable forest species and then burning the degraded forest to use it for agriculture. During the period 1980-1990, the annual rate of agricultural frontier growth was 2.9%, reaching 32 million hectares by 1990 (World Movement for Tropical Rainforests 2002).

The original forest must also be converted into cleared land for livestock production. Later grasses are introduced, which in some cases are associated with legumes (Rodríguez 1995). Livestock production is an activity that requires the field worker to live in one place and limits shifting agriculture. In Amazonia there are two identifiable methods of livestock production: on the one hand are the small-scale traditional ranchers, and on the other, commercialized/intensive cattle raising.

Small ranchers, generally in a situation of poverty, with limited pasture management due to the lack of technical assistance and information on adequate technology, have reduced levels of productivity in terms of litres of milk/cow or kilos of meat/steer.

In the second case, intensive livestock production is carried out, which is mainly managed by livestock companies with greater extensions of land and economic resources. This type of cattle rancher carries out pasture management, introduces improved stock and uses other industrial products to complement feeding the livestock. Intensive livestock production has expanded in Amazonia and is linked to international markets through meat exports.

Intensive grazing in a single field throughout the year leads to extreme trampling of the forage, limiting its normal development and causing soil compaction. This leads to the disappearance of cultivated grasses and in some cases the abandonment of the pastures, as they are converted into young fallows, difficult to recuperate. Cattle raising activity in Amazonia has intensified in recent years, i.e., the land supports a greater number of head of cattle per unit of surface, a situation that is highlighted in Brazil and Bolivia. In Brazil, for example, the States of Rondonia and Pará show a significant increase in livestock production pressure, with an annual increase of 11.7% and 9.68% in the number of head of cattle per km², respectively, during the period 2001-2006. Rondonia went from 27.69 head of cattle/km² in 2001 to 48.15 head of cattle/km² in 2006.

In Brazil, the increase in bovine livestock has been huge and fast, from 34,721,999 head of cattle in 1994 to 73,737,986 in 2006, occupying 74% of the deforested area. The average annual growth rate for the cattle herd increased significantly, if we compare the numbers by five-year increments; during the period 1994-1999 the annual increase in head of cattle was 4.7%, and the period 2001-2006, was 7.4%. The speed of cattle herd growth is differentiated among the states, of which Rondonia is the undisputed leader, with an annual rate of 11.7% between 2001 and 2006. Smeraldi and May (2008) stresses the fact that for each four additional head of cattle added to the State's herd over the last five years, three were added in Amazonia. It is worth noting that 75% of the cattle herd is concentrated in the states of Mato Grosso, Pará and Rondonia. In addition, there are two aspects of large-scale cattle ranching that contribute to the production of greenhouse gases: (i) the emission of nitrous oxide from excrement; and (ii) the 21-300 times increase of methane due to the intestinal fermentation of the ruminants (Smeraldi and May 2008).

BOX 3.12

BOLIVIA: LAND MANAGEMENT AND A WEAK LEGAL-INSTITUTIONAL FRAMEWORK

"Regarding land ownership in the lowlands, there is no recent, reliable information and there are large areas where several corporations, persons and communities have overlapping territorial claims. Official statistics show that between 1955 and 1994 some 30 million hectares of public lands were given away (40% of the region's total area) to different groups. Nearly 23 million hectares were given to mid-sized and large farming enterprises, three million to small scale agricultural settlers and three million to indigenous groups. Nevertheless, a much greater proportion of the region's land is under 'de facto' private control, as a product of a great many illegal and semi-legal manoeuvres, above all, by entrepreneurial growers. In many cases, these groups have falsified documents, bribed government officials, obtained properties without complying with the legal requirements or bought land knowing that it had been acquired illegally".

Source: Pacheco (1998).

In Bolivia, the principal departments for bovine livestock are Beni and Santa Cruz, predominated by medium and large-scale ranchers. The Department of Beni contains 48% of the country's cattle, in an area greater than 200,000 km². Bolivia's total cattle herd increased by 31% between 1994 and 2004, from 5.4 million head in 1994 to 7.1 million head in 2004. Meat production also grew by 36%, from 125,000 MT in 1994 to 169,000 MT in 2004 (Bolivia: *Unidad de Análisis de Políticas Sociales y Económicas* 2004).

In Colombia, intensive livestock production also grew in its Amazonian sector. The cattle consume a variety of forest undergrowth species and fruit from its trees, and generally develop on acid soils, with little consideration for ecological criteria, and productive yield is relatively small (*Instituto Amazónico de Investigaciones Científicas* [SINCHI] 2007).

Regarding access to the principal factors of production, land and labour, these markets are generally distorted, due to the problems associated with assigning property rights and to incomplete information, which negatively affects their efficient operation. This promotes repeated non-compliance of norms, overlapping property rights and to squatters' rights being claimed based on possession rather than title.

Agroproductive systems have developed in parallel with structural changes in landholding. In this sense, the nations of Amazonia have carried out processes of agrarian reform, in order to reduce the concentration of landholdings, but with differing results. In Brazil, most of the land in Legal Amazonia is in the public domain, or that of the federal governments. Legally, the lands may be sold to large private landholders. Thirty-one percent of the area is in the hands of 0.8% of farming or ranching units, with landholdings greater than 200 hectares. An indicator of the imbalance in land access is the Gini coefficient, which showed certain improvement in the northern region, by decreasing from 0.882 in 1968 to 0.714 in 2000. Regarding legitimacy of ownership, IMAZON indicates that 31% of lands in Legal Amazonia are owned by persons who lack property titles and registration. These properties occupy 1.58 million km^2, which is equivalent to the combined territories of Spain, France, Germany, the Czech Republic and Hungary. Only 4% of Legal Amazonia has complete documentation, regulated by the National Colonization and Agrarian Reform Institute (Incra) (Fearnside 2003).

Furthermore, the widespread availability of unorganised labour and the limited number of contractors affect the efficiency and equity of the agrarian labour market. This worsens working conditions for farmers, since contracting mechanisms that fail to respect workers' rights are employed: in some extreme cases, situations of slavery have even been identified.

BOX 3.13

BRAZIL: SLAVE LABOUR IN AGRICULTURAL PRODUCTION IN AMAZONIA

Between 1960 and 1970, modern slave labour was initiated in Brazil, in response to the expansion of modern agriculture in Amazonia. The labour force came from places with few job opportunities and limited access to land and financial services. Furthermore, large-scale agribusiness has generated heavy pressure on the region's natural resources, promoting accelerated deforestation processes and an increase in slave labour.

The Sharma study estimates that there are between 25,000 and 40,000 workers in conditions of slavery. Marañón, Piauí and Tocantins are the three Brazilian states that provide the highest numbers of slave labourers. Pará is the state with the greatest requirement for slave labour, followed by Mato Grosso. The principal activities utilising slave labour are: livestock production (43%), deforestation (28%), agriculture (24%), forestry activities (4%) and charcoal extraction (1%).

In 2005, the Special Group for Mobile Inspection freed 4,113 persons, mainly in the agricultural states of Mato Grosso and Pará.

Source: Sharma (2006).

UNSUSTAINABLE AGROPRODUCTIVE SYSTEMS IN EXPANSION

The accelerated and disorderly growth of agriculture and livestock production has reduced the vegetal cover and contributed to soil deterioration. There are unsustainable agroproduction systems on fragile ecosystems that ignore the close relationship between them and their ecosystem services. These systems interact with the natural milieu without considering the consequences (soil erosion, biodiversity loss, deterioration of soil support services, and loss of quality in bodies of water). The ecosystem soil support service is affected by the changes in its structure and the dynamics of the macro- and micro-organisms that affect soil fertility. This means higher future costs of using the resources and affects the quality of life of the local inhabitants.

The incentives and underlying factors for the operation of unsustainable agricultural productive systems in Amazonia are of different types. On the one hand are structural causes, such as poverty and migrations. In areas near the Amazonian region, the conditions of poverty push the populations toward Amazonia, where manpower is needed for the many different agricultural activities (e.g. soya and coca) and expanding cattle ranches. In this way, in Bolivia miners and Andean *campesinos* are driven towards the lowlands. The growers' poverty and strong market incentives have encouraged soil over-utilization which has led to an acceleration of migratory agriculture and this, in turn, results in increased deforestation. In Peru, for example, migratory agriculture is responsible for 81% of the deforestation in that country's Amazonian region (Peru: *Instituto Nacional de Recursos Naturales* [INRENA] 2001).

In an area as fragile as Amazonia, this behaviour translates into the degradation of environmental quality and over-exploitation of natural resources. The lack of definition regarding property rights is also an incentive for the illegal or irregular acquisition of land. All of this contributes to an unmanageable occupation of the territory and changes in land use to engage in illicit or illegal productive activities.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

Extensive livestock farming is one of the most important causes of land-use change in Amazonia.

In addition, promoting investments in infrastructure projects, and especially for highways, has also generated great dynamism in the Amazonian region and has encouraged the expansion of unsustainable agricultural practices. This investment in highway infrastructure has allowed the continuous growth of increasingly efficient and more economical multi-modal transportation that further supports agricultural and livestock production. Exports from areas of limited access are now possible at more competitive prices. To this one must add Brazil's construction of waterways that have allowed a river network to be developed, thereby reducing the cost of transportation by 40 to 60% (for example, in the Northern Corridor, the river route that connects the Madeira river to the Amazon). This makes it possible to incorporate new productive areas (e.g. Tocantins and Marañón) (*Banco Interamericano de Desarrollo* [BID] 2000).

On the other hand, market conditions, expressed in terms of the growing demand for food products and inputs for the agrofood industry, together with government policies, are another incentive for monoculture production. Dynamic and large-scale markets, such as the United States, China, Europe and Japan, encourage crop production in large areas of Amazonia. Because of fuel subsidies, reduced labour costs, relatively low land values and tax exemptions, the region has a competitive advantage in those markets, (Killeen and Da Fonseca 2006).

The growing demand for biofuels (ethanol, biodiesel and others) also increases pressure on the tropical rainforest, especially if production plans are based on species adapted to the tropical climate and soils, such as oil palm, sugarcane and elephant grass (Killeen and Da Fonseca 2006).

The adoption of technological innovations can be seen in very large productive units. In this case the grower-entrepreneur has the technological information and resources needed to access appropriate technologies. Evidence shows that the productive development and the use of technology do not

Dynamic and large-scale markets, such as the United States, China, Europe and Japan, encourage crop production in large areas of Amazonia.

FIGURE 3.8a
Ecuador: part of the provinces of Orellana – Sucumbíos (1977)

"More damage has probably been done to the Earth in the 20th century than in the whole of humanity's earlier history"

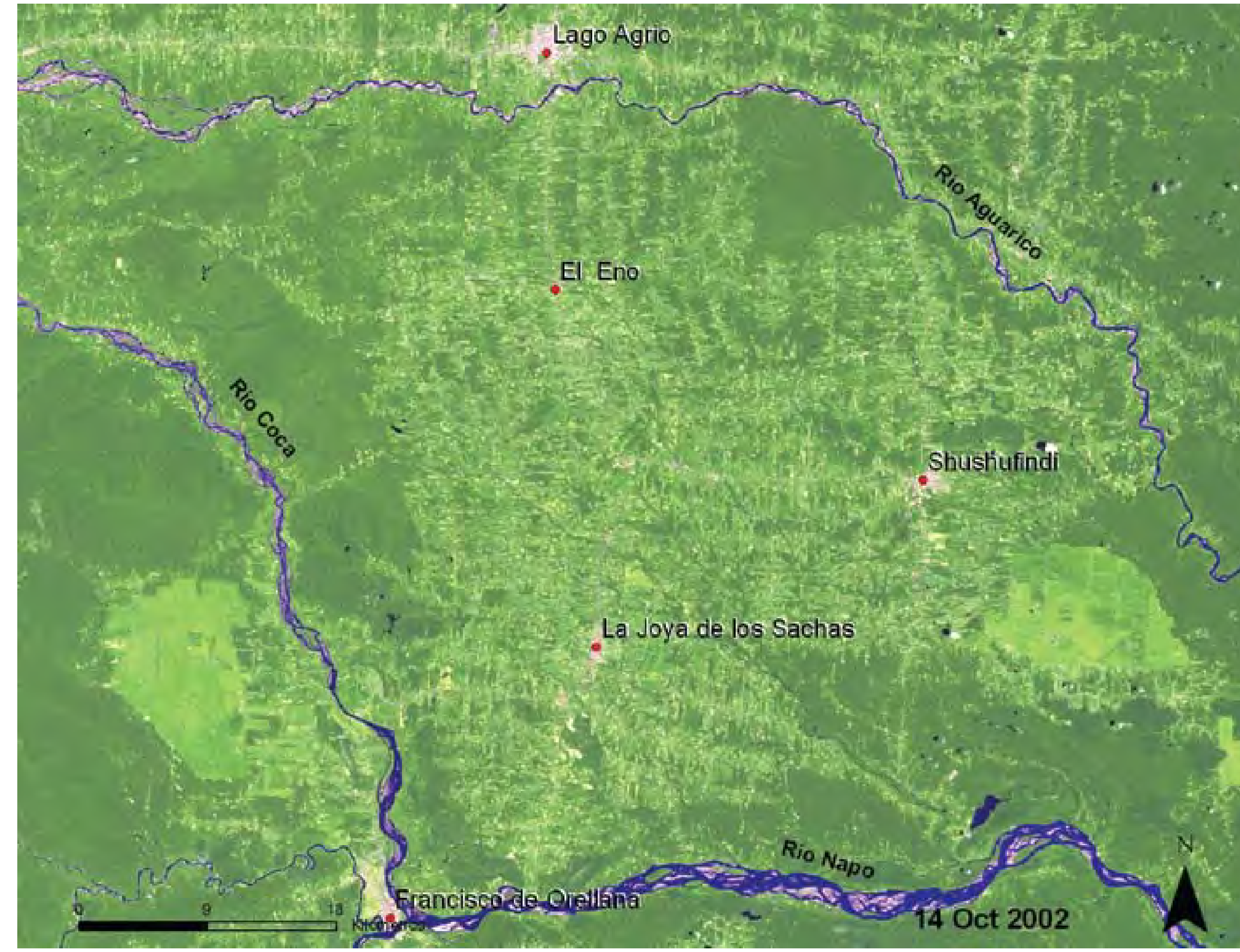
JACQUES YVES COUSTEAU (1910-1997), FRENCH SAILOR AND RESEARCHER

always respect the value of ecosystem services; to the contrary, economic growth occurs at the cost of those services. In the case of smaller productive units, evidence shows that it is customary to transpose productive practices, suitable for other regions, with a different endowment and quality of natural resources (e.g. the soil), without recognising the fragility of Amazonian ecosystems. A limited articulation can also be seen between local wisdom, linked to improving the productivity and efficiency of agroproductive systems and the proposed technologies.

There are also asymmetries in access to productive and commercial information. To wit, the information gap on alternative technologies, climate, good agricultural practices, international prices, export volumes and seasonality of the competition, commercial preferences and requirements of target markets, alternative marketing channels and good commercial practices, lead to decisions being taken in a context of greater uncertainty than would naturally exist in the trade in agricultural and livestock products.

Unsustainable agroproductive systems (monoculture and large scale livestock production) have adverse environmental, social and economic impacts. The environmental impacts include deforestation, agricultural and livestock exploitation beyond the support capacity of the land, soil erosion, water pollution from intensive use of agrochemicals, and loss of biodiversity, to name a few. Intensive

FIGURE 3.8b
Ecuador: part of the provinces of Orellana – Sucumbíos (2002) 25 years later; changes in soil usage, intensive deforestation and new islands in the Napo river channel, a sign of growing sedimentation.



soil use translates into a loss of its physical, chemical and biogeochemical properties. As a result, ecosystem supply, regulation and support services are seriously affected.

Social impacts refer to more conflicts about access to land, the expulsion of the local population, an increase in precarious employment or slave labour, increased prevalence of diseases among the local population due to water pollution, a reduction in the population's food security because of changes in habitat characteristics, making food more expensive (Segrelles 2007). Economic impacts include the rising costs of production due to the increased use agrochemicals to compensate for the loss of soil fertility. Furthermore, intertemporal economic costs associated with benefits lost because of market restrictions due to inadequate agricultural and manufacturing practices, increase when ecosystem services are degraded.

In Peru, for example, soil degraded through erosion in Amazonia represents 60% of the country's total eroded area. Most soil degradation is caused by erosion and acidification.

In Bolivia, the expansion of the agricultural frontier was carried out on land unsuitable for agriculture and in soil fit for forestry and subject to rapid hydrological erosion. The advance of soya cultivation leads to replacing grasslands, for which new lands must be opened or deforested in other areas to accommodate livestock (Dros 2004).

IN THE AMAZONIAN REGION THERE ARE ALSO PRIVATE INITIATIVES AND PUBLIC PROGRAMMES TO PROMOTE A SUSTAINABLE AMAZONIA.

In Colombia, the expansion of livestock production and increased pressure to free up new areas increase damage to other ecosystems, since it affects fauna that may be in vulnerable or in danger of extinction (Colombia: Instituto Amazónico de Investigaciones Científicas [SINCHI] 2007).

In contrast to the operation of unsustainable agroproductive systems, there are also private initiatives and public programmes in the Amazonian region to promote a sustainable Amazonia. The State promotes development of sustainable agricultural productive systems, offering financing and technical assistance, as well as facilities for better access to alternative markets (fair trade and ecological markets).

The development of technological innovations by public institutions has also been important in managing sustainable productive units for small and mid-sized growers; for example, the International Center for Tropical Agriculture (CIAT) in Bolivia, the Brazilian Agricultural Research Corporation (Embrapa) in Brazil, the Amazonian Scientific Research Institute (SINCHI) in Colombia, the Peruvian Amazonia Research Institute (IIAP) in Peru, among others.

The private sector has also invested in the productive development of Amazonia, with criteria of sustainability and paying attention to the demands of specialised markets. An example of that is the growing production of organic coffee. Coffee traditionally has been an important export product for countries like Colombia, Ecuador and Peru.

However, the international crisis in the prices of this product was an incentive for implementing differentiation strategies (premium and special, including organic) coffee. Today, organic coffee production is an alternative for small growers in the Amazonian foothills (e.g. Caquetá in Colombia, San Martín and Amazonas in Peru, and Orellana in Ecuador), since prices paid for organic coffee can be twice those of traditional coffee. Setting up and consolidating productive chains is an important step in promoting the organization of production and marketing, thereby reducing transaction costs and improving market access.

PHOTO REPORT: MIGUEL BELLIDO / EL COMERCIO

In Brazilian Amazonia and the Andean countries' high forest, coffee is a commercial crop that is gaining ground.

In Brazil, since 2003 new agro-productive models have been promoted, based on economic and environmental feasibility and on land use management. For this purpose the Incra has created alternative programmes for Legal Amazonia, such as agro-extraction settlements, projects for sustainable development and forestry projects (Brazil: *Ministerio de Desarrollo Agrario* 2006).

Furthermore the Embrapa is designing and disseminating integrated agricultural, livestock and forestry production systems to improve the economic and ecological sustainability of productive units. The idea is to use these systems to improve soil fertility through crop and grass rotation, and to optimise the use of inputs and crop diversification and, as a result, improve the profitability of the productive unit while minimising deforestation. It is also developing alternative methods of livestock production management, showing it is possible to have sustainable livestock production based on more productive technologies, and on restricting the areas of cultivation, according to their capacities for agricultural or livestock production.

In Colombia, SINCHI is implementing the Programme for Research on Sustainable Productive Systems. Within this framework, it identifies, evaluates, systematises and improves species. It also develops and transfers technologies, based on recovering and strengthening local and traditional communities' knowledge. As a result of this, ten sustainable production systems have been established that have been evaluated in ecological, economic and social terms (Colombia: *Instituto Amazónico de Investigaciones Científicas* [SINCHI] 2007).

The IIAP is developing and disseminating productive alternatives that promote the development of sustainable productive systems. The projects include: diversification of productive systems to produce native Amazonian fruits in communities within the zone of influence of the Iquitos-Nauta highway; genetic improvement of camu camu *(Myrciaria dubia)* to produce it in floodplains soils; improvement of vegetal species to conserve species and ecosystems; technological development and sustainable use of bio-exportable products, among others (Peru: Instituto de Investigaciones de la Amazonía Peruana [IIAP] 2001).

IN PERU

60%

OF ALL SOILS DEGRADED BY EROSION ARE IN AMAZONIA.

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MIGUEL BELLIDO / EL COMERCIO

AT TIMES IT IS DIFFICULT TO BE PRECISE ABOUT WHAT IS RURAL AND WHAT IS URBAN IN AMAZONIAN SETTLEMENTS.

3.5 | HUMAN SETTLEMENTS

Amazonia currently has a population of 33,485,981 inhabitants, with an estimated population density of 4.2 people/km² during the period of 2000-2007 (see Chapter 2). This is a result of a long process of human occupation, which does away with the belief that Amazonia is a "demographic vacuum", still held by many people from outside the region (Commission on Development and Environment for Amazonia 1992). The present day territorial configuration of Amazonia is a spatial expression of the natural, economic, social and political processes of the countries it comprises, the effects of which, in terms of growing urbanization and the densification of certain economic activities, has implied population relocation and the transformation of natural resource use and consumption patterns. Over the last twenty years, most of the Amazonian population has relocated into its cities, following the Latin American trend and Caribbean, which shows 75.3% of its population established in urban zones (UNEP 2003).

As is customary in any growing city, the Amazonian variety has problems of access to water supplies and environmental problems, such as water and air pollution and solid waste disposal and treatment, which take on greater relevance insofar as these problems directly affect the ecosystem and the services it provides.

THE RURAL AND URBAN PANORAMA OF AMAZONIA

Since the mid-1950s, the process of Amazonian occupation has adopted varying patterns that enable us to identify human settlements with differing characteristics. As mentioned in chapter 2, the demographic flows in Amazonia have been anything but simple; to the contrary, the Amazonian family unit is highly mobile (Padoch 2006). Many Amazonian households are rural and urban at the same time: families maintain dwellings and productive activities in rural areas as well as in peripheral urban settlements (Aramburú and Bedoya 2003). However, one can observe a predominance of urban areas or consolidated traditional cities with more access to basic services and infrastructure. Peripheral human settlements have formed as a consequence of migration and are generally precarious (Padoch 2006). With time, these settlements tend to consolidate and become annexed to the cities. However, there are also rural settlements with small populations and few resources that are, to a large degree, going through a growing process, while still others remain on the margin of this process, such as those that are mainly home to indigenous communities.

Classification and information on rural and urban settlements are, therefore, not entirely accurate in the Amazonian context (Padoch 2006). An example of this can be found in Brazilian Amazonia, where new immigrants continue their practices of planting foodstuffs in their yards for their own consumption (Winkler Prins 2005). In fact, over the past few decades there has been a process of extensive urbanization. Urban rhythm and life styles have subjected rural areas to the culture and conditions of consumption and production typical of that life style, with a tendency to eliminate the gap between what is rural and what is urban, unifying the concept of regional and urban problem areas.

As mentioned in Chapter 2, a predominance of urban population in the Amazonian countries was seen in 2001, with the excep-

Traditional consolidated cities have more basic services and infrastructure.

BOX 3.14

AMAZONIAN CITIES AND AREAS OF INFLUENCE

Porto Velho
Porto Velho's area of influence covers four of its neighbouring municipalities and another five centres along highway BR-364, which is the main means of travel between the existing rural settlements.

Río Branco
This city is favoured by highway BR-364, which allows year-round access from the Atlantic coastal regions of Brazil. The area of influence of the Acre state capital is made up of local, small, sparsely populated centres, like Brasileia, Epitaciolandia, Feijó, Sena Madureira and Boca de Acre.

Iquitos y Pucallpa
The urban populations of the Loreto and Ucayali regions are concentrated in the three most important cities in the border areas of that eco-region: Iquitos, located on the banks of the Amazon; Pucallpa, on the banks of the Ucayali River; and Yurimaguas, on the banks of the Huallaga River, a tributary of the Marañón. These cities, which have become poles of population concentration, exercise intense influence on the exploitation of natural resources and on environmental deterioration. In addition to the city dwellers, an important portion of the urban population is made up of the inhabitants of intermediate towns, provincial and district capitals. Twenty percent of the urban population of this eco-region lives in these settlements.

Source: Brazil: Ministerio del Medio Ambiente (2006b); Peru: Instituto de Investigaciones de la Amazonía Peruana (2007).

tion of Amazonian Ecuador and Guyana that continued to have more than 70% rural population. Generally speaking, 62.8% of the total Amazonian population is urban meaning that approximately 21 million Amazonian inhabitants live in urban areas. In Guyana, four of the country's ten administrative regions have urban centres, which, together with population of the capital city, Georgetown, had 339,873 inhabitants or 45.2% of the total population in 2002. The rest of the population is settled in villages along the coast, and a few are scattered across the interior of the country.

The Amazonian portions of Brazil, Peru and Venezuela contain more than 60% urban population (see Figure 2.3, Chapter 2). In the case of Brazil, the occupation of Legal Amazonia shows great heterogeneity where one can distinguish: an extensive territory with low demographic density, typified by a disperse rural population with minimal pressure on the environment (Brazil: Brazil: *Ministerio del Medio Ambiente* 2006c). This area is the most remote frontier of Legal Amazonia, in terms of human occupation and is represented by lands north of the Amazon River, the north of Pará, the north-east of Amapá (Amazonas) and the south-east of the State of Acre, the last mentioned in south-western Amazonia (Brazil: Ministerio del Medio Ambiente de Brasil y Ministerio de Integración Nacional 2006). Its principal characteristic is that it is marked by many indigenous lands and conservation units.

There are also two other types of rural settlements: those that are dispersed but exert pressure on the environment, and others that are connected to local centres with significant rural modernization. The first of these is found in central Amazonia and in western Rondonia, where there is great pressure for expansion of the agricultural and mining frontiers. The second type of rural settlement includes a large portion of central and northern Mato Grosso, where the expansion of the agricultural and ranching frontier, mainly through soya and cotton production, implies contracting labour in large agricultural and ranching establishments. The local urban centres are expressions of the relationship between modern agriculture and the need for products and services, essential to the development of contemporary agro-industrial complexes.

It should be mentioned that the *várzeas* (floodplains) are associated with these areas of medium density populations, linked to local centres. These are areas of periodic flooding, located all along the Amazon and its principal tributaries and are the most densely populated areas of Amazonia. The *várzeas*, with their conglomerate of high islands surrounded by lowlands exposed to seasonal flooding by the rising rivers, and *cochas* or lagoons of stagnant water, constitute an important eco-

The Ver-O-Peso market in Belén, Pará: Intense commercial activity in one of Amazonia's largest cities.

SERGIO AMARAL / OTCA

system used for seasonal agriculture and agroforestry systems. The *várzeas* are of high economic importance in zones like the Amazon River delta and Manaus, in Brazil, as well as in Iquitos and Pucallpa, where the greatest population of Peruvian Amazonia is concentrated. The *várzeas* are made up of soils, enriched by sediments that provide the productive base for many of the products consumed in the region (*Tratado de Cooperación Amazónica* [TCA] 1994).

During the second half of the 20th century, Amazonian occupation responded to colonisation criteria and geopolitical visions (see Chapter 1). At that time large State colonisation programmes were developed along the highways. Brazil and Peru were the countries that most used these strategies, such as those implanted along the Trans-Amazonian and BR-364 highways (Mato Grosso and Rondonia) in Brazil, and all along the *Marginal de la Selva* highway (Amazon Jungle Road), in Peru. However, the rivers continued to be the main means of transport for communication between Amazonian villages, thus constituting the axes for placement of human settlements. This situation is slowly changing. New highways that cross Amazonia began to respond to the need for facilitating the outlet for production of both soya and wood or mineral products. Doubtless, these inspired the placement of new human settlements, to provide services for these activities, and that are being established along the highways and are becoming a new form of settlement expansion in Amazonia.

Regarding the similarities of Amazonian human settlements in the eight countries, one can see high rates of population growth, an ever-greater participation of urban areas and a predominance of "traditional axis cities" with a significant area of influence. However, some of the countries still have significant rural areas.

62.8% of the Amazonian population, approximately 21 million people, live in cities.

Many intermediate Amazonian cities have very high rates of population growth.

Bolivia registers 51.6% of its Amazonian population as urban. The population growth rate for the period 1992-2006 was 3.2%; this is far above the average growth rate for Latin America for the 2000-2005 period, which was 1.5%, with a population density of 1.1 inhabitants per km². The department of Santa Cruz is in a transition area between Amazonia and the Chaco, where the Amazonian region is concentrated in its northern zone. Of the more than 2 million inhabitants, only 269,000 are considered to be Amazonians, according to the 2001 census. The department of Pando is also a leader in population growth and percentage of urban population (4.4% and 46.3%, respectively) (Bolivia: *Instituto Nacional de Estadística de Bolivia* 2001). If Santa Cruz is included as an Amazonian city, then this city, Cobija (Pando) and Trinidad (Beni) are the most important urban settlements in Bolivian Amazonia.

Brazil has nine states within its Legal Amazonia, among which the states of Amapá and Roraima had the highest rates of population growth, 5.3% and 4.3%, respectively, during the period 1991-2005. By 2007, the percentage of urban population in Brazilian Amazonia was 68.22%, with a population density of 4.7 inhabitants per km². The Brazilian Amazonian cities of Manaus and Belén are the largest in the region, with 1.6 and 1.4 million inhabitants, respectively. The total estimated population of four cities: Belén, Manaus, Sao Luis and Cuiabá was 4.5 million inhabitants in 2007, and represented approximately 18% of the total Brazilian Amazonian population (Brazil: *Ministerio del Medio Ambiente de Brasil y Ministerio de Integración Nacional* 2006).

Most of the population of Colombian Amazonia lives in the departments of Caquetá, Putumayo, Guaviare and Amazonas, with a total of 960,239 inhabitants in 2005, and an average urban percentage of 49.6%. The cities with the largest populations are: Florencia, San José del Guaviare, Puerto Asís and Leticia (Colombia: *Departamento Administrativo Nacional de Estadística* [DANE] 2007)

SEBASTIÁN CASTAÑEDA / EL COMERCIO

Twenty-four Amazonian cities already have more than 100,000 inhabitants, and are expanding and diversifying their services, including recreational ones.

Ecuador had an estimated Amazonian population of 629,000 inhabitants in 2006, and urbanization was limited to 24.9% of its population. However, the Province of Pastaza registered an urban population of 40%, the city of Puyo being the most important (Ecuador: *Instituto Nacional de Estadística y Censos* [INEC] 2006).

Peru had an Amazonian population of approximately 4.3 million inhabitants, with an average annual growth rate of 1.7% in the period 1993-2005. Although the Amazonian region covers the largest part of Peruvian territory, it is the least populated area. Nevertheless, 61.7% of the population of the Amazonian departments is considered urban. Iquitos, Pucallpa and Tarapoto are the most important cities of Peruvian Amazonia (Peru: *Instituto Nacional de Estadística e Informática* [INEI] 2007).

Venezuelan Amazonia had one of the lowest populations, only 70,000 in 2001, and a scant population density of 0.38 inhabitants/km². Of the whole population, 75.2% was considered urban, living in the city of Puerto Ayacucho, the Amazonas state capital.

Suriname and Guyana consider their entire population to be Amazonian. Paramaribo and Demerara-Mahaica, are, respectively, their most populated departments. The capital cities of both countries: Paramaribo (242,946 inhabitants in 2004) and Georgetown (235,017 inhabitants in 2005) the highest population concentrations.

GROWTH DYNAMICS OF AMAZONIAN CITIES

Amazonia has undergone an accelerated, unplanned urbanization process that has resulted in approximately 62.8% of its population, to wit, 21 million people living in cities. There are large cities with more than a million inhabitants, such as Belén and Manaus in Brazil, and Santa Cruz in Bolivia. There is another group of mid-sized cities, with over 200,000 inhabitants, such as Iquitos and Pucallpa in Peru; Rio Branco, Macapá, Imperatriz, Sao Luis, Cuiabá, Várzea Grande, Ananindeua, Santarém, Porto Velho and Boa Vista, in Brazil; Paramaribo, in Suriname; and Georgetown, in Guyana (see Table 3.13).

As mentioned in Chapter 2, the development of Amazonian cities, in the countries sharing the region, has been varied and conditioned by different factors, For example, in Peruvian cities there are two general formats for organisation and development. In the lower forest or floodable Amazonia, such as Iquitos, human settlements are isolated; in the upper forest there is a variety of equally important small and medium-sized cities. These latter are based on an agrarian economy; in Iquitos the economic base is extraction and more recently, services. In Colombia, there are departmental capitals with fewer than 50,000 inhabitants, except for Florencia that has 151,000; these cities are not connected to each other. In Bolivia, most of the cities are connected, by land, to the main urban and economic centres of the country, with exception of *Cobija.*

The urban network of Brazil's Legal Amazonia is structured around four general systems: Manaus, Belén, Sao Luis and Cuiabá, and on the urban agglomerations of Goiania, Brasilia, Teresina and Timón which, in spite of not belonging to the area of Legal Amazonia in Brazil, exercise influence over an extensive border area (Brazil: *Ministerio del Medio Ambiente* 2006c). One can also see that the principal urban nuclei generate growth dynamics over the smaller urban nuclei. Thus, the metropolitan region of Belén has an estimated population of 2.15

BOX 3.15

GEORGETOWN: URBAN DEVELOPMENT

The evolution of this capital city began in December 1781, with the proclamation of British Governor, Colonel Robert Kingston, after defeating the Dutch. However, in January 1782, a French squadron, allied with the Dutch, recovered Fort St. George and the English were forced to surrender. The French commander, in that same year, proclaimed, "it was considered necessary to establish the capital, which would become a business centre". The colonies of Demerara and Essequibo were returned to the Dutch in 1784. By 1789, Stabroek was a village of 88 houses and 780 inhabitants.

In 1796 The English returned. In May 1812, when Demerara, Essequibo and Berbice finally passed into British hands, it was decided that the town would be formally called "George Town". In March 1837, an ordinance was issued, abolishing the Georgetown police force and creating the position of mayor and his corresponding mayoral council.

Georgetown was elevated to the category of city when the colony was declared a Bishop's See by Queen Victoria, in August 1843. At the beginning of the 19th Century, Georgetown consisted of three sections: Stabroek, Werk-en-Rust and Robbstown-Newtown. In 1852, Lacytown was incorporated into the city. The residential areas extended into the ex-plantation areas of Vlissengen and Bourda. By 1970, the city had grown by approximately 2.5 square miles as a result of urban development.

Source: An extract from Guyana: Central Housing and Planning Authority (2000).

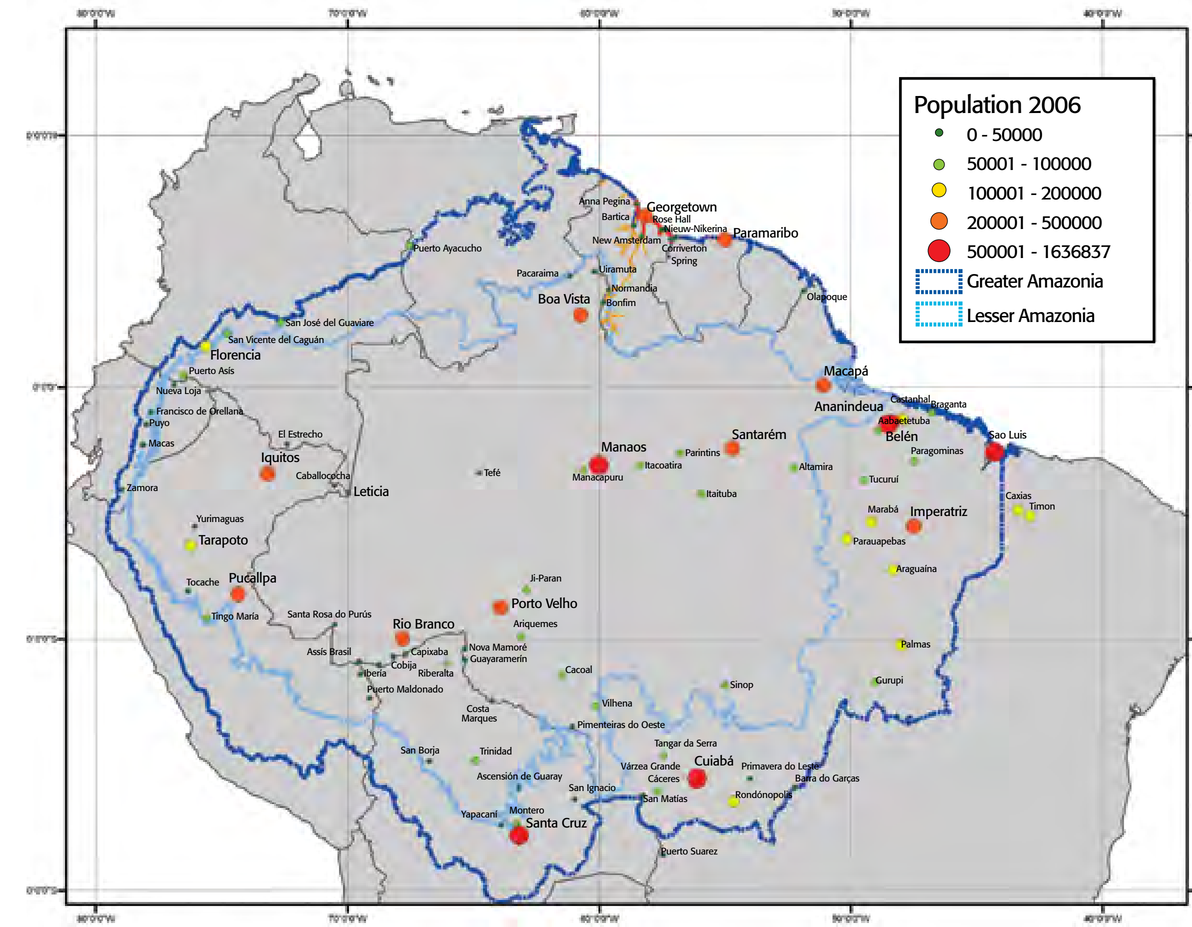
TABLE 3.13
Amazonian cities with populations greater than 100,000 inhabitants

COUNTRIES / AMAZONIAN REGION	CITIES	POPULATION BY YEAR		
BOLIVIA		1992	2001	2008
	SANTA CRUZ*	697,278	1.113.582	1.545.648
BRAZIL		1991	2000	2007
ACRE	RÍO BRANCO	168,679	226,298	269,505
AMAPÁ	MACAPÁ	154,063	270,628	328,865
AMAZONAS	MANAUS	1,006,585	1,396,768	1,646,602
MARAÑÓN	CAXIAS	84,331	103,485	108,542
	EMPERATRIZ	210,051	218,673	217,192
	SAO LUIS	246,244	837,584	917,155
MATO GROSSO	RONDONÓPOLIS	113,032	141,838	164,969
	VÁRZEA GRANDE	155,307	211,303	244,185
PARÁ	ANANINDEUA	74,051	392,627	484,278
	BELÉN	849,187	1,272,354	1,408,847
	CASTAÑAL	92,852	121,249	137,226
	MARABÁ	102,435	134,373	196,468
	SANTARÉM	180,018	186,297	274,285
RONDONIA	PORTO VELHO	229,788	273,709	304,228
RORAIMA	BOA VISTA	120,157	197,098	246,156
TOCANTINS	ARAGUAÍNA	84,614	105,874	109,571
	PALMAS	19,246	134,179	175,168
COLOMBIA		1993	2000p	2005
CAQUETÁ	FLORENCIA	96,247	130,500	143,871
GUYANA		1970	2002	2005
DEMERARA-MAHAICA	GEORGETOWN	63,184	135,382	235,017
PERU		1981	1993	2005
LORETO	IQUITOS	178,738	274,759	396,615
SAN MARTÍN	TARAPOTO	34,979	77,783	105,500
UCAYALI	PUCALLPA	89,604	172,286	232,000
SURINAME		1980	2000	2004
PARAMARIBO	PARAMARIBO	169,798	200,970	242,946

* For the purposes of this analysis, the city of Santa Cruz is considered Amazonian.

Source: Colombia: National Statistics Administrative Department (DANE); Peru: National Institute of Statistics and Informatics (INEI); Bolivia: National Statistics Institute; Brazil: Brazilian Institute of Geography and Statistics (IBGE); Guyana: Environmental Protection Agency (EPA); Suriname: General Bureau of Statistics.

MAP 3.1
The most important Amazonian cities



Source: Original production of GEO Amazonia, with the technical collaboration of UNEP/GRID - Sioux Falls and the University of Buenos Aires, using data from Bolivia: Conservation International and INE-Bolivia; Brazil: IBGE; Colombia: CIAT-Bolivia and DANE; Ecuador: INEC; Guyana: EPA; Peru: INEI; Suriname: General Bureau of Statistics; and Venezuela: INE-Venezuela.

Cities located along international borders play an important role in regional integration process. They are points of commercial articulation that provide basic services on both sides of the border.

million inhabitants (in 2005), of whom 1.4 million live in the municipality of Belén and 740,000 in its outskirts. Manaus, which has no metropolitan area, has only one municipality with 1.64 million inhabitants. Manaus and Belén form strong centres of attraction, while Sao Luis and Cuiabá also have a strong degree of attraction, so that subordinate urban centres grow in their vicinities (Brazil: *Ministerio del Medio Ambiente de Brasil y Ministerio de Integración Nacional* 2006).

Many intermediate Amazonian cities have very high rates of population growth. For example, in Peru, Puerto Maldonado (Madre de Dios) is growing at rates of over 5% per year; and between 1961 and 1993 the population of Iquitos (Loreto) multiplied more than four-fold, while that of Pucallpa (Ucayali), did so six-fold. In Colombia, the urban centres showing greatest relative population growth during the period 1985-1993 were Miraflores (Guaviare), with 1.66%; Albania, Morelia and San Vicente del Caguán (Caquetá) and Villagarzón and Mocoa (Putumayo). None of these are consolidated or large cities; to the contrary, they are small cities, yet characterised by accelerated expansion. In Brazil, in the past six years the cities of Caracaraí, Coari and Cruzeiro do Sul have grown by 28.57%, 30.36% and 28.59%, respectively. Likewise, in Bolivia the cities of Riberalta, Trinidad and Guayaramerín-Boliviano in the Department of Beni, have grown very rapidly over recent years.

Another group of cities that should be mentioned are those along the borders (see Map 3.1). These cities play an important role in regional integration processes. They are points of commercial articulation that provide basic services for the populations on both sides of the international political boundaries. It should be stressed that these small to medium-size cities are dissimilar in size and urban development. On the tripartite border between Peru, Colombia and Brazil are the cities of Caballococha (Peru), a minor populated centre, with 3,700 inhabitants; Leticia (Colombia), a city of 35,000 inhabitants; and Tabatinga (Brazil), a city with 42,500 inhabitants. Another nucleus of border cities is that between Peru, Brazil and Bolivia, which joins the states or departments of Madre de Dios, Acre and Pando, respectively. Cities located along this axis are, for example, Epitaciolandia, in Brazil, that has grown 28.7% over the last six years; and Cobija, in Bolivia which, during the census period of 1992-2001, registered a population growth rate in excess of the national average of 7.92%.

This accelerated and disorderly phenomenon of urban growth in Amazonia is causing problems, not only in the form of Amazonian natural resource exploitation, but also for the quality of life of the urban population. The growing demand for supplying basic urban services has, by far, exceeded the planning capacity of the local development agencies. Thus, the cities with over 500,000 inhabitants are facing problems of basic sanitation, traffic jams, inadequate solid waste disposal, loss of air quality to mention but a few. If the fact that many of the Amazonian cities contain the most extreme levels of poverty is added to the mix, then their inhabitants are even more vulnerable.

URBAN ENVIRONMENTAL PROBLEMS

a) Access to water and contamination

As seen in Section 3.3, in Bolivian, Colombian, Ecuadoran and Peruvian Amazonia, 61% of the Amazonian population lacks access to potable water and 70% has no sewerage services, according to a study carried out by Nippon Koei Lac Co. and the General Secretariat of the Andean Community (2005). Furthermore, Peruvian Amazonia has the least access to potable water and sewerage, followed by Colombia, Bolivia and Ecuador, according to the same study.

In the Andean regions of Amazonia, statistics show the average coverage of water and sanitary services as being below the respective national averages, and in rural areas it falls below 15%. Among the principal causes for the delay in providing water and sanitation services in Andean Amazonia one finds a wide dispersion and diversity of ethno-linguistic families, limited development of appropriate technologies and methodologies for dealing with the Amazonian reality, insufficient legal framework and a scant allocation of financial resources (Nippon Koei LAC Co. and the General Secretariat of the Andean Community 2005).

BOX 3.16

POTABLE WATER IN SURINAME

In spite of the fact that along the coast, water services in Suriname should be supplied by a single institution, in order to improve service quality, these services have not yet been integrated to the Suriname Water Company. And, although local communities and organisations should manage water services for the interior of the country, the pilot water committees do not seem to be functional. Community participation and a focus on community-based management should be adopted in these cases.

Institutional problems also affect sanitation services in Paramaribo. The drainage system is neither efficiently nor effectively managed. The current responsibility for these services is shared by several institutions. Experience has shown that there should be a single authority in charge of maintaining and administering this system in urbanized areas, such as Greater Paramaribo. Not only does not such authority exist, but there is no Sanitation Master Plan for Paramaribo.

Finally, a culture of environmental conservation must be developed. Planning becomes an instrument for guiding water management in Suriname both as a natural resource and a consumer good.

Source: Suriname: Sectorial Analysis of Drinking Water Supply and Sanitation in Suriname (2007).

According to the Bolivian Vice-Ministry of Basic Services, Santa Cruz is the department with greatest coverage for potable water, with 87.39% of its population served (both urban and rural). At the other extreme, the department in the country with the least potable water coverage Beni, where only 44.88% of its inhabitants in urban and rural areas have access to these services. In the urban environment, in 2005, the Cooperativa de Servicios Públicos Santa Cruz Ltda., which provides service to the city of Santa Cruz, recorded coverage of water services at 99%, and sewerage at 49%.

In the city of Iquitos, EPS Sedaloreto S.A., the agency in charge of the service for the urban population, registered potable water coverage at 70%, and sewerage service at 60%. Coverage for both services has remained stable over recent years, meaning that the connections keep pace with population growth, and indicating a shortfall of investment to increase coverage levels. It should also be mentioned that there are serious problems with clandestine connections. The average continuity for potable water service in the second quarter of 2005 was seventeen hours per day, although in some sectors of the city, such as San Juan, water was only available for six hours a day (*Superintendencia Nacional de Administración de Servicios de Saneamiento* 2005).

FIGURE 3.9a

CITY OF PUCALLPA-PERU, 1975

FIGURE 3.9b

CITY OF PUCALLPA-PERU, 2007

The area of the city of Poucallpa, in Peruvian Amazonia, has multiplied several times as the course of the Ucayali river has shown significant variation.

In Guyana, the Guyana Water Incorporated (GWI) is a public corporation that currently supplies 85% of the water supply for urban zones. As part of its plans the GWI seeks to increase its potable water supply during the next five years to 90% of the country's coastal population.

One of the problems of Amazonian cities, in respect of water pollution, in addition to domestic sewage coming from the cities themselves, is the use of toxic substances in agricultural activities. In Amazonia, herbicides are the most frequently used, followed by insecticides, fungicides and acaricides. In Brazil, the widespread use of herbicides is associated with direct planting schemes, an agricultural technique that reduces soil quality and promotes the growth of harmful weeds. Among the principal active ingredients consumed are glyphosate and 2.4 D acid, representing 48.8% and 10.33% of the herbicides used, respectively (Brazil: Instituto Brasileño de Geografía y Estadística [IBGE] 2004).

Another factor of concern regards mercury and other heavy metal pollution (iron, manganese, cadmium and lead) of Amazonian waters, a result of mining and forestry activities that affect city water supply sources. An example of this problem is the contamination of the Nanay River basin, which supplies water to the city of Iquitos (Peru). There is growing, partly illegal, gold-mining activity in the basin that uses a dredging system, and there is also intensely mechanised forestry activity that removes the topsoil of the forests

Cities with more than 500,000 inhabitants have problems of basic sanitation, traffic jams, inadequate solid waste disposal and loss of air quality.

ENRIQUE CÚNEO / EL COMERCIO

Noise contamination due to the proliferation of small motor vehicles is a problem in various Amazonian cities.

In the city of Iquitos there is a serious chronic health risk dueto noise from vehicles such as motorcycles and *mototaxis*, most of which have no noise control devices.

on both banks of the Nanay and Pintuyacu rivers and accelerating the increase in heavy metals in basin waters. This contamination has caused health problems among some of the basin's populations, generated by ingesting fish and water with a growing content of mercury, cyanide and other heavy metals.

b) Air and noise contamination

The most important sources of air pollution affecting Amazonian cities include: industry, vehicles and burning forests. To this is also added burning vegetal debris after cutting weeds in the yards and gardens of homes and public parks, and burning solid waste in local dumps.

During the dry season (June to September) in the northern zone of Mato Grosso and Rondonia, intense air pollution is produced from forest and grassland fires, affecting the cities of Cobija (Bolivia), Epitaciolandia and Brasilea (Brazil), Iñapari (Peru), and other settlements in the area. The traditional burning of solid waste in these cities is another source of air pollution. According to Brown (2007), the area affected by fire in the region of Pando (Bolivia) covered 241,513 hectares. Furthermore, 23 of the 45 days monitored during 2006 showed concentrations of particulate material (smoke) in excess of 150 µg/m3 and, on 18 days, it was more than 400 µg/m3.

Similarly, the lack of pavement on many roads creates severe problems of air pollution from settling dust during the dry season (Dourojeanni 1998). However, there is no detailed information on the levels of contamination or on the impacts this has on the health of the population.

In the city of Iquitos (Peru), the results of the atmospheric basin inventories indicate two situations regarding air quality: (i) the mobile sources generate the highest concentrations of carbon monoxide (CO) (88.21%); nitrous oxides (77.21%); and volatile organic compounds (VOC) (76,59%); and (ii) fixed sources are the greatest generators of total suspended particles (TSP), with 89.52%, and SO_2 with 86.82%.

The highest amount of CO and VOC coming from mobile sources is emitted by motorcycles and scooters adapted for carrying three passengers (92% of the CO and 95% of the VOC between the two types of vehicles). Amazonian cities, other than the Brazilian ones, because of their climatic characteristics and for other reasons such as their population's income level and culture, use scooters or mototaxis, as their principal means of transportation and these are the most common means of personal transportation from one place to another. The use of this type of transportation also generates high noise levels in the city. In the case of fixed sources, it should be mentioned that in the city of Iquitos, Peru, 84% of the SO_2 is emitted by a single company: Electro Oriente, the electric generation company (*Municipalidad Provincial de Maynas* 2006).

Although it is an evident problem, especially for outsiders, there is very little information on noise levels in Amazonian cities. A study on Iquitos (Peru) revealed that there is a serious and chronic health risk from noise emissions produced by vehicles like motorcycles and *mototaxis*, most of which circulate without mufflers, giving the city a constant noise level 58% and 44% above the World Health Organisation designation for moderate noise levels (50 dB) and severe noise levels (55 dB), respectively. On the average, noise registered in the districts of Iquitos and Punchana, from 7:00 hours until 22:00 hours fluctuates around 79 dB. The highest noise indexes are between 18:00 hours and 22:00 hours (Peru: *Comisión Nacional del Medio Ambiente* [CONAM] 2005).

c) Solid waste

One of the principal problems with disorderly urban growth is the inadequate disposal of solid waste. Amazonia is not exempt from this problem, although it is added to by the traditional practice in some countries of burning waste at home, the most common practice being the use of open air dumps with no strategy for lixiviates management. This causes pollution of the soil, subterranean and surface waters and, in turn, generates foci of disease for the inhabitants, especially in low-income sectors, who consume and use contaminated water that gives them parasites and diarrhoea. Their children are especially vulnerable. In this context, it is essential to invest in building sanitary landfills in Amazonian cities and creating incentives for the development of integrated plants to produce bio-fertilizers. Although the countries have drafted plans for solid and liquid waste management in the principal Amazonian urban centres, it is necessary to move from the diagnostic and formulation stages to articulate and apply these processes (Nippon Koei Lac Co and the General Secretariat of the Andean Community 2005; Corpoamazonía 2006 [personal communication]).

BOX 3.17

"QUEMADAS" (SET FIRES) ARE THE LEADING CAUSE OF AIR POLLUTION IN BRAZILIAN CITIES

The conclusion of a 2002 IBGE survey (Munic) of the country's 5,560 municipalities was that air pollution is not a problem restricted to the large Brazilian urban centres, and that its most frequent causes are not industries or motor vehicles, but "quemadas" and unpaved streets and highways.

The results of the survey indicate that 1,224 municipalities (22% of the total), including the Federal District (Brasilia), reported the frequent occurrence of air pollution. Almost half of the Brazilian population (85 million) resides in the municipalities reporting this problem and 54% of them are in the south-east. Among the municipalities that reported the occurrence of air pollution, the causes mentioned were: "quemadas" (64%), unpaved roads (41%), industrial activity (38%), agricultural and livestock production activities – dust, pulverisation of agrotoxic substances, etc. (31%) and vehicles (26%).

Fires set in cut forests ("quemadas") are the most frequently mentioned cause of air pollution in almost all of the regions. The exception is in the south, where the first place in this ranking is held by agricultural and livestock production activities (53% of the municipalities) with "quemadas" appearing in second place, tied with unpaved roads at 43%, which also come in second in the north, north-east and central-west of the country. This position is occupied by industrial activity in the south-east (45%).

The "quemadas" are the most significant cause of air pollution, in both cities that are less urbanized (with an urban population of up to 30%) and those of high urbanization (an urban population equal to or greater than 70%). Unpaved roads are in second place as the most frequent cause among less urbanized cities, and as the third cause among highly urbanized cities. Similarly, among smaller cities, 61% of the municipalities with up to 20,000 inhabitants reported facing degraded air quality, and 69% reported this situation for cities having between 20,000 and 100,000 inhabitants.

Source: Brazil: Instituto Brasileño de Geografía y Estadística (IBGE) (2002).

TABLE 3.14
Final disposal of waste in Amazonian regions of Brazil (2000) (in percentages)

REGIONS	FINAL WASTE DISPOSAL			
	DIRECT COLLECTION	INDIRECT COLLECTION	BURNED OR BURIED	OTHER
ACRE	77.1	8.8	6.7	7.4
AMAPÁ	89.4	5.2	2.9	2.5
AMAZONAS	75.6	13.9	7.7	2.8
MARAÑÓN	71.6	8.0	14.3	6.1
MATO GROSSO	85.0	8.1	5.2	1.7
PARÁ	72.3	14.0	10.6	3.2
RONDONIA	84.9	3.2	10.0	1.8
RORAIMA	94.8	0.2	3.8	1.1
TOCANTINS	94.4	0.7	4.1	0.8

Source: Brazil: *Instituto Brasileño de Geografía y Estadística* (IBGE) (2002)

According to IBGE (Table 3.14), the Amazonian states show levels of waste collection above 70%; however, the practices of burning are still relevant in Marañón, Pará and Rondonia.

The absence of adequate planning for urban growth creates a situation where there is neither adequate provision for the installation of sanitary landfills, nor the establishment of mechanisms for reusing and recycling waste materials. This leads to people disposing of those materials in informal dumps, because they have no other means of disposing of them.

In the city of Manaus, most solid waste is collected directly or indirectly, but a significant volume is burnt or deposited in vacant lots or in bodies of water, causing environmental problems. The public sanitation system operated by the Municipal Prefecture is being expanded and modernised to increase the efficiency of collection and final disposal of urban and hospital waste. Controlled disposal of waste in Manaus is considered to be good and it receives adequate treatment; however, it is necessary to extend the coverage of garbage collection (*Programa de las Naciones Unidas para el Medio Ambiente* 2002b).

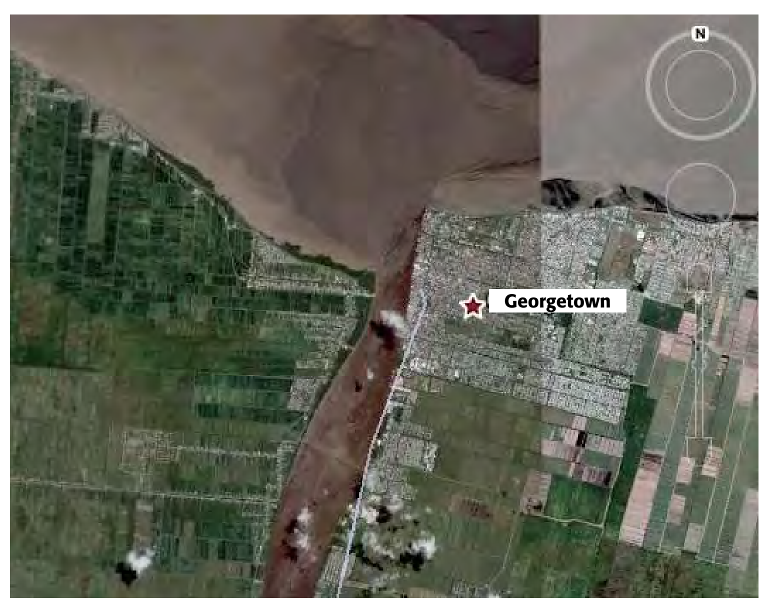
The city of Georgetown generates 51,100 tons of solid waste annually, with a per capita waste production rate of 0.6 – 0.8 kilos/inhabitant/day (Guyana: Environmental Protection Agency [EPA] 2007). Two contractors, who collect approximately 90% of the solid waste produced, carry out the city collections. The contractors also collect most commercial waste in their operating zones, while there are also small informal collectors who charge a fee to pick up waste from the population in the zones they attend to. Solid waste collection in Georgetown has proven to be efficient in the zones where it operates.

ENRIQUE CÚNEO / EL COMERCIO

The lack of urban growth planning means there are no proper sanitary landfill areas, or mechanisms to re-use or recycle waste.

The open air disposal of untreated urban waste is an important source of pollution in Amazonian cities.

SERGIO AMARAL / OTCA



Large, intermediate and small Amazonian cities are the sign of an Amazonia whose population is growing at an accelerated rate.

CRISTIAN GUERRERO / GTZ

THE AMAZONIA OF TODAY HAS MASSIVE AND ACCELERATED DEFORESTATION AS A SYMBOL OF A PREOCCUPYING DYNAMICS THAT IS A RISK TO THE INTEGRITY OF ITS ECOSYSTEM.

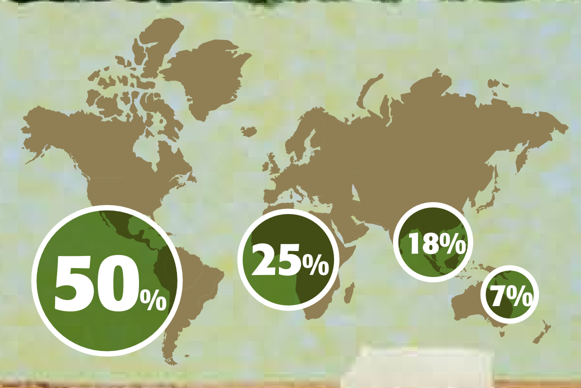
CONSERVACIÓN INTERNACIONAL

THE AMAZONIAN FOREST

It operates like a sink that absorbs carbon dioxide and other greenhouse gases (GHG) from the atmosphere and in exchange, it liberates oxygen; its accelerated reduction limits this function, which is vital for maintaining regional and global climate balance. Forest conservation prevents the loss of biodiversity, controls soil erosion and regulates the water cycle.

The inhabitants of Amazonia
They make up a complex ethnic, social and economic mosaic. The indigenous population is currently a minority and continues to live in the forest. Colonists, riverside inhabitants and urban dwellers, originally from different geographical origins, have contributed to the Amazonian cultural diversity.

The world's tropical forests. The tropical rainforest is the most complex biome in the world. It is found in the tropical lowlands, in an environment that is always hot and humid.



Deforestation of the Amazonian forest (by country)

Country	Deforestation (km²/year) (period 2000-2005)
Brazil	22,513
Bolivia	2,247
Colombia	942
Venezuela	553
Ecuador	388
Suriname	242
Guyana	210
Peru	123
TOTAL	27,218 km²

Profile of the Amazonian forest

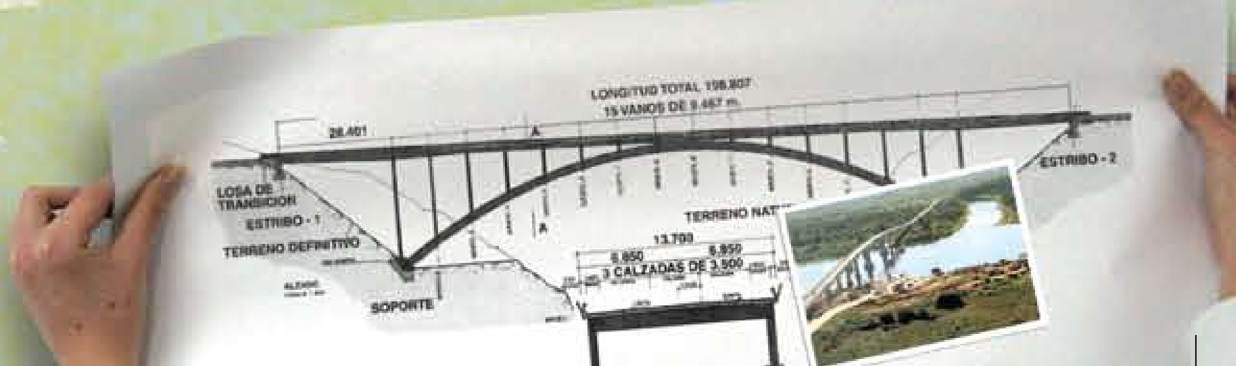
Non-forest vegetation. Savannahs with small trees, frequently with twisted trunks, dispersed across the countryside.

Flooded forest. High aquatic diversity and productivity. It extends along the rivers and is almost entirely flooded during the rainy season.

Open forest. Made up of palms, vines and bamboo, with a more open canopy than the dense forests.

Dense forest. Humid tropical ombrophilous forests on dry land, as well as transitional forests with large, high-commercial-value trees.

What can be used



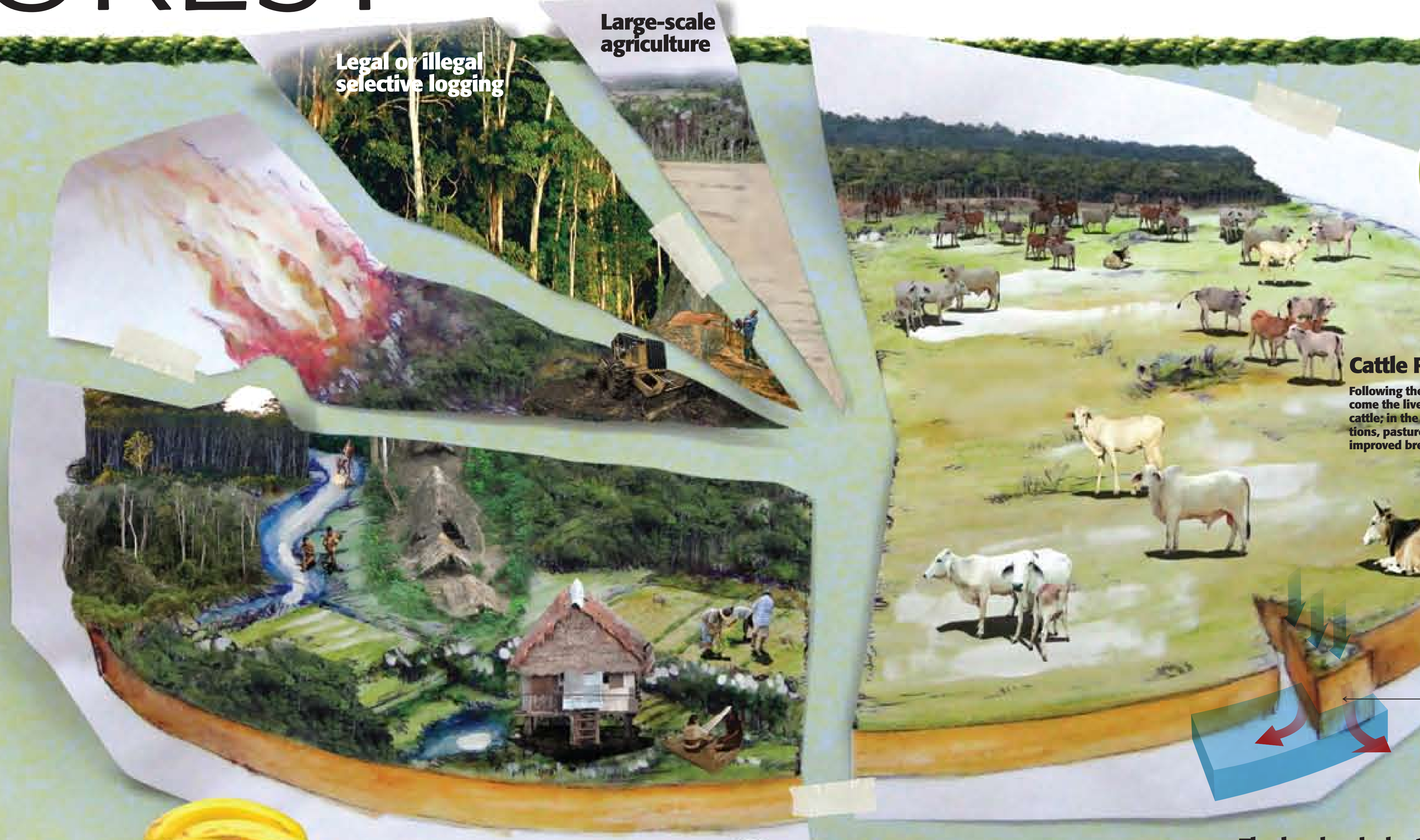
VECTORS OF DEFORESTATION

Forest fires, mining, urbanization, construction of roads and dams

First, the underforest and underbrush are cleared and then the large trees are cut. The area is left to dry for a few months and then is set on fire.

Small-scale subsistence agriculture

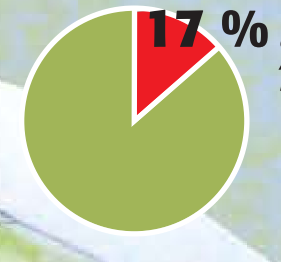
A significant part of the deforestation is caused by migrants or forest squatters, generally campesinos without land, who carry out spontaneous, non-technical agricultural or extraction activities, either on their own or under the auspices of certain government policies.



Cattle Ranches

Following the clearing of the forest, come the livestock ranches, generally cattle; in the more technical exploitations, pastures are managed and improved breeds are introduced.

Deforestation alters the **water cycle**, reducing the soil's absorption of water and accelerating runoff, also bringing on leaching of the fragile Amazonian soil.

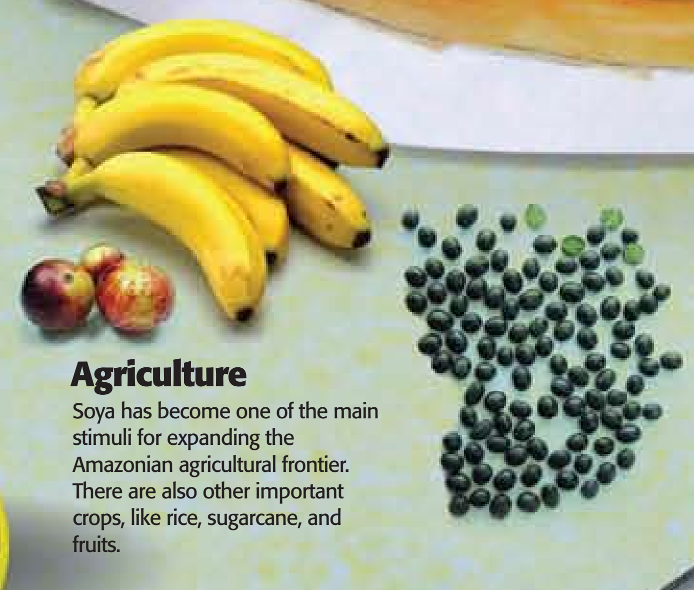


of the primary forest of Amazonia has been lost to date.

THE AMAZONIAN ECONOMY

The mega-infrastructures

The great highway and energy projects are a growing presence in Amazonia; however, they are mainly beneficial to other regions, being the focus of serious environmental risks (e.g. forest depredation, pollution).



Agriculture

Soya has become one of the main stimuli for expanding the Amazonian agricultural frontier. There are also other important crops, like rice, sugarcane, and fruits.

The lumber industry

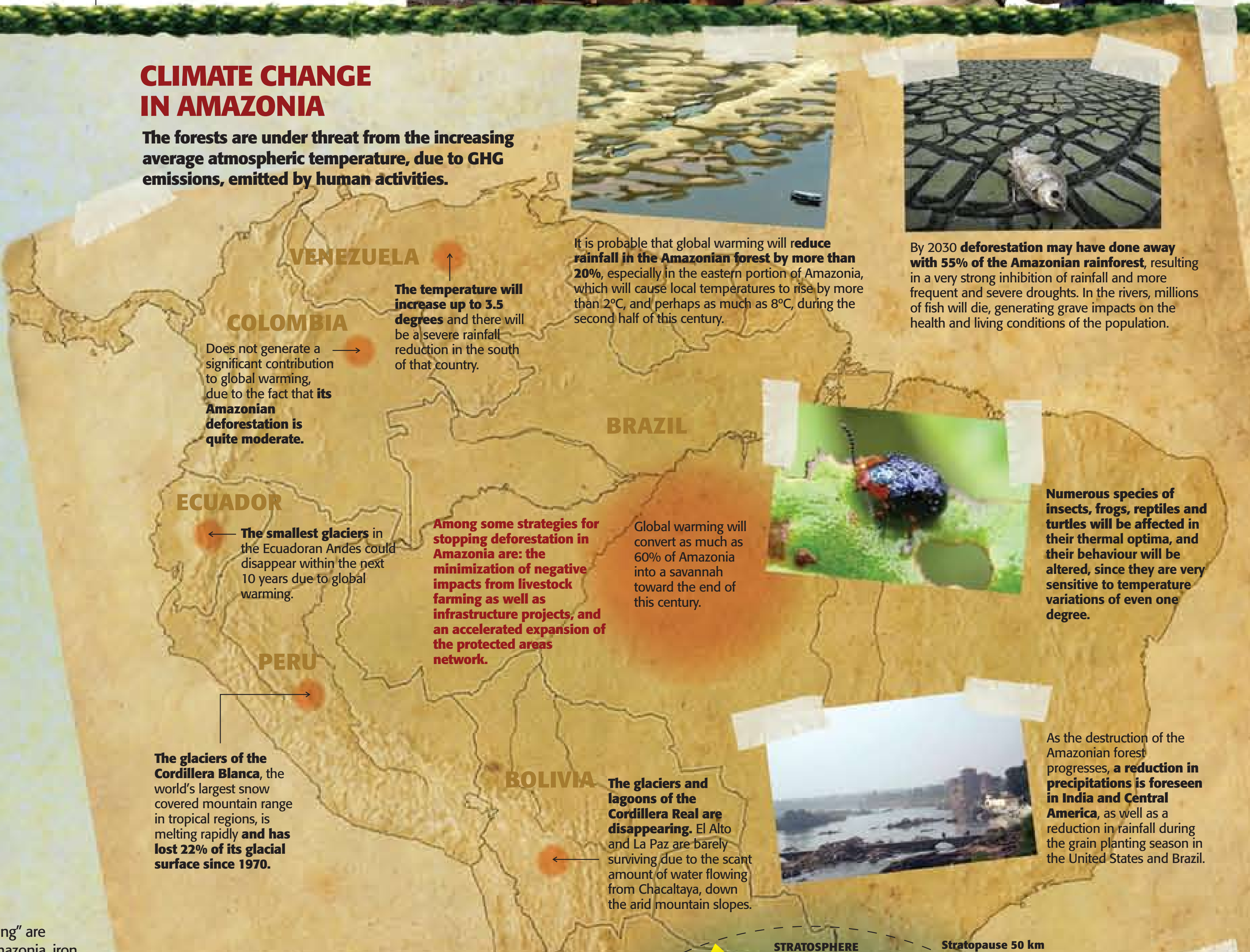
Generally speaking, the clear-cutting in Amazonia is controlled through licences or concessions that only authorise cutting certain species and in determined volumes. However, there is abundant evidence of the significance of illegal logging in almost all of the countries.

Mining

Artisan mining and "large-scale mining" are present in Amazonia. In Brazilian Amazonia, iron and bauxite are being exploited, using high-technology methods. Petroleum and gas are also extracted in various places, introducing high environmental risk for forests and rivers.

CLIMATE CHANGE IN AMAZONIA

The forests are under threat from the increasing average atmospheric temperature, due to GHG emissions, emitted by human activities.



It is probable that global warming will **reduce rainfall in the Amazonian forest by more than 20%**, especially in the eastern portion of Amazonia, which will cause local temperatures to rise by more than 2°C, and perhaps as much as 8°C, during the second half of this century.

By 2030 **deforestation may have done away with 55% of the Amazonian rainforest**, resulting in a very strong inhibition of rainfall and more frequent and severe droughts. In the rivers, millions of fish will die, generating grave impacts on the health and living conditions of the population.

The temperature will increase up to 3.5 degrees and there will be a severe rainfall reduction in the south of that country.

Does not generate a significant contribution to global warming, due to the fact that **its Amazonian deforestation is quite moderate.**

The smallest glaciers in the Ecuadoran Andes could disappear within the next 10 years due to global warming.

Among some strategies for stopping deforestation in Amazonia are: the minimization of negative impacts from livestock farming as well as infrastructure projects, and an accelerated expansion of the protected areas network.

Global warming will convert as much as 60% of Amazonia into a savannah toward the end of this century.

Numerous species of insects, frogs, reptiles and turtles will be affected in their thermal optima, and their behaviour will be altered, since they are very sensitive to temperature variations of even one degree.

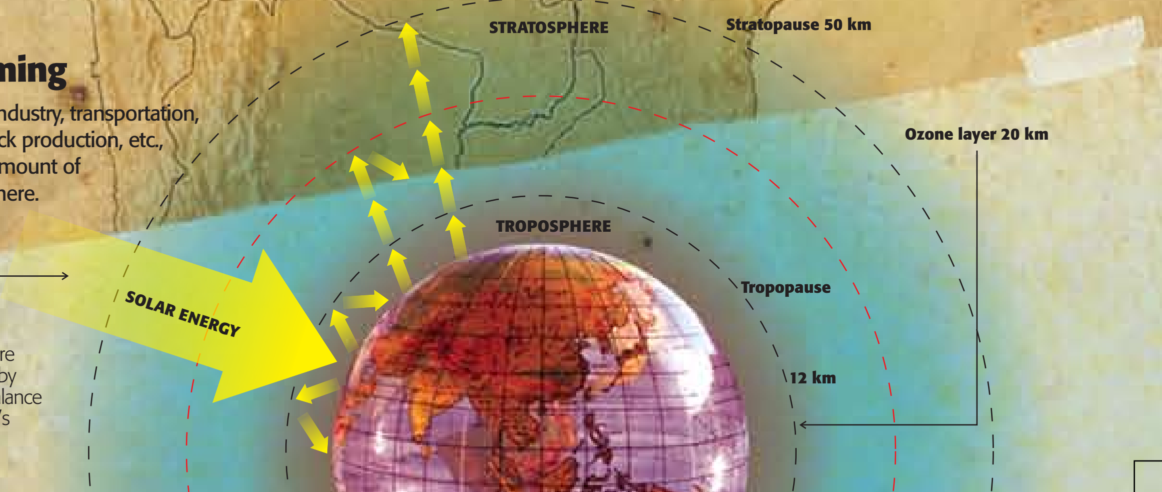
The glaciers of the Cordillera Blanca, the world's largest snow covered mountain range in tropical regions, is melting rapidly **and has lost 22% of its glacial surface since 1970.**

The glaciers and lagoons of the Cordillera Real are disappearing. El Alto and La Paz are barely surviving due to the scant amount of water flowing from Chacaltaya, down the arid mountain slopes.

As the destruction of the Amazonian forest progresses, **a reduction in precipitations is foreseen in India and Central America**, as well as a reduction in rainfall during the grain planting season in the United States and Brazil.

Global warming

Burning fossil fuels, industry, transportation, deforestation, livestock production, etc., have increased the amount of GHGs in the atmosphere.



The modified atmosphere retains more heat, thereby damaging the natural balance and increasing the Earth's temperature.

FOOTPRINTS OF ENVIRONMENTAL DEGRADATION

- 4.1 IMPACTS ON **ECOSYSTEM SERVICES**
- 4.2 IMPACTS ON **HUMAN WELL BEING**
- 4.3 **VULNERABILITY**

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THIS CHAPTER ANALYSES THE IMPACTS OF THE AMAZONIAN ENVIRONMENTAL situation, on both ecosystem services and on human well being; to wit, it will explain how environmental degradation affects Amazonian ecosystem functions and limits the opportunities and capacity of the population to improve their living conditions.

4.1 | IMPACTSON ECOSYSTEMSERVICES

Ecosystem services are the benefits that society receives from functioning ecosystems. Ecosystem services include provision, regulation, cultural and support services. Provision consists of goods obtained from ecosystems, such as: food, fibres, minerals and fuel, among others. Regulation services comprise diverse processes, such as self-purification of air and water, carbon absorption, climate regulation and water cycle regulation, to mention a few. Cultural service refers to the intangible benefits enjoyed by mankind, such as recreation, reflection, spiritual enrichment, and more. Finally, support services involve those necessary for producing other ecosystem services, among these, the production of oxygen, soil fertility and/or soil formation (World Bank – World Resource Institute 2005a).

The Amazonian ecosystem is varied and complex. It has very important functions, such as carbon capture, regulation of the water cycle and climate, regulation of infectious diseases (it regulates the virus, bacteria and parasite population), provision of forestry (lumber and non-lumber yielding) products, availability of pollinating insects, among other things. Notwithstanding, this ecosystem has been severely affected by environmental degradation, which is expressed as growing deforestation, contamination of bodies of water, loss of species and habitat reduction, soil erosion and deterioration of aquatic ecosystems (see Chapter 3). This environmental situation has led to the deterioration of ecosystem services, in both quantity and quality, and has left the mark of environmental degradation by affecting both the stock and the continued generation of those services. Thus, ecological vulnerability increases, making the balance of ecosystem even more fragile. It should, however, be highlighted that the magnitude of the impacts on ecosystem services vary among the different Amazonian zones, according to the specific characteristics of each.

ENRIQUE CÚNEO / EL COMERCIO

The ecosystem services are deteriorating due to a lack of understanding of the way they function and the lack of consideration for the consequences of the decisions made on production and consumption.

BURNING AND IRRESPONSIBLE DISPOSAL OF SOLID WASTES ARE CONTRIBUTING TO ENVIRONMENTAL DEGRADATION IN AMAZONIA.

ENRIQUE CÚNEO / EL COMERCIO

In Bolivia, undisturbed forest has 43% more biomass and 70% more species diversification among small mammals, than forests that have been affected by deforestation.

It is common knowledge that Amazonia contains great biodiversity, although it is distributed among many fragile ecosystems, and therefore, fragmentation, species loss and loss of habitat, affects its balanced functioning and its capacity for resilience. Because natural ecosystems know no political boundaries and biodiversity has its own patterns of function and displacement, biodiversity loss impacts related ecosystems, beyond national borders.

Different studies show our limited knowledge of the impact generated by the loss of biodiversity on natural ecosystems. In Amazonian countries, the efforts to quantify the value of ecosystem services derived from biodiversity, are still very limited and fail to recognise that biodiversity loss (for example, of micro-organisms; see Section 3.4) affects soil quality, making it more compact. This condition affects support services, since soil fertility is reduced requiring the user to face the economic costs of re-establishing it. Similarly, the loss of biodiversity affects pollination, which, in turn, generates adverse effects on agricultural development and the reproductive dynamics of the forest.

Deforestation and fires bring about negative impacts on ecosystem services. These effects are not isolated, but are generally associated with other processes, thereby multiplying their impact. Scientific literature mentions several undeniably important impacts generated by forest loss and degradation. Provision services are affected in the reduction of biodiversity and the decrease in supplies of lumber and non-lumber forest products. Regulatory services show changes in the patterns of climate regulation, the reduction of the forest's ability to absorb carbon and the perturbation of the water cycle, among other changes (Foley and others 2007). Furthermore, deforestation not only affects wildlife functions, limiting the capacity for providing goods for local human consumption or for industrial use, but it also affects regional hydrology and global climate (Laurance, Vasconcelos and Lovejoy 2000).

Deforestation also leads to loss of nutrients in the soil, which affects support services. For example, in an investigation by the Woods Hole Research Center and IPAM, it was shown that while a mature forest concentrates 130 mega-grams of carbon per hectare (Mg C/ha), a secondary forest can absorb 34.4 Mg C/ha and pasturelands concentrate only 3 Mg C/ha. Along those lines, the re-accumulation of nitrogen, phosphorous, potassium and calcium in the surface soil of secondary forests is superior (20%, 21%, 42% and 50%, respectively) to that registered in a primary forest. In contrast, the degraded area of pasturelands is only able to concentrate 2%, 4%, 15% and 11%, respectively, for each element (Markewitz and others 2004).


CONSERVACIÓN INTERNACIONAL

Deforestation and fires (favoured by selective logging) generate negative impacts on the forest's ecosystem services.

Deforestation causes forest fragmentation. In areas where there is lumber activity and burning, there is evidence of a reduction in the diversity of arboreal and fauna species. In Bolivia, for example, undisturbed forest has 43% more biomass and 70% more diversity of small mammalian species than forests that have been affected by those activities (Fredericksen and Fredericksen 2002). This type of impact has also been documented for other areas of Amazonian forest (Azevedo-Ramos and others 2006; Lambert and others 2005).

Selective tree harvesting is an historical practice of lumber exploitation that favours the regeneration of certain species while affecting ecosystem balance and the composition of forest species. This leads to making the forest more prone to fires, due to the dryness of kindling materials, directly affected by the increased flow of sunlight. In a study on Brazilian Amazonia an inverse relationship was found between the density of light flow and the number of days necessary for branches to reach a point at which they are able to produce expansive fire (Holdsworth and Uhl 1997). This is an important concern in Brazil and Guyana.

Forests also offer an ecosystem service for the entire planet, since they store approximately 10% of the carbon in their biomass. As a consequence of deforestation and burning, this carbon capture service has been reduced, thereby releasing enormous quantities of carbon into the atmosphere (Fearnside 2005).

The loss of water quality owing to the waste dumped into it from different activities (mercury from gold mining, nitrates and chemicals from agro-chemicals and hydrocarbon spills, among others) affects the aquatic food cycle and causes aquatic spe-

THE FOREST'S CAPACITY FOR CARBON ABSORPTION IS ASSOCIATED WITH THE AGE OF THE FOREST. A MATURE FOREST CONCENTRATES 130 MEGAGRAMMES OF CARBON PER HECTARE, WHILE SECONDARY FORESTS CONTAIN ONLY 34.4 MEGAGRAMMES PER HECTARE.

Infrastructures, such as oil or gas pipelines, are not exempt from causing environmental deterioration, especially when emergency situations occur (spills, explosions).

ENRIQUE CÚNEO / EL COMERCIO

Selective tree harvesting favours the regeneration of certain species while affecting ecosystem balance and the composition of forest species.

cies loss as well as bringing about irreversible damage to the ecosystem services that the water resource provides (loss of the ability to auto-purify itself, reduction of water available for use in other activities).

There is serious concern in Amazonia over the effects of water pollution by mercury, because of the changes it causes in ecological niches of local fauna from bio-accumulation of that element in the food chain. In fact the concentrations of mercury in many carnivorous fish species are above the limits established by the WHO (Hacon and Azevedo 2006). Informal gold mining is an important source of mercury being dumped into nature; it contributes 3% of the mercury found in the zone, or 150 MT/year (See Chapter 3, Section 3.3).

Furthermore, the growing sediment load that has increased from deforestation in the headwaters of the basin, expanding agriculture and ranching and the construction of poorly designed roadway infrastructure, have affected the natural conditions of water bodies and with it the habitat of aquatic flora and fauna species.

The development of unsustainable agro-productive systems has generated changes in the cultural and productive patterns of Amazonia and its local communities. Cultivation practices designed to achieve greater productivity, without considering their environmental impacts, have led to increasing use of agro-chemicals, which has affected ecosystem equilibrium. In this regard, the environmental concerns are concentrated on the toxicity

CONTAMINATION OF WATERCOURSES WITH MERCURY GENERATES CHANGES IN THE ECOLOGICAL NICHES OF LOCAL FAUNA, DUE TO BIO-ACCUMULATION IN THE FOOD CHAIN.

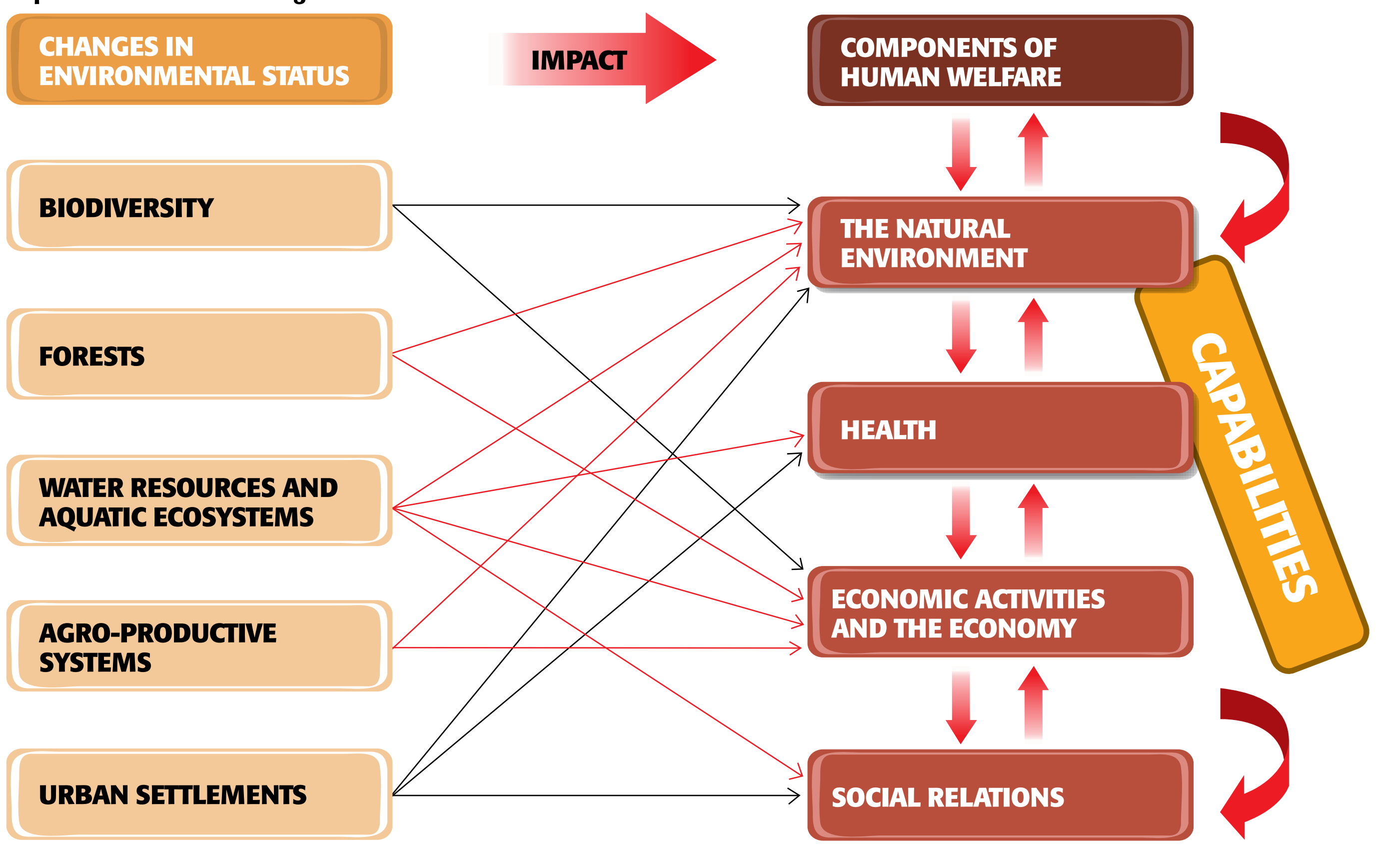
affecting the soil's microorganisms, insects, plants, and birds, which are beneficial not only to agriculture, but also to other economic activities (Wood and others 2000). Unsustainable agro-productive systems negatively affect the support service corresponding to soil fertility and, therefore, limit its productive capacity for growing crops.

Increased soil compaction and the reduction of nutrients and organic material, among other problems, reduce the availability of land for agricultural development and accelerate soil degradation, which affects ecosystem resilience.

Although pesticides have not notably contaminated surface and subterranean waters, there are many local situations that arouse concern. In spite of the fact that the studies are insufficient, an increased sensitivity to organochlorinated pesticides, which are easily bio-accumulated, has been reported in aquatic organisms, and, on the same note, it is well known that the use of fungicides can have negative impacts on tropical fish populations (Pardo and Gudynas 2005, Pasquis 2006, Global Water Partnership 2001).

The footprint of Amazonian environmental degradation on ecosystem services gives evidence to how limited the knowledge of the Amazonian ecosystem function is, as well as the intertemporal costs associated with that deterioration. This situation shows the importance of promoting interdisciplinary scientific research that will allow for improving understanding of the magnitude of the environmental costs in Amazonia and the urgency of launching concerted action to counteract them.

FIGURE 4.1
Impact on human well-being



Fuente: PNUMA (2007b).

4.2 | IMPACTSON HUMANWELL-BEING

Human well-being refers to the possibility of people to live the kind of lives they consider to be of value, and the opportunity they have to achieve their aspirations. Among the essential elements of human well-being are health, access to material goods, security and adequate social relationships (UNEP 2007b).

An analysis of the effects of environmental degradation on human well-being implies considering the consequences of the environmental situation on the population's health, economic activities and social relations. The effects on health include an increase in the incidence of diseases from environmental causes. The impacts on the economy and economic activities refer to the restrictions or ease for accessing goods and services, as well as the income and assets necessary for maintaining an acceptable quality of life. Finally, social relations allude to the conflicts generated by access to and use of natural resources, the loss of social cohesion and local cultural values, among other things (Figure 4.1).

IMPACTS ON HUMAN HEALTH

The principal impacts of environmental degradation on health are: increased disease prevalence associated with the increased predator–prey imbalance, causing diseases, changes in eating patterns; and decreasing food security.

A reduction of biodiversity is, in fact, one of the factors that have caused the reappearance of infectious diseases or the appearance of new diseases affecting human health, due to the disappearance of natural predators that prey on the vectors of these diseases (Millennium Ecosystem Assessment 2006).

For example Brazilian Amazonia contains human pathogenic viruses and arboviruses such as dengue, yellow fever, Mayaro and Oropouche, among others that occur naturally in the region. For example, an elevated incidence of yellow fever was found on the island of Marajó as a result of the migration of non-immune persons to areas where the vector is found (Vasconcelos and others 2001) (Table 4.1). There is evidence that colonisation, mining, dam building and other activities that change the Amazonian environment, affect the epidemiology, ecology, life cycles and distribution of viruses (Vasconcelos and others 1992).

Malaria is one of the high incidence transmissible diseases of Amazonia. Deforestation has been blamed as one of the main causes of malaria, in this sense; some studies indicate that when an area is 20% deforested, vector activity increases significantly and, therefore the risk of malaria expansion increases. The World Health Organisation reports that between 400,000 and 600,000 people are infected with malaria yearly in Amazonia (Walsh and others 1993; Foley and others 2007).

In Suriname there is a relationship between areas of small-scale gold mining and centres of malarial and other tropical disease transmission (Heemskerk 2001). Water wells, opened by miners, become breeding grounds for mosquitoes and other disease vector organisms.

Peruvian Amazonia is one of that country's zones with particularly high incidence of malaria, where habitat deterioration and deforestation are causing a loss of ethno-

LINO CHIPANA / EL COMERCIO

Biodiversity reduction is one of the factors that have caused the reappearance of infectious diseases and the appearance of new diseases.

TABLE 4.1
Arbovirus in Brazilian Amazonia and probable factors for their appearance

VIRUS	PROBABLE FACTORS FOR THEIR APPEARANCE	DISEASES IN HUMANS
DENGUE	Poor mosquito control, Amazonian urbanisation	Yes, epidemic
GAMBOA	Hydroelectric dams, migratory birds	No, to date
GUAROA	Hydroelectric dams	Yes, sporadic cases
MAYARO	Deforestation	Yes, seasonal
OROPOUCHE	Deforestation; urbanisation and colonisation	Yes, epidemic
TRINITI	Hydroelectric	No, to date
YELLOW FEVER	Amazonian deforestation; urbanisation, lack of immunisation	Yes, epidemic

Source: Vasconcelos and others (2001).

botanical knowledge in the region and of the species with anti-malarial potential as well as the biocides traditionally used by indigenous communities (Pérez 2002).

The loss of species used in traditional medicine affects health and gives the local populations incentives to be ever more dependent on modern western medicine. For example, in 1997 Inrena reported that in Peruvian Amazonia 340 species, 229 genera and 88 botanical families were used for medicinal purposes. In general, many indigenous communities have organised themselves to establish health programmes, but, in spite of that, Montenegro and Stephens (2006) cite several examples of studies suggesting that many of the local populations still have limited access to health service programmes and when these programmes exist, they are frequently culturally inappropriate.

Foley and others (2007) point out that deforestation and forest degradation affect the availability of plants and medicinal substances for use in health care (Shanley and Luz 2003). Therefore, deforestation affects the habitat of viruses or puts pressures on them to migrate to other places, which generates disease areas that had not previously been reported (Schoeler and others 2003).

There has also been a notable increase in respiratory diseases in Amazonia, due to the growing number of fires used to convert natural forests. In addition, a large number of Amazonian inhabitants also continue using solid fuels to cook and warm themselves. The atmospheric contamination produced by burning, as well as the precariousness of the stoves within the houses, has caused significant levels of mortality from respiratory diseases, especially among children. In areas were the demand for firewood has exceeded the local supply and the people cannot afford other forms of energy, there is a growing vulnerability to diseases and malnutrition from consuming water contaminated by microorganisms (unboiled) and incorrectly cooked food.

Another disease recognised as a public health problem in Amazonia is Chagas' disease, caused by the parasite Tripanosoma cruzi, which is transmitted by the bite of the vinchuca insect, Triatoma infestans. Chagas' disease weakens organs like the heart, the oesophagus or the colon over a long period of ten to twenty years. The spread of this disease has been enhanced by habitat modification from cutting and burning trees and bushes; replacing primary vegetation with agricultural crops; and the expansion of population centres, which has integrated the population into the disease's wild transmission cycle. The insects live in the cracks and holes of the walls of dwellings and bite the inhabitants (Organización Panamericana de la Salud 2005; Cáceres and others 2002). The Amazonian countries have all subscribed to the "Amazonian countries' initiative for surveillance and control of Chagas' disease" (Yamagata and Nakagawa 2006).

Local populations still have limited access to health service programmes and when these programmes exist, they are frequently culturally inappropriate.

The populations of voluntarily isolated indigenous communities are also vulnerable to different diseases that spread across the region, including the flu. This population has seen its habitat affected by timber harvesting, forest fires and petroleum and gas exploitation, which have obliged them to move away from their traditional zones of settlement.

Finally, the degradation of the Amazonian ecosystem also has implications for food security, because it does not only affect the health of the population but also the availability of native foods and water of a quality adequate for foodstuff production. The poorer segments of the population are most vulnerable, which produces an even graver situation of malnutrition for them (Foley and others 2007).

IMPACTS ON THE ECONOMY

The deterioration of ecosystem services caused by environmental degradation in Amazonia has yet to be economically quantified; however, there can be no doubt that it does have a value. There is no certain knowledge as to the cost of treating the waters of polluted river basins, nor the costs of mitigating the environmental impacts associated with deforestation. In many cases, these valorisations of intangibles are ignored, or are difficult to quantify; especially, because aspects such as climate regulation have no market value, allowing them to be expressed in monetary terms. For that reason this section presents some quantifications of the economic impacts of biodiversity loss and deforestation for which there is information; as can be expected, the real impacts in Amazonia are far greater.

The loss of potentially useful species (those used in pharmaceutical or manufacturing products) or the scarcity of species in the market, due to over-exploitation or loss, constitutes a huge economic impact, which is difficult to evaluate. Scarcity is expressed in higher prices, but the disappearance of species constitutes a total loss of value. Another example is the increase of pests in crops, due to the disappearance of natural control agents; or the disappearance of tourist activities in the region, due to the loss of scenic resources, scenic beauty being one of them.

Deforestation and forest degradation have economic impacts to the extent that they eliminate three potentially commercial products: wood, non-timber yielding products (for example brazil nuts) and ecosystem services. Thus, deforestation leads to the extinction of economically valuable species (Tabarelli and others 2004) and to the search for new areas for extraction. Scarcity of commercially valuable woods affects companies, given that the potential generation of earnings is reduced since there is less of the product available. This also causes the lumberjacks and harvesters to migrate to other municipalities or places, given the lack of jobs or opportunities for generating income.

An interesting example of this impact is the case of mahogany. In Peru, as of 2003, mahogany was included in appendix II of the Convention on International Trade in Threatened Species of Wild Fauna and Flora (CITES). Most of the country's mahogany production is exported, although the tendency is toward decreasing the volume of exports. Export value reached its minimum in 2005 – 2006, when a National Export Quota was established. The volume of exports was 23,584.54 m^3 in 2005 and 21,802.13 m3 in 2006. The value of these

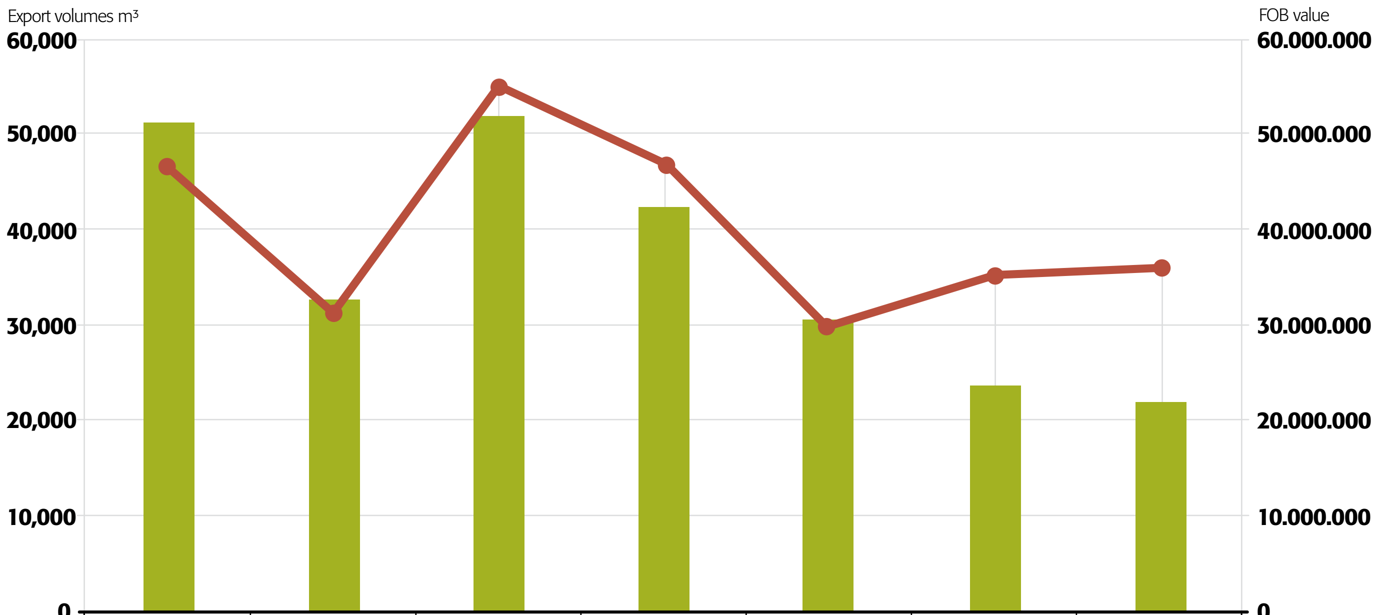
BOX 4.1
ECUADOR: THE EFFECT OF PETROLEUM EXTRACTION ON THE HEALTH OF AMAZONIAN POPULATIONS

In May 2003 a trial began against the Chevron Texaco Corporation for environmental and social impacts, especially for water pollution in the Amazonian forests of eastern Ecuador. It is the first case of a collective suit against a foreign company for environmental and social impacts in its two decades of operations. This trial was originally presented in the United States in 1993 and was the first case in which a US court required acceptance of Ecuadoran jurisdiction.

In respect of its implications for human health, the population of San Carlos (canton of Sachas, province of Orellana) is known as the "cancer zone", due to the numerous cases reported, and, seemingly, this increase in mortality is related to the Texaco petroleum operations. The leukaemia rate in children is four times higher than other areas. Claims were also brought against the Corporation due to the contamination affecting two indigenous nationalities (Cofán and Secoya), which are on the brink of extinction, as well as its having provoked the extinction of a third indigenous nation (Tetete).

Sources: <http://www.texacotoxico.com>, <http://www.sustainlabour.org/documents/latam/Informe%20-20 Medio%20Ambiente%20ALC.doc>.

FICURE 4.2
Peru: Mahogany exports



2000	01	02	03	04	05	06
586,652	3,284.287	520,755	4,240.640	307,659	2,358.454	20,028
467,882.036	35,040.374	55,945.941	4,885.725.277	294,582.334	3,532.840.737	3,604.288.166

Source: Perú: Ministerio de Agricultura (2007).

exports was US$40,143,539 (yearly average for the period 2000 through 2006), which represents approximately 23% of the total value for wood exports. In recent years this average has dropped to US$35.7 million (Perú: Instituto Nacional de Recursos Naturales [INRENA] 2007b). One can infer that for 2007, the reduction has been greater, because of the quota reduction. In the case of Brazil, the prices of mahogany move differently. Prices usually increase when controls are applied to limit illegal mahogany harvesting. Ecuador recently applied a ban on mahogany and cedar, which caused a rise in price on the black market.

Deforestation in Amazonian countries has led to measures for mitigation, which has meant additional contributions from the public budget to improve forest management control and supervision measures. It is also relevant to look at the potential income lost to ecosystem services, such as the sale of carbon services, which is associated with forest conservation, although this market is not yet in full operation. The study by Niles and others (2001) estimated the net present value that would be received from establishing measures for carbon mitigation for Latin American countries, as can be seen in Table 4.2.

Killeen also mentions that the largest economic asset of Amazonia is its carbon reserves, which are estimated at a value of US$2,800 million, if it were monetised at current market values. For example, if the Amazonian countries would accept to reduce their rates of deforestation by 5% per year for thirty years, this could qualify as a reduction in greenhouse gases and generate around US$6,500 million annually during the life of the agreement. Distributed on an equitable basis among approximately 1,000 Amazonian municipalities, that amount would be equivalent to nearly US$6.5 million per year per community that could be duly invested in health and education, which are priority requirements for most of these communities (Killeen and Da Fonseca 2006). Although this option of selling carbon services is not yet totally developed and some of the countries have reserves about entering into this system, it is a good opportunity for posting a referent for the region's potential value.

THE LARGEST ECONOMIC ASSET OF AMAZONIA IS ITS CARBON RESERVES, WHICH ARE ESTIMATED AT A VALUE OF US$2,800 MILLION.

TABLE 4.2
Total annual mitigation of carbon and the income associated through sustainable agriculture, reduction of deforestation and reforestation (2003-2012)

COUNTRIES	TOTAL CARBON FROM ALL ACTIVITIES 2003 - 2012	TOTAL NET PRESENT VALUE 2003-2012, ALL ACTIVITIES
LATIN AMERICA		
BOLIVIA	137,0	US$1.041,7
BRAZIL	750,2	US$ 5.614,3
COLOMBIA	68,6	US$ 511,4
COSTA RICA	12,9	US$ 97,0
ECUADOR	77,0	US$ 580,8
GUATEMALA	27,0	US$ 202,5
GUYANA	21	US$ 15,1
HONDURAS	18,3	US$ 134,5
MEXICO	63,7	US$ 467,7
NICARAGUA	14,1	US$ 103,7
PANAMA	22,2	US$ 168,4
PARAGUAY	68,8	US$ 521,6
PERU	28,4	US$ 204,0
VENEZUELA	58,9	US$ 442,6
SUBTOTAL	**1.349,1**	**US$10.105,3**

Source: Niles and others (2001).

On the other hand, the current status of Amazonian water resources is generating important impacts on the local population's economy, in urban as well as rural zones. In urban zones, the supply of potable water for a growing population gives rise to the need for investment in infrastructure, which currently falls short of providing universal coverage. If the factor of water source contamination is added, the resulting cost for service provision is even greater. Table 4.3 shows that the level of investments in water and sanitation for the period from 2002-2015 in Amazonia for the Andean countries will require US$11,900 million.

Those directly affected by this are the users, given that rate increases will be directly applied, since private concessionaires provide these services in the large cities. In the case of the rural Amazonian sectors of Andean countries, most of the existing potable water and sewerage systems have basically been financed by the users themselves (resident associations) and by national and/or local governments, based on resources transferred by the national government (Nippon Koei LAC Co. y Secretaría General de la Comunidad Andina 2005).

The status of Amazonian water resources generates a series of economic impacts. Although there is no firm evidence regarding the variability and possible reduction of the volume of flow in Amazonian rivers, if it were to occur, there would be problems in potable water supply for the cities, as well as for agricultural activities.

In respect of Amazonian fisheries, it is well known that a good part of the regional economy and of the nutritional sustenance of its inhabitants are based on exploiting the diversity of aquatic organisms, especially that of its fish, which constitute an important part of the region's economic, social and cultural dynamics. Since the 1990s, this resource has generated commercial flows of be-

In urban zones, supplying potable water for a growing population gives rise to the need for investment in infrastructure, which currently falls short of universal service coverage.

TABLE 4.3
Andean countries: Investment in water and sanitation for the Amazonian region (2002-2015) (in millions of US$)

COUNTRY	PERIOD	TOTAL AMOUNT	YEARLY AVERAGE	FOREIGN INDEBTEDNESS (%)
BOLIVIA	2002 / 2010	1.069	118,8	46.6
COLOMBIA*	2003 / 2006	1.358	339,5	s.i.
ECUADOR	2003 / 2015	2.017	144,1	16,1
PERÚ	2002 / 2011	2.404	240,4	10,3
VENEZUELA*	2004 / 2015	5.053	421,1	s.i.
TOTAL	**2002 / 2015**	**11,901**	**1.263,8**	

*The participation of Colombia and Venezuela is proportionally less than that of other countries
Source: Nippon Koei LAC Co. and the General Secretariat of the Andean Community (2005).

IN BRAZILIAN AMAZONIA, THE AGRICULTURE AND RANCHING ACTIVITIES OCCUPY 30% OF THE ECONOMICALLY ACTIVE POPULATION.

tween US$100 million and US$200 million per year (Bayley and Petrere 1989; Petrere 1989; Almeida and others 2006; Barthem and Goulding 2007), which are likely to be affected by a species reduction.

Regarding the economic impact generated by the operation of agro-productive systems, we see a varied situation. Large-scale agriculture favours a higher rate of employment in the region, which generates positive economic impacts in the welfare of the population. Furthermore, recent changes in the market have led to concentration of landholdings, which, in turn, has brought with it larger investments in technologically more advanced productive systems and increases in productivity. However, this type of monoculture system generates high costs for several economic activities, because of the deterioration of ecosystem services. On the other hand, small-scale migratory agriculture in countries such as Peru, Ecuador and Bolivia generates short-term income at the cost of causing greater deforestation, which imposes greater costs on the development of productive activities in the long run.

It should be pointed out that the environmental costs of agricultural activity in the region have never been quantified. Water pollution causes the reduction and disappearance of fish and affects the lives of other species with important economic impacts. However, agriculture and livestock activities also generate benefits. In Brazil, the agriculture and ranching activities of Brazilian Amazonia represent nearly 20% of the regional Gross Domestic Product (GDP) and occupy 30% of the economically active population. As mentioned previously, in recent years there has been a significant increase in planted area.

The disordered growth of Amazonian human settlements affects the population in that it produces neither the sought after access to nor the efficient performance of basic services. In most cases, infrastructure development does not keep pace with the accelerated dynamic growth of the human settlements, which affects family economics.

The population living in more developed Amazonian cities is affected by the environmental problems of air pollution, noise from the vehicular fleet and water contamination, as mentioned in Chapter 3, Section 3.5. These factors, as they become extreme, can affect the productivity of the population in its daily routine and increase the cost due to illness. Sadly, there is no specific information on the matter.


ERNESTO ARIAS/ EL COMERCIO

Inadequate final disposal of solid waste places the population's health at risk.

The development of human settlements in Amazonia has led to promoting investments in road infrastructure within the cities as well as in their surroundings, providing acceptable articulation of urban agglomerations. Doubtless, these initiatives have a positive economic impact on the productive activities developed by the inhabitants, but they are also associated with environmental costs.

In summary, the economic impacts caused by the status of the Amazonian environment are, in some cases, positive; however, in many other cases they are negative and vary in magnitude. Impacts that are associated with the marketplace are quantifiable, although most frequently, it is the benefits rather than the costs that are calculated. On the other hand, those impacts that are not associated with the market have been minimally quantified, and therefore we have little certain knowledge of their magnitude. This demonstrates the need for detailed studies to establish a cost–benefit ratio for Amazonian environmental degradation.

SOCIAL CONSEQUENCES: CONFLICTS

Conflicts over the use of Amazonian ecosystems (for the conversion or exploitation of mineral, petroleum or water resources) affect the biodiversity and sustainable management of those ecosystems, but they also affect the local participants, both the indigenous populations and the colonisers. The lack of regulation, the insecurity in terms of planning, speculation and land invasions are the consequences of colonisation processes in tropical ecosystems. The clandestine invasion of colonisers, illegal timber extraction, the presence of squatters on isolated lands, etc., are processes that result in changes in existing social relations and, in many cases, conflicts between social groups.

The social consequences unleashed by the loss of biodiversity, frequently have long-term repercussions. Many indigenous communities see their traditional ways of life, their customs and their religious beliefs af-

THE ABSENCE OF ADEQUATE PLANNING FOR URBAN GROWTH MEANS THAT IN MANY CASES, WASTE DISPOSAL TAKES PLACE IN INFORMAL DUMPS.

TABLE 4.4
Principal economic impacts by status of water resources and aquatic ecosystems

VARIABILITY IN THE AMOUNT OF WATER RESOURCES
- Increases cost of resource access (principally in cities). - Drastically reduces waterway communications. - Disrupts economic activity (reduction of agriculture and livestock production, increase in cost of basic foodstuffs due to lower availability) .
WATER POLLUTION
- Reduces demand for agricultural and hydro-biological products (greater risk of consuming contaminated foods). - Higher public spending for disease care. - Reduces agriculture and livestock production for self-consumption. - Disincentive for development of economic activities.
INCREASED SEDIMENTATION
- Increases agricultural production in mud flats (as they drain). - Reduces life expectancy of dams and hydroelectric complexes. - Reduces navigability.
REDUCTION OF HYDRO-BIOLOGICAL RESOURCES
- Scarcity of foodstuffs. - Reduced economic income (due to greater fishing efforts). - Changes in activities: abandon fishing. Fishermen become farmers and generate greater pressure on the forest.
Source: In house production.

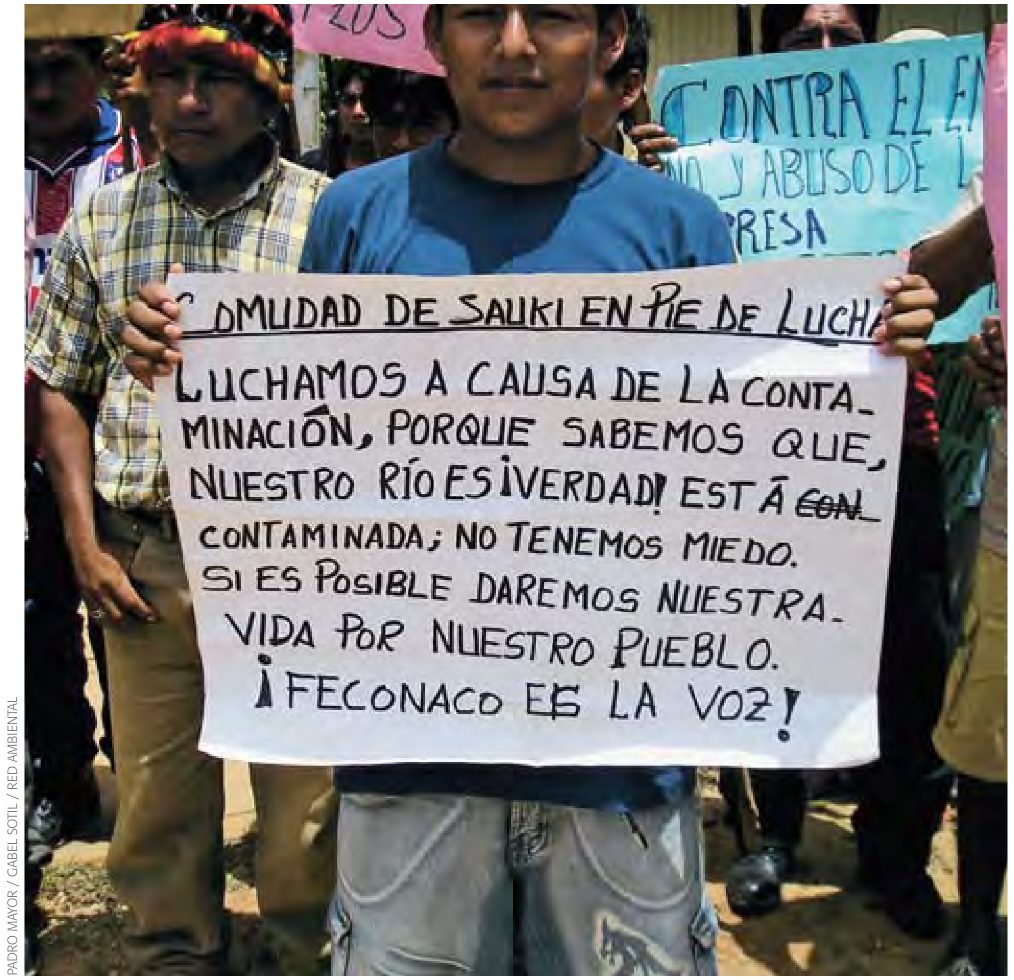
Indigenous populations are affected also by productive activities like petroleum and gas extraction.

fected and their social institutions disrupted by the arrival of new forms or models of territorial occupation. For example, indigenous villages in the Brazilian states of Amazonas and Rondonia have been invaded by farmers, ranchers and gold miners, resulting in violent confrontations and expulsion of traditional populations from their lands. This has happened all over Brazilian Amazonia at different times. Not only does it lead to a cultural loss for the region (uses and customs) but also the loss of traditional wisdom on the use of local biodiversity (medicinal, agricultural or sustainable extraction activities).

Another aspect of this change in social relations comes as a consequence of migration from rural to urban areas. This disordered urbanisation process and its respective consequences of inequity, social marginalisation of population groups and the creation of urban belts of extreme poverty, generate social conflicts and problems of cultural identity.

Ethnic groups or indigenous populations in voluntary isolation are also affected by productive activities like petroleum and gas extraction. These populations are very fragile and, therefore more vulnerable than others. The case of Camisea, Peru, illustrates how the advance of these activities affects this vulnerable population by displacing it and altering its way of life. But this case is repeated among remote populations all over Brazil, Colombia (the Bloque Sirirí) and Ecuador. In the Yasuní region of Ecuador, an Amazonian zone where indigenous peoples of the Tagaeiri and Taromenane groups live in voluntary isolation and where there is also an impressive biological diversity, these peoples have been threatened by petroleum initiatives, such as Block 31 and the Ishpingo-Tiputini-Tambococha

PADRO MAYOR / GABEL SOTIL / RED AMBIENTAL



The inhabitants of Amazonia are aware of the environmental degradation that their region is undergoing and are raising their voices in protest.

megaproject. The Ecuadorian government has expressed its firm intention of leaving millions of barrels of proven oil reserves underground, as long as the international community supports the creation of a fund for sustainable development in this region.

Faced with the oil spills in the headwaters of the Amazonian sub-basins of Peru, Ecuador and Colombia, the affected inhabitants have sued the petroleum companies in international courts, for the huge amounts of petroleum waste products generated by their activities and the eventual abandonment of the oilfields without applying measures for bio-remediation.

In the Colombian case, in particular, and as a consequence of the problems of public order, continuous attacks against petroleum infrastructure led to recent oil spills that involved both the surrounding soil and bodies of water.

INEQUITY, SOCIAL MARGINALISATION OF POPULATION GROUPS AND THE CREATION OF URBAN BELTS OF EXTREME POVERTY, GENERATE SOCIAL CONFLICTS AND PROBLEMS OF CULTURAL IDENTITY.

Floating dwellings are one way that riverbank settlers protect themselves from the impact of the floods that occur regularly close to Amazonian rivers.

SERGIO AMARAL / OTCA

4.3 | VULNERABILITY

Vulnerability is defined as a set of characteristics and conditions, of a social nature, that make society, or a component of it, prone or susceptible to suffering damages and losses when it is the object of threatening events or external physical phenomena (Lavell 2007). Amazonia is a region that presents a high degree of social and economic vulnerability, owing to the fact that the majority of its population lives in conditions of extreme poverty (see Chapter 2).

A broader conception of vulnerability, which is associated with more than physical events alone, is one that contemplates three principal dimensions (World Bank-World Resource Institute 2005a): (i) exposure to pressures, perturbations and unforeseen events; (ii) sensitivity of persons, places, ecosystems and species to the pressures or perturbations, and their capacity for anticipating and dealing with those pressures; and (iii) the capacity for resistance of the peoples, places, ecosystems and species to deal with the unforeseen events and perturbations, without ceasing to perform their normal functions.

The dangers or threats potentially faced by the Amazonian region are vast and tend to increase considerably over time. There are natural dangers associated with geological, geo-morphological, atmospheric, hydro-meteorological and biotic dynamics, such as droughts, floods, overflows, seismic activity, erosion and landslides. There are other dangers called socio-natural, which are produced as a result of the inter-linkages of social practices with the environment, such as deforestation, migration, forest fires and global warming. And finally, there are technological dangers directly and unilaterally associated with human activity, such as accidents from petroleum and mining exploitation, explosions and fires in gas and hydrocarbon installations.

JAVIER MEDINA / EL COMERCIO

The precarious conditions for potable water supply are a health hazard for the Amazonian population.

FLOODS HAVE BECOME MORE FREQUENT IN RECENT YEARS, DUE TO THE EFFECTS OF CLIMATE CHANGE.

EXPOSURE TO FLOODS

Amazonian floods are generally frequent and happen on a yearly basis throughout the watershed, during the rainy season. These are concentrated in zones where the rivers have little gradient and their flow forms meanders. Overflows are also caused by intense and growing deforestation in the piedmont sectors of the Andes, which cause the rivers to erode the banks, carrying a significant amount of soil downstream into the lowlands. This generates the effect of rivers eroding the banks to expand their channels and, at times, even changing their course.

Urban occupation on flood terraces reduces the area available for absorption of rain and the ability of the channel to transport the extra water; the river then rises and creates the risk of flooding. Furthermore, dwellings and urban infrastructure, frequently located along the rivers are exposed to flooding problems. Thus, the location of settlements and infrastructure are fundamental, since, on the one hand, they can increase the danger of flooding, and on the other, their presence in these areas constitutes a condition of vulnerability. Another element is the fact that many Amazonian villages have no drainage systems.

In Peru, floods occur in five departments located in the Amazonian region (Madre de Dios, Amazonas, San Martín, Ucayali and Loreto), where four great watersheds are located: those of the Marañón, Huallaga, Ucayali and Madre de Dios. Floods in this region endanger populated as well as unpopulated areas, where without human activity, these floods cause no damage. The first case refers to the populated centres, where agriculture and ranching activities and infrastructure (roads, power lines, etc.), are located near the riverbanks.

The disorderly occupation of the land, causing it to be used for different activities in danger-prone areas, and the ignorance of the way the Amazonian ecosystem works on the part of immigrant populations, brings about inappropriate use of the land for agricultural activities or to establish unsuitable types of construction, and makes the Amazonian population more vulnerable to natural events than the inhabitants of other regions, with the consequent physical and moral damage.

Floods have become more frequent in recent years, due to the effects of climate change, which, as a consequence, has generated increased economic costs for the region's countries. For example, in the area including the department of Madre de Dios (Peru), the state of Acre (Brazil) and the department of Pando (Bolivia), which make up the MAP Initiative (Madre de Dios, Acre and Pando), there is evidence of an increase in flooding (Brown 2007). The costs resulting from floods in the zone of Acre have climbed as high as US$220 million in the last 20 years, with a tendency of increasing in recent years since 2000 (see Table 4.5).

EXPOSURE TO ENVIRONMENT DEGRADING ACTIVITIES

The paucity of knowledge on Amazonian biodiversity, the high costs of scientific and technological research on biodiversity and the threat of illegal trafficking in biodiversity, have all resulted in certain species becoming highly vulnerable. Predatory exploitation of biological resources, beyond their capacity for regeneration (using dynamite or poison for fishing, etc.) makes ecosystems more fragile and susceptible to damage. The lack of planning in forest management is also a factor that increases vulnerability.

The highly diverse forested area of Amazonia and the "hotspots" of diversity in el Cerrado and the Andes, supply the world with ecosystem services through their biodiversity, carbon reserves, water resources and climate regulation. On the local level, the biological resources of the region provide sustenance and income for the inhabitants, through fish, land fauna, fruit and fibers, but they also contribute great value to the world economy. Unfortunately, the production systems tend to be based on extraction, centered on short-term economic returns, which make them economically and ecologically unsustainable. There is currently no current mechanism or market to convert the ecological services of Amazonia into the financial resources needed to pay for its conservation or to subsidise the sustainable management of its renewable natural resources (Killeen and Da Fonseca 2006).

Deforestation in Amazonia also unleashes a series of effects that make the natural and human ecosystems more vulnerable. In previous chapters we have examined the relationships that the forest has with climate regulation (water cycle) and with the conservation of biodiversity, which leads us to conclude that the greater the rate of deforestation, the more fragile the ecosystems become, and some may even disappear.

An example of a fragile area, given its exposure to the pressures of forestry and petroleum activities, is Yasuní, in Ecuadorian Amazonia. According to Romo (2008), a single hectare in this zone has double the arboreal species that can be found in the United States or almost all of Europe. In a study covering an area of no more than ten hectares of forest, they found 107 amphibian species, which makes this place the most bio-diverse on the planet for this group. This is why Yasuní is one of the few places in the world that can be highlighted as a biodiversity hotspot.

Similarly, water pollution caused by the inhabitants dumping solid waste into the rivers and from accidents in hydrocarbon activities; mercury contamination from certain mining activities, deforestation and contamination with residues from illegal drug-trafficking operations, are all factors that reduce Amazonia's capacity to respond to the threats and dangers it faces.

An additional element that must be taken into account is the food security of the Amazonian population. Forest degradation, water resource contamination and the growth of populated centres are generating changes in the population's patterns of consumption and problems in the availability of foodstuffs. Doubtless, the indigenous population, which makes its living by gathering or subsistence farming, is the most vulnerable; although there is a large riverside population, which lives on extraction that will also feel the effects. At another level, the production of biofuels, based on sugarcane and corn, could also bring problems of food security to the countries of the region.

Climate change

The Amazonian forest is intimately related to world climate. According to Nepstad, Amazonia influences climate, acting like a gigantic consumer of heat close to the earth, and absorbs half of the solar energy that arrives, through evaporation of water from its foliage. Furthermore, Amazonia is an ample and relatively sensitive storehouse for carbon, which is being released into the atmosphere through deforestation, drought and fire, which

BOX 4.2
MIGRATION AND VULNERABILITY

Migration into Amazonia that occurred during the last century and intensified after the 60s has caused important environmental impacts that have raised the levels of danger and vulnerability. The migrant population comes, mainly, from the sierra with a tendency to reproduce its culture in a different medium, which is why it deforests areas to plant crops and to construct adobe dwellings, with disastrous consequences. This is in contrast to the practices of the native population, which, having knowledge of the local environment, locates its dwellings better, builds them adequately so that they better resist floods, makes temporary use of the plains for planting crops and, generally, is less exposed to suffer from natural disasters.

Recently, the development of economic activities such as petroleum exploitation, mining and agroindustry, added to the development of roadway infrastructure, has attracted populations seeking sources of work and income. The municipalities receive income from the economic activities through taxes and have the resonsability to administer the basic services for these large population flows. The limited capacity of local management leads to populations facing greater risks associated with the lack of planning.

Source: Perú: Instituto Nacional de Defensa Civil (Indeci) (2006).

TABLE 4.5
Evaluation of damages in Acre

YEAR	DISASTER	ESTIMATED COST (DOLLARS)
1988	FLOODING	90 MILLIONS
1997	FLOODING	33 MILLIONS
2005	FLOODING	84 MILLIONS
2006	FLOODING	16 MILLIONS
TOTAL		**220 MILLIONS**

Source: Brown (2007)


ISABEL GUERRERO

Water pollution affects the poorest segment of the population.

Predatory exploitation of biological resources beyond capacity for generations makes ecosystems more fragile and susceptible to damage.

MIGUEL BELLIDO / EL COMERCIO

Forest fires contribute to the generation of greenhouse gases.

IT IS KNOWN THAT IF THE LOSS OF THE FOREST EXCEEDS

30%

THE INHIBITION OF RAINFALL WILL BECOME MORE SEVERE.

in turn contributes to global warming. Finally, the water that drains out of these Amazonian forests into the Atlantic Ocean makes up between 15 and 20% of the total world discharge of fresh river waters, and could be sufficient to influence some of the great ocean currents in their important task as regulators of the global climate system (Nepstad 2007). For this reason, conserving the Amazonian forest is a necessity of global importance and amplitude; the stability of the planet's climate will depend on this conservation.

As mentioned in Chapter 2, Section 2.5, Amazonia is in a period of transformation, due to climate change. Global warming will probably cause a reduction in precipitation by more than 20% and will increase the average temperature by more than 2 °C (or even as much as 8 °C) by the end of this century, if mankind is unable to reduce greenhouse gas emissions. This tendency to drought (most severe in eastern Amazonia) and warming could be enhanced by the large-scale disappearance of the forest in eastern Amazonia and its replacement with savannah and semi-arid type vegetation (Nepstad 2007).

There is evidence that, during the Amazonian dry season, there were distinct patterns of rainfall and higher temperatures in deforested areas (National Aeronautics and Space Administration [NASA] 2006). Other research has established that cumulative rainfall has decreased significantly at the end of the rainy season and increased at the end of the dry season (Chagnon and Bras 2005). The loss of vegetation cover means that there is less heat absorption, resulting in less humidity in the atmosphere. Over the long run, this could lead to a reduction of rainfall, which would be devastating for the population of the region, since it could convert up to 60% of Amazonia into savannah lands during this century, according to a study conducted by INPE (Nobre and Oyama 2003).

Several studies using satellite data suggest that deforestation in Amazonia may affect regional climate. Agriculture and cattle ranching expansion, fire, drought and tree harvesting could deforest 55% of the Amazonian rainforest by 2030 (Nepstad 2007). Extensive forest degradation would gather speed, due to the relationship between the ecosystems and the climate of the Amazonian region. It is known that if the loss of the forest exceeds 30% (Nepstad and others 2007), the inhibition of rainfall will become more severe, and will generate a vicious circle, fostering forest fires, reducing the release of water vapour and increasing the emission of smoke into the atmosphere, with the consequent suppression of precipitation.

Forest fires contribute to the generation of greenhouse gases. During the last half of last century there was been evidence of a reduction in the period of time between forest fires. Instead of centuries going by between events, some forests burn every five to fifteen years (Cochrane and Schulze 1999; Alencar and others 2006). With every new fire, the forest becomes more susceptible to subsequent fires. The higher frequency of forest fires is also related to deforestation. The tops of the constantly green trees in the Amazonian canopy protect the forest from the intense equatorial sun, like a gigantic umbrella that intercepts most of the solar energy, keeping it from falling on the forest's dark, damp substrate, many meters below. Each tree that dies, or is extracted, creates a hole, through which sunlight penetrates the forest and heats its interior. The heating and drying of the forest substrate is the principal factor determining the inflammable character of the forest and more so when the forest cover is thin or very close to the forest floor (Ray and others 2005). It must be noted that fires caused by solar rays are still rare in Amazonia, although they do constitute a growing threat.

Man-made fires are abundant in the central forests of Amazonia. These are set to clear the forest for agriculture or pastures or to improve forage. However, fires frequently extend beyond their planned limits and spread through nearby forests. During the severe drought of 1998, approximately 39,000 km^2 of standing forest burned in Brazilian Amazonia (Alencar and others 2006), which makes up twice the area cut during that year. Also, during the severe drought of 2005 (Aragón 2007), at least 3,000 km^2 of living forest were burnt in the regions of Madre de Dios, Pando and Acre, in south-eastern Amazonia (Brown 2007).

Climate change also impacts the health of the population, making it more vulnerable. However these effects vary in magnitude, according to the size, density, localisation and well-being of the affected populations (Githeko and others 2000). Deaths and mortality rates (infectious diseases, sanitation problems and damage to the sanitation infrastructure) have increased, as a consequence of heat waves, droughts, fires and floods caused by climate change. Many models have analysed urban populations, whose conditions of poor housing (overcrowding and poor ventilation) are particularly vulnerable at extreme temperatures (Kilbourne 1989, Martens 1998). However, the effects on rural populations are different and there are few studies available.

Climate change has also increased the infestation of insects and the propagation of diseases. In South America, malaria, leishmaniasis, dengue, Chagas' disease and schistosomiasis are the main diseases transmitted by climate sensitive vectors. Others are yellow fever, the plague, Venezuelan equine encephalitis and several arboviral diseases detected in Amazonia (for example, Oropouche fever). As a consequence of the drought caused by El Niño, Brazilian populations migrate from rural to urban areas in search of work, which enhances the transmission of malaria and leishmaniasis in the cities. However, malaria has also been seen to increase with the floods, associated with El Niño.

As mentioned earlier, the Amazonian basin plays an important role in the water cycle and balance of the region. Changes in the quantity, quality and frequency of water availability can affect the habitat and behaviour of many plant and animal species. These changes, added to extreme events, can push ecosystems beyond their average conditions.

Deaths and mortality rates have increased as a consequence of heat waves, droughts, fires and floods caused by climate change.

POTABLE WATER IS ONE OF THE BASES FOR THE DEVELOPMENT OF A HEALTHY AMAZONIAN POPULATION.

ENRIQUE CASTRO MENDÍVIL / PRODAPP

STAKEHOLDERS' RESPONSES TO THE AMAZONIAN

ENVIRONMENTAL SITUATION

5

5.1 ENVIRONMENTAL **GOVERNANCE**

5.2 REGIONAL **PLAYERS**

5.3 MAIN **ENVIRONMENTAL ACTIONS**

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THE ENVIRONMENTAL SITUATION OF AMAZONIA HAS GENERATED A SERIES OF responses from the stakeholders in Amazonian matters. Based on its national environmental institutional structure, each country has developed actions with the common objective of providing responses for dealing with the region's environmental degradation. This chapter will review the ways these countries have organised their environmental institutions and principal policies related to Amazonian environmental management. It will also identify the principal Amazonian players and the most relevant mutual processes for regional actions.

It should be pointed out that it is not the purpose of this chapter to carry out a comparative analysis between systems of environmental management, or to comment on its efficiency and effectiveness; however, it helps to know that the way environmental management is organised in the countries is highly varied. This will influence the way each is able to handle resource management in the Amazonian region.

5.1 | ENVIRONMENTAL GOVERNANCE

There is a series of interacting stakeholders in Amazonia, whose actions are generally governed by a system of rules and procedures that make up the institutional framework of environmental management. The efficient, effective and legitimate exercise of the power held by each of these players is, precisely, the origin of its governance (Fontaine, Van Vliet and Pasquis 2007).

ENVIRONMENTAL INSTITUTIONALISM

Each of the eight Amazonian countries has its own environmental institutional structure, as will be seen further on. At the ecosystemic level there is no single environmental institution, neither is there a single common authority. However, these countries are subscribers to the Amazon Cooperation Treaty (ACT), whose objective is to carry out joint efforts, mainly for environmental preservation and the rational utilisation of Amazonia's natural resources, reserving the right of each country to exercise its sovereignty in the most appropriate manner.[1] ACT is a permanent venue for consultation among the countries, for articulation of policies and promotion of sustainable development projects for Amazonia, through its institutional structure in the Amazon Cooperation Treaty Organisation (ACTO) (Box 5.1).

. The environmental institutional framework of the Amazonian countries is varied, as can be seen in Table 5.1. Most of the countries have a ministry in charge of environmental policies, except for Guyana, which has a specific institution, without ministerial rank: the Environmental Protection Agency (EPA). In the case of Peru, the Min-

ANTONIO ESCALANTE / EL COMERCIO

Amazonia's inhabitants are aware of their duties and rights as citizens.

1 *The treaty is binding, but does not have a mechanism for the adoption of binding decisions.*

BOX 5.1
AMAZON COOPERATION TREATY ORGANISATION (ACTO)

The Amazon Cooperation Treaty (ACT) was signed on 3 July 1978 by Bolivia, Brazil, Colombia, Ecuador, Guyana, Peru, Suriname and Venezuela, to promote joint actions for the harmonious development of the Amazon basin.

As part of the Treaty, the member countries assumed a common commitment to preserve the environment and foment a rational utilisation of Amazonia's natural resources.

In 1995, the eight countries decided to create the Amazon Cooperation Treaty Organisation (ACTO), to strengthen and implement the Treaty objectives. The ACT amendment was approved in 1998 and the Permanent Secretariat was established in Brasilia in December 2002, and finally installed in March 2003.

ACTO is mandated to institutionally strengthen the coordination and joint action required by the demands of Amazonia, and represents a show of interest, on the part of the governments, to attend to those demands in a prioritised manner. It also deals with strengthening ties between the countries, through regional cooperation and the need to forge a common vision for the sustainable development of Amazonia.

In its Strategic Plan 2004-2012, ACTO establishes four strategic lines of action: (i) Conservation and sustainable use of renewable natural resources; (ii) Knowledge management and technological exchange; (iii) Regional integration and competitiveness, and (iv) Institutional strengthening. These lines of action are applied to six topical areas: water; forests/soils and protected natural areas; biological diversity, biotechnology and bio-commerce; land use management, human settlements and indigenous affairs; social infrastructure: health and education; and transportation, energy and communications infrastructure (OTCA 2004).

Source: ACTO < http://www.otca.info/ >.


ERNESTO ARIAS / EL COMERCIO

The voice of Amazonian inhabitants is heard with ever-increasing force.

THE NATIONAL ENVIRONMENTAL NORMS CONSIDER PARTICIPATION BY CIVIL SOCIETY TO BE ABSOLUTELY NECESSARY AND HAVE CREATED MECHANISMS TO PROMOTE IT.

istry of the Environment was recently created to replace the National Environmental Council (CONAM). It will begin full operation in early 2009. It should also be mentioned that, although the environmental ministry figure, per se, is predominant, as is the case of Brazil, Ecuador and Venezuela, there are other institutional modalities, as in Bolivia, for example, where more than one ministry covers environmental matters and natural resources; and in Colombia and Suriname, where the ministry is shared with other areas (the Ministry of Environment, Housing and Territorial Development [Ministerio de Ambiente, Vivienda y Desarrollo Territorial] in Colombia and the Ministry of Labour, Technological Development and Environment in Suriname). There is a committee or national council in the structure of most of these ministries, which serves as consultative or multi-sector organ, whose structure may be very complex, as in the case of Brazil. These differences demonstrate the heterogeneous treatment of environmental matters in the different countries.

The political constitution of all Amazonian countries includes some article, dealing with the right to a healthy environment, which establishes a clear mandate on the use and management of the environment. In Brazil, for example, Article 225 of the Federal Constitution of 1988 stipulates that all citizens have the right to an ecologically balanced environment, to the common use of that environment, essential for the quality of life, and that the citizenry and political powers are responsible for defending and preserving it for present and future generations. The Peruvian Constitution consecrates natural resources as national patrimony in its articles 66 through 69; it therefore commits to watch over the sustainable usage of those resources. It also promotes the conservation of biological diversity and of protected natural areas. The Suriname Constitution is less explicit than the foregoing two, but it does establish that the social objective of the State is oriented to create and foster the conditions necessary for protecting nature and maintaining an ecological balance.

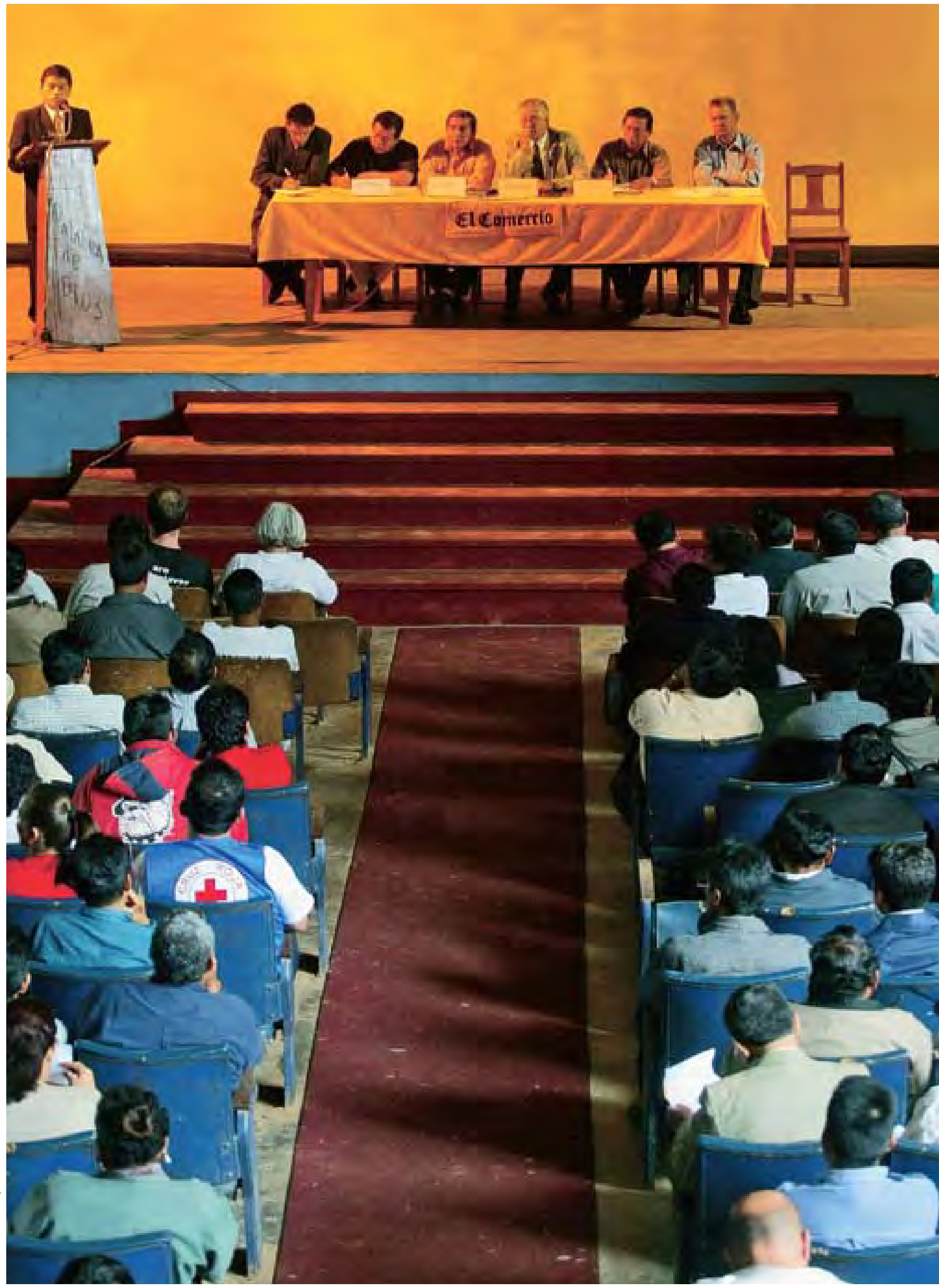
The countries also have national environmental systems that organise the competencies and functions among the different levels of environmental management (see also Table 5.1). For example, Colombia has its National Environmental System (SINA), which is defined as "the set of orientations, norms, activities, resources, programmes and institutions that allow the functioning of the general environmental principles contained in this law" (Law 99 of 1993). "SINA is made up of: (i) general principles and orientations, (ii) current specific norms, (iii) State entities responsible for environmental policy and actions, (iv) community and non-governmental organisations concerned with environmental problems, (v) economic sources and resources to manage and recover the environment, (vi) public, private or mixed entities that carry out activities for producing information, scientific research and technological development in the environmental field"[2]. Furthermore, the national government regulates the organisation and operation of the National Environmental System.

In respect of the management of Amazonian resources, it can be seen that each country has its own organs or specialised institutes (see Table 5.1). However, the functions are not the same in all cases; to wit, some only carry out monitoring and control, while others decide on and implement specific policies for their national Amazonian areas. Generally speaking, the functions of the Amazonian areas are shared by several institutions, which carry out certain coordinated activities with their neighbouring countries.

This varied structure of environmental institutions has articulating elements, embodied in a series of norms that allow environmental management to function. However, it is necessary to establish policy priorities to ensure efficient management, considering the breadth of the topic and the restrictions it faces. A common element in the countries of the region in respect of environmental management of Amazonia is the difficulty of integrating environmental priorities into national development plans. Brazil is an exception, given that it has the Sustainable Amazonia Plan, integrated into the National Development Plan, the latest version of which was approved in May 2008. Colombia has also made integration efforts in these matters; in Peru, although the topic of environmental sustainability is recognised in national accords, its inclusion in national plans and specific actions is still very limited. In both cases, the zones of most demographic and economic importance are not found in Amazonia; thus, although they are Amazonian countries, the environmental management of this region is, as yet, incipient.

Data on public budgets destined for environmental management in general, and that of Amazonia in particular, are not available for all of the countries, because national accounts do not allow for that differentiation (the allocation is generally by economic sector) or because there has been no requirement for them. There are also difficulties in budget monitoring, so it is also difficult to ascertain its effectiveness. Some figures reveal the different budgetary magnitudes between the countries. For example, Brazil had a federal budget for environmental management in Amazonia, of US$1,000 million in 2005, while Peru had a public environmental expenditure in 2004 of US$163 million, and Guyana, of US$198,200 in 2006

2 *Article 4 of Title II of Law 99 of 1993.*



ERNESTO ARIAS / EL COMERCIO

Participatory mechanisms are gaining importance in the debate on common problems and decision making.

The participation of different local stakeholders in managing natural resources and environmental quality has become an important element in preventing the spread of conflict, as well as contributing to the integration of Amazonia into the national setting.

TABLE 5.1
Environmental institutions of the Amazonian countries

	BOLIVIA	BRASIL	COLOMBIA	ECUADOR	GUYANA	PERU	SURINAME	VENEZUELA
ENTITY RESPONSIBLE FOR THE ENVIRONMENT	● Ministry of Rural, Environmental and Agricultural Development (biodiversity, forest resources and the environment) ● Ministry of Water	● Ministry of the Environment ● Government Council ● National Council on the Environment (CONAMA)	● Ministry of the Environment, Housing and Territorial Development ● National Council on the Environment	● Ministry of the Environment ● National Secretariat on Development Planning	● President of Guyana ● Sub-Cabinet –Committee on Natural Resources and the Environment ● Natural Resources and Environment Advisory Committee (NREAC) ● Environmental Protection Agency (EPA)	● Ministry of the Environment	● Ministry of Labour, Technological Development and the Environment ● National Institute of the Environment and Development	● Ministry of Popular Power and the Environment
REFERENCE TO THE ENVIRONMENT IN THE CONSTITUTION	● Political Constitution of the Republic of Bolivia (1967, with reforms in 2002)	● Federal Constitution (1988)	● Political Constitution of Colombia (1991)	● Political Constitution of the Republic of Ecuador (1998)	● Constitution of the Republic of Guyana (1980)	● Political Constitution of Peru (1993)	●Constitution of the Republic of Suriname (1987)	● Constitution of the Bolivarian Republic of Venezuela (1999)
ADMINISTRATION, CONTROL AND MONITORING THE NATURAL RESOURCES OF AMAZONIA	● National Institute of Agrarian Reform ● Superintendency of Forestry ● Departmental Prefectures ● Municipal Governments	● Brazilian Institute on the Environment and Renewable Natural Resources (IBAMA) ● Brazilian Forestry Institute	● Amazonian Institute for Scientific Research (SINCHI) ● CorpoAmazonía C.D.A. ● Cormacarena CRC ● Corponariño ● Corporinoquia	● Institute for Amazon Regional codevelopment (ECORAE)	● Subcommittee on Natural Resources and the Environment – Advisory Committee on Natural Resources and the Environment (NREAC)	●National Institute of Natural Recourses (INRENA) ● Peruvian Amazonia Research Institute (IIAP)	● Ministry of Physical Planning, Land and Forest Management ● Ministry of Natural Resources	● Venezuelan Institute of Amazonian Research (Instituto de Investigación de la Amazonía Venezolana (IVIA)

Source: UNEP, ACTO and CIUP (2007).

ANTONIO ESCALANTE / EL COMERCIO

The indigenous communities and local populations are consolidating their venues for dialogue and participation.

INTERNATIONAL ENVIRONMENTAL MATTERS RELATED TO AMAZONIA

Et is important to point out that the Amazonian countries have been involved in discussions and decisions on international environmental matters. Most of the countries are signatories of the multilateral environmental agreements (MEAs), and their environmental legislations are based on those principles. The relevant MEA for Amazonia are shown in Table 5.2: the UN Framework Convention on Climate Change and the Kyoto Protocol; the Convention on Biological Diversity; the International Tropical Timber Agreement; the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); the Ramsar Convention on Wetlands; the Cartagena Protocol on Biosafety; and the Non-Binding Agreement on Forests.

The fact that most of the countries recognise the aforementioned MEA implies that national norms are arrived at in accord with the principles established in these multilateral agreements. Thus, it is possible to find national policies referring to national plans or strategies on biodiversity, forestry policies, policies on the protection of fauna, and policies or laws on water resources.

The existence of policies on natural resources does not, however, guarantee that these resources are managed in a sustainable manner in Amazonia. The socio-political and economic dynamics of each country make for a varied application of the policies in each case. Furthermore, some countries have stronger institutional structure than others, given the political stability of some of them that allows the institutions to develop long range plans and strategies. On the other

There is a very minimal presence of the State in the Amazonian region because it has always been considered an inhospitable y region of low-priority.

TABLE 5.2
International conventions and principal national policies

	BOLIVIA	BRAZIL	COLOMBIA	ECUADOR	GUYANA	PERU	SURINAME	VENEZUELA
INTERNATIONAL CONVENTIONS								
UN Framework Convention for Climate Change – Kyoto Protocol	●	●	●	●	●	●	●	●
Convention on Biological Diversity	●	●	●	●	●	●	●	●
International Tropical Timber Agreement	●	●	●	●		●		●
CITES Convention	●	●	●	●	●	●	●	●
Ramsar Convention on Wetlands	●	●	●	●		●		●
Cartagena Protocol on Biosafety	●	●	●	●			●	●
OTHER CONVENTIONS								
CAN Decision 391: Common Regime for Access to Genetic Resources	●	n.a.	●	●	n.a.	●	n.a.	n.a.
Cross-border accords	● (with BRA,PER)	● (with BOL, PER, COL, GUY, VEN)	n.i.	● (with PER, COL)	● (with BRA)	● (with BOL, BRA, ECU)	n.i.	● (with BRA)
NATIONAL POLICIES								
Policies on sustainable development	●	●	●	●	●	●		●
National Strategy or Plan on biodiversity	●	●	●	●	●	●	●	●
Forestry or Forest Policies	●	●	●	●	●	●	●	●
Policies for wildlife protection	●			●	●	●		●
Policy or law on water resources	●	●	●	●	●	●		●

n.a.: not applicable. n.i.: no information.
Source: In house production.

State agencies have a weak presence in the application of environmental policies.

ARCHIVO PRODAPP

IN SEVERAL COUNTRIES OF THE REGION THERE ARE CONFLICTS OF COMPETENCIES OR A LACK OF THEIR DEFINITION, AND LITTLE COORDINATION AMONG THE DIFFERENT PUBLIC SECTOR ENTITIES.

hand, other countries constantly change their policies, strategies and officials, which impedes continuity of their activities, above all considering that the environmental matters require long term interventions.

On the other hand, there are also environmental matters of sub-regional importance that have made it possible to develop environmental policies with an Amazonian regional impact. Such is the case of the Andean Community of Nations (CAN), a process of integration subscribed to by four of the eight Amazonian countries. Having gone beyond economic and commercial matters, to which it was dedicated in its first decades of application, it now constitutes a venue for dialog and responses to environmental matters of importance for Amazonia. The Andean - Amazonian countries (Bolivia, Colombia, Ecuador and Peru), as members of CAN, have adopted divers accords, called "Decisions", in particular Decision 391, on a Common Regime for Access to Genetic Resources. CAN also supports the implementation of accords of the Convention on Biological Diversity in the member countries, and has been able to establish a Regional Strategy for Biodiversity for the Countries of the Andean Tropics and promotes the implementation of national strategies in each country.

PRINCIPAL ENVIRONMENTAL POLICIES

In general, in the formulation of public policies, Amazonia has been considered peripheral. Although Amazonian matters have begun to be discussed, public policy in the different countries does not yet have an integrated management perspective. In this sense, the ACTO has made it clear that inter-sectorial state policies are a necessity in Amazonia, because regional environmental challenges recognise no borders and require regional strategies (OTCA 2007).

There is a very profuse body of environmental norms, which generates, more than legal vacuums, overlapping and at times contradicting norms

There are national environmental policies as well as general and specific norms. Table 5.3 shows the principal environmental norms by country, a majority of which cover all natural resources. In general, there is a very profuse body of environmental norms, which generates, more than legal vacuums, overlapping and at times contradicting norms (Fontaine, Van Vliet and Pasquis 2007). In several countries of the region there are conflicts of competencies or a lack of their definition, and little coordination among the different public sector entities, which makes applying the norms even more difficult.

In Amazonia, in particular, there is a notably scant presence of Government; although this situation is changing in many countries, due to the implementation of public decentralisation, current attention to Amazonia is still very tentative. Many countries have had centralised administrations that have placed their highest priorities on investments in coastal or capital cities and have left Amazonia behind, considering it an inhospitable place of low priority (The ACT Amazonian Commission for Development and the Environment 1992). An exception to this situation is Brazil, which is characterised by its organisation into federal states, each with political and economic autonomy, which has facilitated the implementation of development policies in its Amazonian region (Weiss, Van Vliet and Pasquis 2007). In this sense, Brazil perceives Amazonian development within the framework of the country's development. In order to adequately coordinate the policies in their respective areas, the Extraordinary Ministry of Strategic Affairs has charge of the supervision of implementing the Sustainable Amazonia Plan (PAS).

BOX 5.2

THE BRAZILIAN STATE OF AMAZONAS ACHIEVED THE SUPPORT OF THE IDB TO IMPROVE LIVING CONDITIONS IN THE IGARAPÉS

In Brazil, the State of Amazonas will receive US$154 million from the Inter-American Development Bank (IDB) within the framework of the Social and Environmental Programme for the Igarapés of Manaos – Prosamim II, through which more than 15,500 families from Manaos will receive direct benefit. The programme includes actions and projects in the basins of the Igarapés Educandos / Quarenta and Sao Raimundo, to improve the environmental, urbanistic, health and housing conditions of the population, based on community participation. The programme includes the following components: i) sanitation and environmental infrastructure to improve potable water service coverage, sanitation (e.g., microdrainage and sewage treatment) and refuse collection; ii) environmental recuperation through the resettlement of families in areas of risk, preservation and conservation of water sources and recuperation of floodable areas; and iii) social and institutional sustainability to improve the programme's operational capacity and administration.

That financing will make it possible to construct drainage and solid waste elimination systems, treatment plants for sewage and solid waste, which will reduce the vulnerability of the population to floods and disease, produced by contaminated water, and will allow for the development of marginal roads to the Igarapés as well as the improvement of urban transportation and electric power systems.

The IDB loan expires in twenty-five years, has a five-year grace period and finances 70% of the total project cost.

Source: Bretas (2008).

TABLE 5.3
Principal national norms by subject

	BOLIVIA	BRAZIL	COLOMBIA	ECUADOR	GUYANA	PERU	SURINAME	VENEZUELA
GENERAL ENVIRONMENTAL NORMS	● Environmental Law N°1333 (1992)	● Social Environmental Decree (Law 6938/81)	● Code for Protection of Natural Resources and the Environment (D.L 1811 of 1974) ● SINA (Law 99 of 1993)	● Law on Environmental Management	● Law on Environmental Protection (1996)	● General Law on the environment ● Law on the National System of Evironmental Management	● Policy of the Environment Ministry (2006-2010)	● Statutory Law on the Environment (1976)
SPECIFIC NORMS	● Forestry Law N° 1700 (1996) ● Law of National Service for Agrarian Reform N° 1715 (INRA 1996) ● Development Plan for Biodiversity, Mining and Hydrocarbons	● Law on Water Resources ● Law on Environmental Crimes ● Forestry Code ● Public Forest Management ● System of Conservation Units	● Promotion of Rational and Efficient Energy Usage ● Guidelines for Integral Water Management ● Land Use Management Law (Law 388 of 1997) ● National Wetlands Policy (2001) ● Forestry Law (Law 1021 of 2006) ● National Biodiversity Policy (1995)	● Law on Forestry and Natural Areas and Wildlife Conservation	● Forestry Law (2006) ● National Parks Decree ● Code for Wetlands Usage ● Decree on Water and Drainage (2002)	● Water Law ● Law on Biodiversity Use and Conservation ● Forestry and Wildlife Law ● Natural Protected Areas Law ● Law on Solid Waste	● Law On Physical Planning ● Law On Natural Conservation ● Law On Fisheries, Soil, Water, Forests, Air and Biodiversity	● Community environmental Management ● Water and Drainage ● Guacaipuro Mission ● Productive Reforestation ● Land Use Management ● Recuperation of Degraded Areas ● Solid Waste and Hazardous Materials Management

Source: In house production.

The current trend in the countries is toward decentralising Public administration, which means giving greater power of decision to the regional and local governments, thus contributing to integrating the Amazonian region into national development plans. An example of this process is the Inter-regional Council on Amazonia (CIAM) in Peru; a mechanism for coordination between regional government organisms of Peruvian Amazonia. On matters of environmental management, the regional governments are not only able to monitor and supervise environmental management, but also to generate policies and norms that help to improve the exploitation of resources in a sustainable manner.

On the other hand, the participation of different local players in managing natural resources and environmental quality has become an important element in preventing the spread of conflict, as well as contributing to the integration of Amazonia into the national milieu. In recent years, Amazonia has seen an awakening of its Amazonian population, claiming its right to participate in its own development. Proof of this is the growing number of social organisations created in several areas and their participation in the oversight and control of environmental management (Buclet 2007). The national environmental norms also consider participation by civil society to be absolutely necessary, and have created mechanisms to promote it. The participative budgets and public hearings for reviewing studies on environmental impact, among others, are tools currently used by civil society. Those mechanisms are not the same, nor are they applied in the same manner in all of the countries and their effectiveness has not received much study; however, it is to be expected that civil society will play more of a stakeholder role in managing the natural environment of Amazonia.

Some of the policy instruments used in Amazonia are preventive in nature, such as land use management, in some countries called, "Ecological-economic zoning (Economic and Ecological Zoning)" (EEZ) or "land use planning". It should be explained that these forms of planning and organisation for land use have different implications from one country to the other, although they use the same name. Another preventive instrument is the environmental impact study (EIA), required before authorising the development of any productive activity. The EIA are used mainly for mining, petroleum and activities that have an impact on the natural environment. In some countries, like Brazil, the EIA are a mandatory requirement for all types of activities.

The policy instruments most frequently used by the Amazonian authorities are those hallmarked "control". These are generally instruments that imply audits, oversight and sanctions, when the case deserves it, and therefore require the use of monitoring and supervision systems. For example, in the case of forestry monitoring, satellite images are a great ally for combating deforestation and illegal lumber exploitation. In Brazil, the National Institute for Space Research's (INPE) Programme of Monitoring the Brazilian Amazon Deforestation (PRODES) is one of the world's most advanced systems for monitoring deforestation in real time (Kintisch 2007). The other countries of the region have no systems for monitoring of

MANY COUNTRIES HAVE CREATED FINANCING FUNDS FOR IMPLEMENTING ENVIRONMENTAL PROGRAMMES; MOST ARE OF A GENERAL NATURE OR ARE CENTRED ON A PARTICULAR THEME.

this type, although, through the Pan-Amazonian project, promoted by ACTO, INPE and the Brazilian Agency for Cooperation (Agência Brasileira de Cooperação; ABC), efforts are being made to implement these systems: meanwhile monitoring and control depend on forestry or ecological police, or on some other monitoring system.

There are also instruments for restoration that attempt to repair a damage already done or to eliminate environmental liabilities. Examples of these instruments are the programmes of environmental adaptation (Peru), the plans for decontamination (Colombia), environmental insurance (for example, in Brazil), and others. These instruments are used mainly in mining and petroleum activities, hydroelectric and highway projects, when the environmental degradation impacts are apparent.

The conservation units for forest, flora and fauna protection, are recognised as one of the most effective strategies for combating the advance of deforestation and illegal lumber exploitation (Soares-Filho and others 2006), and have been widely utilised in the Amazonian countries. Some countries have conservation units for sustainable lumber production and for the integral protection of the biodiversity.

Another recently developed type of mechanism for environmental management is the environmental financial instrument. Many countries have created financing funds for implementing environmental programmes, most are of a general nature or are centred on a particular theme, such as those associated with funds for protected natural areas. In some cases, there are sectorial funds that are channelled toward the conservation of the environment. Another example related to forests, is the carbon market, through which, although in a limited manner, CO_2 capture or the environmental service provided by the forest, is commercialised (Box 5.4).

There are economic instruments that are not generally used, although they have many possibilities for development, in that they motivate a change in consumer behaviour through incentives. This is the case with the concessions, which imply the allocation of a right to use for a determined time and according to specific conditions. The concessions have been relatively successful in forest and biodiversity management. There are also economic instruments for decision-making, such as methods of natural resource and environmental evaluation, cost avoidance and efficiency, among others, which are increasingly being used by public decision-makers. Finally, the use of non-traditional methods, based on the potential for generating income through environmental services to subsidise economic growth that avoids deforestation and rewards conservation, have recently been adopted by some of the countries (Killeen 2007).

BOX 5.3

THE PROCESS OF ECOLOGICAL AND ECONOMIC ZONING IN THE ACTO COUNTRIES

The countries of the Amazon Cooperation Treaty Organisation, through technical meetings in Manaos (1994), in Brazil, and Santa Fe de Bogotá (1996), in Colombia, agreed to promote economic and ecological zoning, as one of the fundamental instruments for providing a technical basis for land use management in the Amazonian countries, and as a tool for the adequate use of Amazonia.

From that time on, many countries developed processes with differing spatial coverage, scales and methodologies, within their respective Amazonian surroundings. In general terms, the countries have been applying the methodology agreed to in the TCA meeting in Bogotá. This is the case of Peru, where EEZ processes are reported in the departments of San Martín, Amazonas, and Madre de Dios, as well as some zones of Loreto and Ucayali, directed by their respective regional governments with the technical support of the IIAP. In that country there is a legal and institutional framework that establishes norms for the EEZ process. In Ecuador there are also reports of EEZ processes in that country's entire Amazonian environment, promoted by ECORAE. In the case of Colombia, EEZ is reported for the Putumayo river basin (1998), Eje Apaporis Tabatinga (2000), and in local areas, in the departments of Guaviare (2001) and Caquetá (2004), conducted by the SINCHI Institute with the support of other institutions.

IN THE PERUVIAN CASE, THERE ARE EEZ PROCESSES IN THE DEPARTMENTS OF SAN MARTÍN, AMAZONAS AND MADRE DE DIOS, AS WELL AS IN SOME ZONES OF LORETO AND UCAYALI, WHICH ARE DIRECTED BY THE RESPECTIVE REGIONAL GOVERNMENTS WITH TECHNICAL SUPPORT FROM IIAP.

In Brazil, on the other hand, according to the specific legal framework of that country, the EEZ is considered as a proposal for land use management, related to the allocation of land use. In this framework EEZ processes have been carried out in a variety of scenarios. Such is the case with the EEZ of the states of Acre and Rondonia, as well as in the area of influence of the BR 163 (Cuiaba – Santarém) highway. In Bolivia, several PLUS (Plan for Land Use) have been developed in almost all Amazonian departments, however, the use allocation for these lands has been based on agro-ecological zoning.

Source: Prepared by Fernando Rodríguez Achung, Peruvian Amazonia Research Institute (IIAP).

DANTE PIAGGIO / EL COMERCIO

DANTE PIAGGIO / EL COMERCIO

The indigenous people of Amazonia are raising their voice, demanding a responsible entrepreneurial presence that would guarantee a healthy environment.

BOX 5.4

BRAZIL: AMAZONIA FUND

Decree 6527 was published on 4 August 2008, establishing the Amazonia Fund, managed by the Brazilian Development Bank (BNDES) of Brazil. That norm authorises the BNDES to attract private resources from voluntary donations, be they national or foreign, to invest in actions for the prevention and monitoring of and combat against deforestation. The hope of the Environmental Ministry is that this fund will, in its first year, attract US$1,000 million.

The fund will attend to areas of forest management and protected natural areas, control and environmental oversight, sustainable forest management, development of economic activities from the sustainable use of the forests, land use management and regularisation of agrarian property and conservation and sustainable use of biodiversity.

An activity steering committee will manage the Fund's actions. The committee will consist of representatives of the Ministry of the Environment, the Ministry of Development, Industry and Foreign Trade, the Ministry of Foreign Relations, of Agriculture and Agrarian Development, of the Interior, of the State Governments and from civil society.

Source: Brasil: Ministerio de Casa Civil (Presidencia) (2008).

JEFFERSON RUDY / acervo PPG7-GTZ

The productive forests require responsible management by the logging companies.

5.2 | THE REGIONAL PLAYERS

The key stakeholders participating in Amazonian environmental management are widely varied in characteristics and cover a wide variety of activities. One way to classify these players includes grouping them as follows: (i) public players, responsible for the formulation and management of public environmental policies in national, regional / state-wide and local situations; (ii) private players, responsible for productive activities of divers goods and services and support organisations, such as NGOs; (iii) international cooperation; (iv) international organisms; (v) academic players, created by universities and other centres of higher education; and (vi) elements from civil society, including a variety of social organisations with specific objectives, such as organised indigenous communities.

Government authorities in different levels of government play an important role in articulating national and international policies and are involved in many bilateral and multi-lateral pro-Amazonian actions; however, it is important to point out that there are still great differences between the countries regarding the political priority given to Amazonia.

A very active group of players in Amazonia are the NGOs. In this case, one should distinguish between those of international and national origin. Most of the Amazonian countries have at least one International NGO working on Amazonian matters, whose best known representatives are: The Worldwide Fund for Nature (WWF), Conservation International (CI), The Nature Conservancy (TNC), to name a few. The national NGOs also play differentiated roles in the countries of the region. Some are dedicated to specific environmental issues, such as the conservation of particular species, while others are identified with more general matters like forestry resources and policies, among others. NGOs have also served to channel financial resources for international cooperation into specific areas, complementing, in some cases, national financial resources. It should be mentioned that many NGOs also play an important role in promoting initiatives among countries for managing neighbouring Amazonian areas.

Another player in the Amazonian region is international cooperation. Initially, cooperation only worked directly through governments, but in recent years, it has also worked through NGOs. In Amazonia, German technical cooperation (GTZ), Dutch cooperation and the US Agency for International Development (USAID) have several task areas. International cooperation not only provides financial resources, but also contributes to the discussion of ideas and support for the consolidation of national policy in cases where the countries of the region so desire. For this reason it is important to strengthen the process of integration and cooperation in the Amazonian region, to take better advantage of international cooperation, so that it can adjust to the principles and priorities established within the framework of these processes.

International organisms, such as the United Nations, inter-governmental agencies, such as ACTO, and multilateral organisations, like the World Bank and the Inter-American Development Bank (IDB), also participate actively. In this case, their participation is in cross-sectional issues, like bolstering capabilities for environmental management or development of science and technology for utilising certain natural resources. These organisations have a variety of fund sources that allow them to develop programmes and projects.

The national NGOs play differentiated roles in the countries of the region. Some are dedicated to specific environmental issues, such as the conservation of particular species, while others are identified with more general matters like forestry resources and policies.

Academia and the scientific institutions of Amazonia form another important participant in Amazonian affairs; however, the financial, human resource, infrastructure and equipment restrictions limit the development of scientific research and technology in most of the countries, so they have to resort to private funding, causing their results to be non-public in nature. In order to articulate the universities of Amazonia and the research that they generate, the Association of Amazonian Universities (UNAMAZ) was created two decades ago. The results of that integration are still a work in process, due to the lack of incentives for dissemination as well as the limitation for developing joint research on issues, such as biodiversity, which require broad comprehension. In this sense, the consolidation of research networks in science and technology and other decisive topics for Amazonian sustainable development within the UNAMAZ framework, is a goal yet to be attained.

There is a wide range of social organisations in Amazonia. In Brazil, for example, there are organisations of social networks such as the Amazonian Work Group (GTA), the Coordination of Indigenous Organizations of the Brazilian Amazon (Coordenação das Organizações Indígenas da Amazônia Brasileira; COIAB) and the Forum for Coordination of Local Amazonian Institutions of Acre, among others. These organised community groups allow for a better-coordinated relationship with the government. In general, there are organised institutions from civil society in all of the countries, which allow improved coordination between the civil population and other national participants.

Another group of stakeholders, who participate actively in the environmental management of Amazonia, are community and religious groups. However, their areas of interest are more specific and varied for each country. For example, in Bolivia, religious groups concentrate on water resources; in Colombia and Guyana, their interest lies in environmental education; while in Brazil, these groups cover a wide variety of subjects, from biodiversity and forests to matters of integration.

RICHARD HIRANO / EL COMERCIO

Humanitarian action groups have brought encouragement and support for the marginal Amazonian populations.

This brief review of the principal players in Amazonia indicates that each stakeholder has specific objectives and competencies. In spite of everything that has been done to date in the Amazonian countries for sustainable development and the number of projects implemented in many places around the region, Amazonia continues to be fragmented as a region and lacks an ample space for coordination among these players (Brackelaire 2003). However, the Amazonian stakeholders do have their strengths, such as their influence in formulating public policies, generating information, their interest in the environmental issues of Amazonia, and channels of communication and dissemination. The recognition of these strengths allows for articulation of long-range efforts and will generate synergies that will optimise the use of human and financial resources, as well as the scope of their results.

TABLE 5.4
Principal community groups in the Amazonian Region

INSTITUTION	COUNTRY
- Campesino (Riberalta) - Coinacapa (Pando - Confederation of Indigenous Peoples of Bolivia	BOLIVIA
- Coord. of Indigenous NGOs of Brazilian Amazonia - Community Radio Stations of Legal Amazonia	BRAZIL
- Association of Woodsmen of Curillo (Amacur) - Association of Woodsmen of Orteguaza - Environmental Campesino Association of Losada – Guayabero (Ascal – G) - Campesino Association of Ariari – Guayabero Acarigua - Committee of Cacao growers of Remolino del Caguán and Suncillas (Chocaguán) - Association of Wood Traders of Caguán (Comadelca) - Network of Civil Society Reserves - Organisation of Indigenous Peoples of Colombian Amazonia (Opiac)	COLOMBIA
- Confederation of Amazonian Indigenous Nationalities (Confeniae)	ECUADOR
- Association American Indian Peoples of Guyana	GUYANA
- Inter-ethnic Development Association of the Peruvian Forest (Aidesep) - Confederation of Amazonian Nationalities of Peru (Conap)	PERU
- Association of Indigenous Village Leaders Suriname (VIDS)) - Indigenous Organisation of Suriname (OIS)	SURINAME
- Indigenous organisation of the Caura basin: Multi-ethnic civil association founded by the ye'kawana and sanema (Kuyujani) - Regional Organisation of Amazonian Indigenous Peoples (Orpia)	VENEZUELA

Source: Coordinadora de las Organizaciones Indígenas de la Cuenca Amazónica (COICA) <http://www.coica.org.ec>.

ENRIQUE CASTRO MENDÍVIL / PROMPERÚ

The stakeholders of sustainable development for Amazonia are very active and committed.

INTERNATIONAL COOPERATION NOT ONLY PROVIDES FINANCIAL RESOURCES, BUT ALSO CONTRIBUTES TO THE DISCUSSION OF IDEAS AND SUPPORT FOR THE CONSOLIDATION OF NATIONAL POLICY.

5.3 | PRINCIPAL ENVIRONMENTAL ACTIONS

In addition to establishing public policies for Amazonia, its countries actively intervene in promoting and implementing programmes and projects to encourage the sustainable development of the region. It is not the intention of this section to offer an exhaustive review of the programmes and projects promoted by the Governments of the Amazonian countries, but to present the principal lines of action and some examples, with emphasis on regional, rather than national, activities. In this sense, the projects and programmes promoted by the Amazonian countries, dealing with environmental and natural resource management have fallen mainly into three areas: plans for integration, information systems and environmental technology, and education.

The objective of the plans for border integration is to develop a consolidated zone for interchange and cooperation on economic, social and environmental matters among countries, in an area that they define for these effects as their political borders. The Amazonian countries share habitats and micro-watersheds, through which common problem areas, such as human settlements, health, indigenous populations, to mention a few, are encountered, which allows them to develop synergies based on their joint efforts.

ACTO, as entity for inter-government coordination and facilitation, includes environmental management as one of its key working areas. In this sense, it supports cooperative processes among the governments of its member countries related to the conservation of natural resources for sustainable development of the region.

BOX 5.5
ENVIRONMENTAL SUBJECT AREAS FOR THE AMAZON COOPERATION TREATY ORGANISATION

ACTO, in dealing with environmental matters, is committed to strengthening and consolidating a vision of Amazonia, which is understood and assumed as a physical and natural unit. It includes relationships of dependence or competition that, in essence, are expressed in terms of its wealth of natural resources and in biodiversity, abundance and balance, which is vital to maintain in order to create conditions for sustainable development. Therefore, among the set of initiatives that ACTO has led on environmental matters, the most notable has been the concept of "integrated management" of Amazonian resources and biodiversity.

ACTO works on the basis of four core topics: forests, biodiversity, climate change, and water resources. During the period 2006–2007, ACTO managed, together with other organisations, nineteen projects that mobilised US$33 million. The amount of financial resources increased by 168% compared to the year 2005. Among the principal projects and activities performed in each of the topical areas are the following:

Forests

1. Selection of criteria and indicators for sustainable forest management: a tool for the continuous monitoring of the sustainable development process. In 2001, fifteen indicators were identified, corresponding to eight criteria. The validation of indicators included training activities, search for information, identification of key players, and others.

2. Monitoring vegetation cover: dissemination of the DETER/PRODES Digital system and survey of the potential for its application in the region. The system developed by the National Institute for Space Research (INPE) which is used by Brazil's Ministry of the Environment to monitor coverage in real time.

3. Puembo Initiative: platform for dialog and coordination between national forestry authorities, to interchange experiences on forestry topics in the region, within the framework of implementation of national forestry programmes.

Biodiversity

1. Project for strengthening regional joint management for sustainable use of Amazonian biodiversity. The objective is to coordinate and stimulate knowledge on regional biodiversity in Amazonia, its uses, conservation and utilisation, which requires collaboration among the countries it comprises. One of the results of this project has been the elaboration of proposals, such as:

- The regional Programme for Sustainable Management of Natural, Protected Amazonian Areas
- Mechanism for Coordinating and Monitoring Trafficking in Wildlife Fauna and Flora in the Amazonian Region
- A Science and Technology Strategy for the Conservation and Sustainable Use of Amazonian Biodiversity

Another result is the implementation of Infotca: a system for geo-processing digital cartographic information from ACTO. One of the applications includes interactive management of information on protected natural areas.

Also currently being prepared is the Support Mechanism for Preservation of Traditional Knowledge, Access to the Genetic Resources and Rights to Intellectual Property, as well as the Methodology for Global Analysis of Risks and the Regional Action Plan on Amazonian Biodiversity.

2. Regional Programme for Amazonian Bio-Trade: Its objective is to promote the sustainable use and conservation of biological diversity, based on regional actions that stimulate trade and investments in products and services from the Amazonian region's biodiversity, taking into account a fair and equitable distribution of benefits. Regional Programme for Amazonian Bio-Trade: Its objective is to promote the sustainable use and conservation of biological diversity, based on regional actions that stimulate trade and investments in products and services from the Amazonian region's biodiversity, taking into account a fair and equitable distribution of benefits.

Water Resources

1. Project "Integrated and Sustainable Development of the Transboundary Water Resources in the Amazon River Basin" (GEF-Amazonas): the preparatory phase was carried out during the period 2006-2007. The objective is to strengthen the institutional framework in ACTO countries, to plan and execute actions for protection and sustainable management of hydrological resources in a coordinated manner, in the face of impacts from human activities and climate change. To date the execution phase of this project has yet to begin.

Climate Change

ACTO considers the "Bali Roadmap", adopted in the 13th Conference of the Parties to the UN Framework Convention on Climate Change, in Bali (December 2007), an interesting opportunity for Amazonian countries, especially regarding the mechanism for reducing emissions from deforestation and forest degradation (REDD). This context is suitable for designing and applying policies to rectify the tendencies of environmental degradation, now occurring in Amazonia

ACTO's actions on this topical area are meant to strengthen the capacities of the Amazonian countries to jointly evaluate the effects of climate change, to commit to measures of adaptation or to mitigation that they prioritise and to present a unified position before international forums where these matters are negotiated.

Source: OTCA (2008).


ENRIQUE CASTRO MENDÍVIL / PRODAPP

The population plays an active role which is decisive in conserving and managing Amazonian resources.

Regarding the participation of international cooperation in the region, GTZ is one of the important players carrying out a variety of projects. An important aspect of its participation is that of risk management; it is also committed to promoting and putting into operation the payment for environmental services (PES) approach; as well as giving its support to conservation and sustainable management of the Amazonian forest, through the Regional Amazonia Programme, in conjunction with ACTO.

As an example of the use of these instruments, some experiences have been carried out in the Amazonian region, among them, the River Guatiquía Project, in Villavicencio, Colombia, that seeks to achieve coordinated and sustainable exploitation of natural resources in the hydrological basin of that river, thereby reducing the risk of catastrophes. The effort has resulted in land use planning under a participatory approach, which has made it possible to link the strategies of poverty reduction with those of disaster risk management (Bollin, Schaef and Heindricks 2005).

Another project is called "Design of a Payment Scheme for Environmental Services in the Sub-watershed of the Alto Mayo, in the San Martín Region of Peru". The purpose of this project is to provide an integral solution for deforestation of the highlands of the Rumiyacu, Mishquiyacu and Almendra micro-watersheds, which are the headwaters supplying water to the population of Moyobamba, one of the principal cities of San Martín Department; this process is currently in the negotiation stages. The PES approach in Peru has also had experience in providing water supply services and deforestation avoidance, among others (Veen 2007). In Brazil, agreements are already being made between states like Acre, Pará and Amazonas, to initiate actions for reducing vulnerability, especially from the impacts of climate change, all within the framework of the Thematic Network on Risk Management in Amazonia (GTZ Brazil 2007).

Elsewhere, bilateral agreements have been subscribed to, with reference to the objectives of the ACT, which serve as a basis for carrying out integrated studies between two countries. To date, the bilateral agreements include: Colombia – Ecuador and Colombia – Peru, both signed in March 1979; Brazil – Colombia, of March 1981; Brazil – Peru, of October 1979; and Bolivia – Brazil, of August 1988. Thus, for example, Colombia and Ecuador developed the Plan for Land Use Planning and Management of the San Miguel and Putumayo river basins; and Colombia and Peru organised themselves to carry out the Plan for the Integral Development of the Putumayo River basin. Also being implemented is the Peru – Ecuador Bi-national Plan that covers an extensive border strip between the two countries, including sectors of their Amazonian borderlands (Box 5.7).

BOX 5.6

TRI-NATIONAL PROGRAMME: CONSERVATION AND SUSTAINABLE DEVELOPMENT OF THE LA PAYA-GÜEPPI-CUYABENO CORRIDOR OF PROTECTED AREAS

This project is a tri-national collaborative initiative among Colombia (La Paya), Ecuador (Cuyabeno) y Peru (Güeppi), whose objective is to establish a model for coordinated management of protected areas lying along common borders; a project that is susceptible to being repeated in other parts of Amazonia.

Its specific objectives include:

- Developing a joint planning process that sets up a common vision and complements and provides feedback to the planning processes of each of the protected areas, including specific plans for resource management and public use, as well as land use management for buffer zones.
- Facilitating joint learning and training processes and the exchange of experiences.
- Strengthen the joint operating capacity among the protected areas, including the development of legal and operational instruments that will allow for coordinated and collaborative action between area teams and their strategic allies.

Source: ACTO (2008).

In the eight Amazonian basin countries there is a project for Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin.

By the same token, the role of the chancelleries must be stressed. Within the framework of border development, they are in charge of the mechanisms for collaborative work, such as community commissions and integration, whose objective is to identify, promote and encourage the combined development of programmes, projects and initiatives for generating a community of significant economic, social and environmental interests. As an example, we can cite the Peru-Colombia Neighbourhood and Integration Commission. Its activities are oriented toward attending to the health, education, environmental and basic nutritional needs of the border zone, respecting the sovereignty of each of the parties.

JUAN PONCE / EL COMERCIO

Joint action by the governments in the border zones is reflected in improved living conditions for the population.

There are also several committees and work groups with assignations of specific activities within the framework of cross-border cooperation. An example is the Tripartite Technical Operational Group in Colombia, Brazil and Peru. This group was founded in 1992 in response to the cholera epidemic of the Amazonian Trapezium, and later considered it pertinent to develop actions for prevention and control of other transmissible pathologies prevalent in the area.

Brazil and Peru have several bi-national cooperation agreements. For example: the Work Group on Amazonian Cooperation and Border Development; the Support Committee at the Bi-national Development Core Iñapari – Assís Brazil; the Working Group on Amazonian Security and Development; the Working Group on the Environment; to name a few. There is also a project called Malaria Control in Frontier Zones of the Andean Region: a Community Focus (Control de la Malaria en las zonas fronterizas de la región andina: un enfoque comunitario; Pamafro), which integrates efforts among Ecuador, Colombia, Peru and Venezuela to reduce malaria in its zones of greatest incidence.

Regarding projects of a regional scope, in the eight Amazonian basin countries there is a project for Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin, considering Climate Variability and Climate Change, Project GEF-Amazonas – ACTO/UNEP/OAS. The Programme for Strengthening Joint Regional Management for the Sustainable Utilisation of Amazonian Biodiversity carried out by ACTO and co-financed by the IDB.

BOX 5.7

BI-NATIONAL DEVELOPMENT PLAN FOR THE PERU-ECUADOR BORDER REGION

Within the framework of the Peru-Ecuador Bi-national Plan, by 2006, the total investment was US$439,430,000, of which US$32,970,000 was destined to agricultural and environmental projects; approximately 37% (US$12.2 million) was concentrated in Amazonian projects, such as forest development of the Bagua (Amazonas) tropical rainforests and management of natural resources in the Pastaza and Morona (Loreto) river basins.

Similarly, by 2006, the Amazonian departments of Peru (Amazonas and Loreto) had concentrated 19% and 13% of the total input from the Bi-national Fund, respectively. These funds are distributed to small educational, healthcare and basic rural sanitation projects.

On the Ecuadoran side, the integration zone covers seven provinces: El Oro, Loja, Zamora Chinchipe, Morona Santiago, Pastaza, Francisco Orellana and Sucumbíos, representing about 50% of Ecuador's territory, along 1,500 km of border. The cantons in El Oro and Loja are the most active. The projects have been oriented to developing water, sanitation and roadway infrastructure, although the portfolio of projects has become more diversified.

Source: Plan Binacional de Desarrollo de la Región Fronteriza Perú-Ecuador (2006a and 2006b).

THE ASSOCIATION OF AMAZONIAN UNIVERSITIES (UNAMAZ) PROMOTES THE SEARCH FOR COMMON SOLUTIONS TO REGIONAL PROBLEMS THROUGH SCIENTIFIC COOPERATION, PROMOTION OF KNOWLEDGE AND PROMOTION OF IMPROVED CONDITIONS FOR THE HUMAN CAPITAL OF THE REGION.

Innovative initiatives have also been established to prevent environmental impacts and social conflicts, for which the commitment and effort of divers players has been required. To this effect, the Yasuní-ITT (Ishpingo-Tambococha-Tiputini) Model Initiative in Ecuador should be mentioned. Its objective is to fight climate change, conserve biodiversity and protect the indigenous populations. To do all that, it requires the creation of an international financial trust that allows Ecuador to be compensated for keeping nearly 1,000 million barrels of crude oil underground in Ecuadoran Amazonia, which would alternatively be exploited by the ITT project. Desisting from exploiting this petroleum in the subsoil is equivalent to keeping nearly 432 million tons of carbon dioxide underground. This initiative has the backing and commitment of the President of Ecuador and has been broadcast among many different venues for dialog and international cooperation in an attempt to receive financial backing. It should be explained that Yasuní is the largest protected area of continental Ecuador and the second most important after Galápagos, and that it is recognised as the zone of greatest biodiversity on the planet. It is also the home of several indigenous peoples in voluntary isolation, including: Tagaeri-Taromenani and the Huaorani indigenous population (Ecuador: Ecuador: Ministerio de Relaciones Exteriores, Comercio e Integración 2008). Different experts point out that this initiative is an alternative way of approaching the matter of ecological debt from a global perspective and with instruments for compensation. A proposal has also been made for establishing an "eco-tax", whose objective would be to create a negative incentive for the use of fossil fuels, through a tax that affects the sale of hydrocarbons (including gas and coal), instead of taxing emissions (Martínez Alier and others 2008).

Regarding the research projects covering several countries, including those outside the region, we can mention the HiBam, which involves Brazil, Ecuador, Bolivia and France, whose purpose is to study the hydrology and geo-chemistry of the Amazonian basin.

The existing environmental information systems in the Amazonian region countries are varied. In spite of the fact that the region generates an appreciable amount of information, it is not disseminated nor is it adequately accessible among Amazonian players. Two examples of national information systems for Amazonia are those of Peru (Biological Diversity and Environmental Information System of Peru [SIAMAZONIA]) and Colombia (System on Territorial Environmental Information of the Colombian Amazonia [SIAT-AC]).

It is also important to mention the effort of Brazil to implement an early warning system to monitor forest coverage and to report on the deforestation situation in real time, denominated DETER. This system was developed by the National Institute of Space Research (INPE). INPE registered a deforested area in Legal Amazon between August 2007 and June 2008 that increased 9% compared to the previous period. Furthermore, it publishes these figures on deforested areas on a monthly basis; for example, it indicated that in Legal Amazon in June 2008 this was 870.8 km^2, which represents a reduction of 20% compared to the area in May 2008 (1,096 km^2). It also indicated that the states most affected by deforestation are Mato Grosso and Pará (Brazil: INPE 2008, taken from UNEP Brazil Office).

BOX 5.8

ENVIRONMENTAL INFORMATION SYSTEMS IN AMAZONIA: COLOMBIA AND PERU

Siamazonía (Information System on the Biological and Environmental Diversity of Peruvian Amazonia) is the reference centre for managing information on biological and environmental diversity in Peruvian Amazonia. Its purpose is to improve the level of knowledge and communication, and thereby contribute with good practices and decisions to the conservation and sustainable use of this region. It was created in 2001, under the initiative of the Biological Diversity Project of Peruvian Amazonia (Biodamaz, Peru-Finland Agreement) and executed in Peru by the Peruvian Amazonia Research Institute (IIAP). It was designed with the participation of regional players versed in the subject matter and with the initial commitment of seven partner institutions.

The available information includes scientific data, organised in databases, documentary information, images, maps and multiple tools for contact and communication. It also allows for entities and specialists to collaborate with information. It functions as a decentralised network, organised by entities and specialists who generate and handle relevant information. It integrates with similar initiatives, like the Mechanism for Facilitation of Information on the Biological Diversity Convention (Clearing House Mechanism, CHM), the Global Biodiversity Information Facility (GBIF) and the Inter-American Biodiversity Information Network (IABIN).

In another area, SIAT-AC (System on Territorial Environmental Information of the Colombian Amazonia) is a process in which a group of stakeholders establish accords, with common objectives, for managing environmental information on Colombian Amazonia; these players are organised as a network of individuals and entities, to support the decision-makers with data and information products, in the regional processes that seek to achieve sustainable development. It is equally valid to define SIAT-AC as a regional expression of the Colombian System of Environmental Information (Sistema de Información Ambiental de Colombia; SIAC) in Colombian Amazonia.

This is an inter-institutional process with first-phase participation by the Amazonian Institute for Scientific Research (SINCHI), as its coordinator; the Ministry of the Environment, Housing and Territorial Development; the Alexander von Humboldt Institute Biological Resources Research Institute; The Special Administrative Unit for Natural National Parks; CorpoMacarena; CorpoAmazonía; the Colombian Institute of Hydrology, Meterology and Environmental Studies (Ideam); and the Colombian Biodiversity Information System (SIB). In the following phases other corporations, academia, professional groups and NGOs were integrated into the process.

At the SIAT-AC portal there is information on the state of the environment: biodiversity, ecosystems, forests; socio-demographic characteristics, resource use, environmental dynamics, cartographic information, on-line consultations, metadata. The SIAT-AC web portal has become consolidated as a reference point for environmental information on Colombian Amazonia.

Sources: Peru: SINAMAZONIA; Colombia: Amazonian Institute for Scientific Research (SINCHI), Alexander von Humboldt Biological Resources Research Institute, and the Ministry of Environment, Housing and Territorial Development (MAVDT) (2007).

DEFORESTED AREA IN BRAZILIAN LEGAL AMAZON IN 2008 INCREASED

9%

COMPARED TO THE PREVIOUS PERIOD.


The study of Amazonian biodiversity attracts scientists from research centres around the world.

ANTONIO ESCALANTE / EL COMERCIO

Referring to education in the Andean-Amazonian area, there is the Andean-Amazonian Plan for Communication and Environmental Education (Panacea), whose objective is to integrate actions by the countries in environmental education and to create a space for interchange and more organic actions. Panacea's lines of work are: (i) public policies and national and regional strategies on environmental education; (ii) communication for environmental education and management; and (iii) formation, training and research in environmental communication and education. However, this plan still has not been put into execution due to the lack of financial commitment by the institutions involved.


ERNESTO ARIAS/ EL COMERCIO

Teams of scientists and researchers on Amazonian topics visit the region frequently.

BOX 5.9

COMMUNITY-BASED NATURAL RESOURCE MANAGEMENT – THE WAI WAI EXPERIENCE, GUYANA

The Konashen district, or "Wai Wai country", as it is commonly known, is located in the southern part of Guyana and is home to one of the Guyana's Amerindian tribes, the Wai Wai. This tribe has occupied an area of around 625,000 hectares from time immemorial, and in 2004 the Guyanese government granted them absolute property title over that land.

Upon receiving the Title, the community requested the Government of Guyana to have Konashen District recognised as part of the proposed National Protected Areas System (NPAS), and as a Community Owned Conservation Area (COCA). To this effect, the community has prepared a draft Management Plan with assistance from Conservation International – Guyana. The Plan includes the goals and objectives of COCA, guidelines for natural resource management, governance structure, and a capacity building programme. There is also a monitoring and evaluation programme in the Plan which will be ongoing in order to meet new challenges and opportunities, and to adapt to new circumstances. The Plan will be evaluated after the first two years of implementation.

The main goals of COCA are: to conserve biodiversity, to maintain traditions and ways of life, to develop the community and to provide opportunities for community members and their families. The implementation of the Plan will be governed by a Management Team comprising the Toshao or Village Captain and Councillors, and complemented by the community ranger programme, record keeper, interpreters, and other elements of management. The Team will be supported internally by the Conservation Club, Women's Group, Church elders, Teachers, etc. and externally by the Ministry of Amerindian Affairs, Environmental Protection Agency, Regional Administration, and other partners.

The next steps leading up the declaration of the Konashen district as a COCA are: approval of the management plan and the declaration of the district as a conservation area by relevant institutions.

Source: Linda Yun, Conservation International, 2007.

BOX 5.10

MADRE DE DIOS, ACRE AND PANDO (MAP) CITIZEN'S INITIATIVE: A NEW MANIFESTATION OF SOCIAL COORDINATION

MAP is defined as a "cross-border social movement that understands that only through collaboration and integration of various segments of local, regional, national and world society will it be possible to achieve sustainable development in south-western Amazonia, capable of sustaining itself through the coming decades and beyond 2100".

Since 1999, in the zone of Madre de Dios (Peru), Acre (Brazil) and Pando (Bolivia) (MAP) an initiative has been developing between institutions and persons from academic-university circles, social organisations, NGOs and municipal and governmental entities, whose objective has been to encourage processes of bringing together good will, democratic participation in decision-making and coordination of plans, programmes and integrationist projects oriented toward sustainable development of the triple border area, the heart of south-western Amazonia.

MAP's objectives are:
- To strengthen the tri-national relations that allow for the projection of regional perspectives from local capacities
- To foster regional endogenous integration in economic, social, environmental and political matters
- To generate models of development with solidarity that prevent environmental degradation

The basis of the organisation rests on two great events: thematic meetings, grouped in the Mini MAP, and the holding of annual encounters, denominated MAP Forums. These encounters have been carried out since 2000, in Río Branco (MAP I), Puerto Maldonado (MAP II), Cobija (MAP III) and in the cities of Brasileia and Epitaciolandia (MAP IV).

MAP has achieved a sense of awareness in the participation of the local participants and that of the institutions interested in executing actions for sustainable development of the region. Among its accomplishments are also: the elimination of passports for the circulation of persons among the three countries, the development of a Local Agenda 21 for participating municipalities, and the construction of scenarios for the mitigation of the Inter-Oceanic Highway.

What makes MAP special, as a civic movement, is that the initiative seeks to generate plural and transparent political spaces in which to deal with matters of common importance, instead of being a reactive manifestation, such as a reaction against the highways.

Source: <http://www.map-amazonia.net>; Gudynas (2007).

LINO CHIPANA / EL COMERCIO

Recreational activities also form a part of sustainable utilisation of natural resources.

BOX 5.11

THE YANACHAGA CHEMILLÉN NATIONAL PARK PROVIDES QUALITY WATER: THE CASE OF "CALIFORNIA'S GARDEN" FISH FARM

California's Garden began its operations in 1996, with a feasibility study for the installation of a fish farm in Oxapampa, where there are favourable conditions for growing trout, such as water of excellent quality coming from springs in the Yanachaga Chemillén National Park (PNYCH).

The water that Yanachaga Chemillén National Park provides for the fish farm is highly oxygenated, causing the trout to develop faster and better exploit their feed compared to their major competitor, found in the city of Huancayo, where each 1.2 kg of feed yields one kg of growth in the trout, while at California's Garden that growth is obtained for each kg of feed. The characteristics of the water are due to the "good health" of the ecosystems preserved by the Yanachaga Chemillén National Park.

Furthermore, due to the greater abundance of oxygen in California's Garden waters, they can work with a density of 28 to 34 kg/m^2 of trout in the ponds, while the optimum density of trout in ponds is normally 15 kg/m^2. This allows them to produce double the trout that other fish farms do, without having to invest in new infrastructure.

By using high quality water, due to the conservation of the Yanachaga Chemillén National Park watershed, California's Garden has managed to double its productivity in the face of its competitors, and currently reports annual exports of more than 250,000 kilogrammes of trout to the European market. Therefore, California's Garden recognises that conservation of the Yanachaga Chemillén National Park is a source of competitive advantage.

Source: Prepared by Fernando León Morales, INRENA, 2006, with information provided by California's Garden S.A., 2005.

Generally speaking the Amazonian countries have developed a series of initiatives to "environmentalise" education in high schools and universities, as well as for teachers, but these have mostly been independent actions in each country.

Referring to the universities, there is an Association of Amazonian Universities (UNAMAZ) that includes more than 60 universities and nearly 40 public research institutions. UNAMAZ was created in 1987 in Belén de Pará, Brazil, at the initiative of researchers and scientists from the eight member countries of ACTO. UNAMAZ promotes the search for common solutions to regional problems through scientific cooperation, promotion of knowledge and promotion of improved conditions for the human capital of the region, however its progress is still quite modest.

There are also multiple initiatives by social organisations that carry out actions in environmental management in Amazonia (for example, the Wai Wai experience in Guyana and the MAP). Individuals organise and carry out actions to improve the environmental situation, at times on as individuals and at other times, in a coordinated manner with local or regional governments. Many institutions and NGOs have contributed to this change through training and empowerment activities with the local populations.

RICHARD HIRANO / EL COMERCIO

Ecological tourism, as the expression of an environmentally responsible economic activity, is increasing its presence in Amazonia.

The private sector is, by nature, a stakeholder that produces environmental impacts, so its behaviour is generally criticised. In recent years, certain companies have adopted strategies of social responsibility, including environmental responsibility. Within this framework, there are initiatives being developed in the private sector that favour processes of sustainable management. The case of ecological tourism is an example of the development of an environmentally clean industry.

In summary, the participants and institutions in Amazonia have developed a series of initiatives in an attempt to respond to the environmental problems they face. The region receives important support from the international community, which translates into technical and financial contributions and research; but it has also developed social processes that have contributed to making the different players join together and offer progressively better articulated responses to benefit a more efficient environmental management. Doubtless, the local institutions have had a fundamental role in responding to the problems. The organisations of civil society have fostered important efforts to solve their problems, basically in healthcare (related to water pollution), but have developed business enterprises as well, which contribute to using the region's natural wealth in a sustainable manner. However there is still much work to be done on cohesion, articulated research, as well as technical and financial resources to be obtained, so that these efforts by the stakeholders of Amazonian development can be reflected in concrete achievements to benefit the region's environment.

SUNSET ON THE AMAZON RIVER:
A BUCOLIC LANDSCAPE, FOR THE
RECONCILIATION OF MAN WITH NATURE.

ANTONIO ESCALANTE / EL COMERCIO

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THE FUTURE OF AMAZONIA

6

6.1 INTRODUCTION
6.2 FUNDAMENTAL ASSUMPTIONS
6.3 A GLANCE AT THE FUTURE AMAZONIA
6.4 EMERGING THEMES
6.5 CONCLUSIONS

ENRIQUE CASTRO MENDÍVIL / PRODAPP

Only the effort and commitment of all of its inhabitants will allow them to build a promising future for Amazonia

6.1 | INTRODUCTION

Considering the biophysical, economic, socio-cultural and political heterogeneities to be found in Amazonia, the different sections of the environmental assessment contained in this report required an extensive process of revision and negotiation. However, one irrefutable observation which received immediate consensus from the principal stakeholders of the eight Amazonian countries, who met to discuss the future perspectives for the regional environment, was: "Our Amazonia is changing at an accelerated pace and the modifications in the ecosystem run deep".

Where are we headed? What are the factors behind these changes? This chapter presents the results of the analysis of the elements that have become a powerful driving force of today's changes in the region, as well as a panorama of future paths that we see as "possible", considering the decisions that the countries and their citizens are making for Amazonia today.

Our Amazonia is changing at an accelerated pace and the modifications in the ecosystem run deep. Where are we headed? What are the factors behind these changes?

4 HYPOTHETICAL IMAGES --CALLED "SCENARIOS"-- HAVE BEEN COMBINED WITH PRIORITY AND/OR CROSS-CUTTING THEMES, IDENTIFIED IN PREVIOUS CHAPTERS.

Four hypothetical images --called "scenarios"-- have been combined with priority and/or cross-cutting themes, identified in previous chapters. Each of the scenarios presents a different path, with a temporal horizon of twenty years, 2006-2026, and a cut-off at the ten-year mark, in 2016 .

In each scenario, we study who makes the key decisions (key stakeholders), how these decisions are made (predominant management approaches) and why these decisions are made (principal priorities). The nature and names of the scenarios are determined by the predominant theme in the particular associated image. All scenarios presented have equal possibilities over the same time frame, but they are not exact projections of the future. However, the hope is that they will serve as a useful guide for reviewing and evaluating the decisions and actions under the responsibility of the different stakeholders and the most important implications they will have over time.

The combination of critical uncertainties determines a scenario. After the evaluation of the possible scenarios, four of the more plausible and relevant for the Amazonian region were selected. It is worth noting that the sustainability scenario, which achieves economic growth for the region, based on sustainable exploitation of its resources and improvement of the population's quality of life, in other words, one in which sustainable development is working, is not being analyzed, because this is the ideal and desirable situation for the region.

1 This period was agreed upon in a participatory manner by the project Technical Committee during the GEO Amazonia Workshop held in Villa de Leyva, Colombia, in May 2006.

BOX 6.1
BUILDING SCENARIOS USING THE GEO METHODOLOGY

In an integrated environmental assessment, GEO, the analysis of scenarios requires three stages: the definition of the objective for scenario preparation, the design of the process contemplated for its preparation, and the construction of the scenarios. The analysis of scenarios is a useful process for achieving awareness among the players and decision-makers, on topics that drive environmental change (for example, the socio-economic dynamic); for stimulating creative planning processes; and for generating new knowledge on the interrelations between the different sectors of society. The objective is to directly and indirectly influence decision-making, in order to promote sustainable development.

During the design stage for the scenario construction process, aspects such as the scope and depth of the analysis, the amount of qualitative and quantitative data to be examined and the weight to be given to expert opinions and to the literature are determined. Generally, scenarios are explained in a qualitative and quantitative manner in order to provide a coherent and multidimensional vision of how events should be handled in the future.

THE OBJECTIVE IS TO DIRECTLY AND INDIRECTLY INFLUENCE DECISION-MAKING, IN ORDER TO PROMOTE SUSTAINABLE DEVELOPMENT.

In general, GEO scenarios give more weight to construction of narratives, based on opinions of experts and qualitative information. In other GEO processes, such as GEO 4 a single, generic model, such as Polestar, developed by the Stockholm Environment Institute, was used to generate quantitative data.

Scenarios are built on assumptions, but a scenario is never a prediction of the future. A scenario is, however, a hypothesis of a simplified, yet possible, future image.

Source: United Nations Environment Programme (UNEP)(2007a; 2007b).

Education for youth: a guarantee for a sustainable future in Amazonia.

JUAN PONCE / EL COMERCIO

6.2 | FUNDAMENTAL ASSUMPTIONS

The preparation of scenarios is based on the identification and analysis of driving forces (Box 6.1). "Driving forces" are understood to be the set of factors and processes underlying the economic, social, environmental, political-institutional and cultural fields, as well as others that affect the environment, now and in the future.

The identification and revision of driving forces in Amazonia was a process rich in discussion and contribution by the members of the Technical Committee and other representatives of key players. These consultations and revisions were carried out in the workshops in Villa de Leyva, Colombia (May 2006) and received feedback in the scenario meeting in Havana, Cuba (August 2006). There follows a list of the driving forces:

Demographic aspects
- Migrations
- Population growth

Social aspects
- Poverty and income inequality
- Basic service coverages
- Internal conflicts (subversive violence or violence promoted by groups acting outside the law)
- General level of education
- General level of employment
- Environmental education

Economic aspects
- Productive activities without sustainable management
- Investment in infrastructure projects (communications and industry)
- Mega-projects and their relation to land-use planning
- Development of monoculture
- Development of illegal crops
- Development of the market for environmental services

Political and institutional aspects
- Regulatory development
- Development of management tools
- Inter-institutional coordination

Science, technology and innovation
- Technology transfer
- Articulation and recognition of traditional knowledge

Culture
- Conservation of multi-ethnicity and culture

Environmental aspects
- Changes in soil utilization
- Water pollution

Upon evaluating this set of driving forces in terms of their implications on the future environmental situation of Amazonia, and of the importance and degree of uncertainty, three driving forces were identified as "critical uncertainties":

The role of public policies aimed at utilisation of natural resources in the region, including the following elements: citizen participation, information, environmental governance and environmental management. Public policy may be oriented toward promoting sustainable development or may be far from it.

Market behaviour: referring to market trends, which may lean toward a market that values environmental services of Amazonia and demands products that are made, based on criteria of sustainability, or, to the contrary, markets that do not insist upon environmental care in the production of goods and services in the region.

Science, technology and innovation for sustainable development of the region that includes scientific and technological responses allowing the development of productive activities and the construction of infrastructure in a sustainable manner, or, which can be absent and far from sustainable exploitation of environmental goods and services.

It should be specified that, given the fact that it is not possible to predict the behaviour of these critical uncertainties, suppositions are used to characterise them. On the other hand, it is assumed that each of these critical uncertainties has a different degree of influence; for example, science and technology do not have the same influence as the market in determining future trajectories. Changes in market behaviour generate incentives that affect the decisions of different social players, while in the case of science and technology, the transmission of changes and incentives in some opportunities is not as fast as the adjustments caused by changes in the market. Amazonia, in particular, is very sensitive to changes in market behaviour.

By identifying and analyzing different combinations of critical uncertainties, four scenarios were selected as being considered highly possible and relevant to the Amazonian region. Each of them have the following fundamental suppositions, in which "+" means improvement, while "-" means reduction or deterioration:

"EMERGENT AMAZONIA" SCENARIO"

(Role of public policies +, Market behaviour +, STI -): public policies promote sustainable development of the Amazonian region based on effective environmental governance, which promotes citizen participation. Market forces provide incentives for developing sustainable productive activities, in such a way that the stability of the ecosystems is guaranteed and ecosystemic goods and services are valued. Science, technology and innovation have limited development; there is neither public investment to generate new knowledge about the natural wealth that the region offers, nor the technological development needed to optimise the sustainable utilisation of its resources.

"INCHING ALONG THE PRECIPICE" SCENARIO

(Role of public policies +, Market behaviour -, STI -): public policies promote sustainable development of the Amazonian region based on effective environmental governance, which promotes citizen participation. However, market forces provide incentive for developing non-sustainable productive activities that affect ecosystem stability and place no value on environmental goods and services. "Science, technology and innovation" have limited development; there is neither public investment to generate new knowledge about the natural wealth that the region offers, nor the technological development needed to optimise the sustainable utilisation of its resources.

"LIGHT AND SHADOW" SCENARIO

(Role of public policies +, Market behaviour -, STI +): public policies promote sustainable development of the Amazonian region based on effective environmental governance, which promotes citizen participation. However, market forces provide incentive for developing non-sustainable productive activities that affect the ecosystem stability and place no value on environmental goods and services. On the other hand there is investment in science, technology and innovation which promotes the generation of new knowledge about the natural wealth that the region offers, and the technological development needed to optimise the sustainable utilisation of its resources.

"THE ONCE-GREEN HELL" SCENARIO

(Role of public policies +, Market behaviour -, STI -): public policies fail to promote sustainable development; the environmental component is missing from the public decision making process. Environmental governance is ineffective and fails to promote citizen participation. Furthermore, market forces provide incentives for developing unsustainable productive activities, affecting ecosystem stability and place no value on environmental goods and services. Science, technology and innovation have limited development; there is neither public investment to generate new knowledge about the natural wealth that the region offers, nor the technological development needed to optimise sustainable utilisation of its resources.

Here is the future of Amazonia.

SERGIO AMARAL / OTCA

6.3 | A GLANCE AT FUTURE AMAZONIA

As indicated in Chapter 2, socio-economic processes have promoted an accelerated change in land use and in the process of cultural integration of the Amazonian indigenous populations. It is also clear that public policy and institutionism in the respective Amazonian countries are the basic components for constructing the future of Amazonia.

The work, "Amazonia without myths" reveals the erroneous beliefs and strategies imposed on the region by industrialized or developed countries, and it alludes to the commitment by the Amazonian countries to assume their responsibility and ensure the development and environmental welfare of the region (Commission on Development and Environment for Amazonia 1992). In sixteen years the dominant forces in Amazonia have changed, and national decisions have directly conditioned the selection of options for development in the region. What forces will predominate during coming decades? How will the current driving forces behave in each of the scenarios? Considering the heterogeneity that exists among Amazonian countries, the answers to these questions are considerably disparate in different parts of the region.

Furthermore, it is worth mentioning that there are driving forces that have begun to emerge and that have acquired importance in recent years, such as global climate change. The Fourth Assessment Report: Climate Change from the Intergovernmental Panel on Climate Change (IPCC) (2007) and divers studies (Case 2002) bear witness to the increased vulnerability of Amazonia in the face of this global phenomenon, and constitute a key driving force in regional environmental performance. The IPCC scenarios present a range of temperature changes that fluctuates between 1.1 and 6.4°C. Different studies indicate that an increase above 2°C generates significant and irreversible changes in the ecosystems (IPCC 2007) (see Chapter 2).

Even with the national differences and a high degree of uncertainty due to limited scientific knowledge in respect of complex interactions between the systems, Amazonian experts have made evaluations on the behavioural tendencies of the driving forces (Table 6.1).

TABLE 6.1
Behaviour of the Driving Forces

CATEGORY	DRIVING FORCES / SCENARIOS	EMERGENT AMAZONÍA SCENARIO	INCHING ALONG THE PRECIPICE SCENARIO	LIGHT AND SHADOWS SCENARIO	ONCE-GREEN HELL SCENARIO
DEMOGRAPHIC ASPECTS	Migrations	↑	↑	↑	↑
	Population growth	↑	↑	↑	↑↑
SOCIAL ASPECTS	Poverty and income inequality	↓	↓	●	↑↑
	Basic service coverage	↑	↑	↑	↓↓
	Armed Conflict	↓	↑	●	↑↑
	General level of education	↑	↑	↑	↓
	General level of employment	↑	↑	↑	●
	Environmental education	↑	↑	↑	↓↓
ECONOMICS ASPECTS	Productive activities without sustainable management	↓	↑	↓	↑↑
	Investment in infrastructure projects (communications and industry)	↑	↑	●	↓
	Mega-projects and their relation to territorial planning	↑	↑	●	↓
	Development of monoculture	↓	↑	↑	↑↑
	Development of illegal crops	↓	↑↑	↑	↑↑
	Development of the environmental services market	●	↓	↑	↓↓
POLITICAL INSTITUTIONAL ASPECTS	Regulatory development	↑↑	↑	↑	↓
	Development of management tools	↑↑	↑	↑	↓↓
	Inter-institutional coordination	↑↑	↑	↑	↓↓
SCIENCE, TECHNOLOGY AND INNOVTION	Technology transfer	↓	↓	↑	↓↓
	Articulation and recognition of traditional knowledge	↓	↓↓	↑	↓↓
CULTURE	Conservation of multi-ethnicity and culture	↑	↓	↑	↓↓
ENVIRONMENTAL ASPECTS	Introduction of invasive species	↓	↑	●	↑↑
	Changes in soil utilization	↓	↑	●	↑↑
	Water pollution	↓	↑	↓	↑↑

LEGEND	SIGNIFICANT INCREASE	INCREASE	REDUCTION	SIGNIFICANT REDUCTION	NO EFFECT
	↑↑	↑	↓	↓↓	●

HERE FOLLOW SNAPSHOTS OF FOUR SCENARIOS AMAZONIA COULD FACE IN 2026. THIS PROVIDES A GLANCE OF THE FUTURE BASED ON KNOWLEDGE OF THE DYNAMICS OF THE DIFFERENT ELEMENT OF TODAY'S SOCIETY.

ENRIQUE CÚNEO / EL COMERCIO

"Emergent Amazonia": poverty in retreat.

"EMERGENT AMAZONIA" SCENARIO

Human settlements in Amazonia underwent demographic expansion during the past two decades. However, thanks to public policies aimed at improving social services, this increase has been accompanied by significant investment to improve basic service coverage and job creation. Amazonian countries have strengthened regulations and legislation in the region. Furthermore, the State has managed to reduce inequality of income distribution through integration and coordination of public policies and, as a result, poverty levels have fallen.

Nevertheless, the level of achievement differs between countries. Central and local governments have been very active in preparing and applying management instruments suited to the Amazonian context, supported as well by inter-institutional coordination, aimed at working according to the priority of the region's environmental issues.

The increasing growth of economic activities in the region, within a framework of regional integration, has favoured the development of infrastructure mega-projects (for example, roads and energy transmission) that facilitate both exchange of products and mobilisation of assets for production (such as labour, inputs and energy sources, among others) among countries. Improved planning and heightened control of negative impacts from these projects contributed to the reduction of the disparity in income and quality of life between the Amazonian population and the rest of the national population in each country. The most remarkable evidence of this positive trend is the reduction of conflict among the different social groups and those related to internal security in some countries.

Public policies recognize the Amazonian region's diversity and promote an integrated management of Amazonian wealth, to wit they favour the development of man and his culture expressed in different ways of life and forms of production, in harmony with nature. Therefore, the recognition of and respect for traditional culture and knowledge stimulate the preservation of traditional uses and customs, as well as an appreciation of Amazonia's multi-ethnic and multi-cultural identity.

In the year 2026, the Amazonian region has a greater awareness of the importance of environmental sustainability, and contributes positively to key environmental indicators

Perhaps one of the limitations for the governments has been their scant contribution to scientific, technological and innovative development. Although this situation differs among the Amazonian countries, it implies not only a limited investment in basic and applied research, but also restrictions to technological transfer. This limits the expansion of existing productive activities and the start-up of promising or emerging productive activities in competitive terms. The countries have not been able to direct public academic or institutional capabilities to make the most of the region's natural resources. Therefore, the expansion of some sustainable productive activities is still costly and ineffective. Local populations have not been able to take part in the distribution of profits derived from the use of biodiversity, except for some private sector ad hoc initiatives. In addition, the scant scientific, technologic and innovative development in the region leads to brain drain to different regions of the country or to other countries altogether, where this subject has more resources and a higher priority in the public agenda.

Environmental Situation

In the year 2026, the Amazonian region has a greater awareness of the importance of environmental sustainability. The region has a positive contribution to key environmental indicators, such as the rate of land-use change and water pollution, thanks to environmental governance, which improved along with strengthening policies and institutionalism, and regional coordination in general.

Deforestation, erosion and loss of genetic diversity also show signs of reduction; hence, it should be recognized the State's success in the application of regulatory instruments and the fight against corruption to combat selective forest extraction, illegal trafficking in species, and introduction of invasive species. Furthermore, public policies have allowed an effective operation of the protected areas to become sustainable, thanks to productive development opportunities offered by the international market, which values environmental goods and services.

The existence of adequate land management instruments (such as, ecologic economic zoning and cadastre), allow modern economic activities and new cities to develop in appropriate zones, avoiding ecosystem degradation and deterioration. Now, land-use planning guides infrastructure projects thanks to regulatory development, the development of management tools, and inter-institutional coordination. A clearer legal framework, more consistent with property rights, creates incentives to invest in sustainable productive activities. Meanwhile, non-sustainable productive activities, particularly monoculture farming and illegal crops, have seen an important decline.

As time goes by and the driving forces behind changes in vegetation cover diminish, this contributes in reducing the variation in water availability, as well as water pollution due to effective operation of the mechanisms that regulate productive activities (mining, hydrocarbons, and agriculture). The "polluter pays" concept is widely accepted.

On the other hand, market demands for sustainable production practices encourage producers to internalize environmental costs through the implementation of environmental management in the different phases of the productive process, reducing the externalities they used to generate. Thus, the quantity of solid, liquid and gaseous waste decreases, just as contamination levels do in the receiving bodies such as soil and water.

The most notable lack is the scant development of science and technology. This restriction limits availability and access to eco-efficient alternative technologies. Furthermore, biodiversity utilisation is insufficient to better care for the needs of the population, such as in food and health, among others.

Technological research and solutions to face climate change have not achieved a significant advance either. Concern and interest on the subject have not generated actions or results that demonstrate its priority for the Amazonian countries.

SERGIO AMARAL / OTCA

Amazonía emergente: mejoran los indicadores ambientales clave.

IN 2015, TEN YEARS AFTER ESTABLISHING THEM, THE GOALS FOR ACCESS TO WATER HAVE BEEN MET.

"INCHING ALONG THE PRECIPICE" SCENARIO

Amazonian population growth increases, particularly due to the migrations stimulated by an economic boom in productive activities, which have grown for more than a decade. Per capita GDP of the Amazonian regions of each country has risen during this century thanks to different public incentives, which have promoted further investments to exploit mineral, forest, hydrobiological and biodiversity resources, among others. Amazonia is known for its ability to adapt large-scale production schemes –"the world's last grain reserve"-, such as ranching, and soybean and transgenic product farming, making it very attractive for multi-national investors and contributing to alleviate the food crisis caused by drought due to climate change in traditional cereal and grain producing areas. It is a response to international market demands for more products at a lesser price.

The development of economic activities in the region, within a framework of regional integration, has significantly favoured the development of infrastructure mega-projects. Most of the IIRSA works are completed, and there is an IIRSA II plan now to expand its road and energy network to improve regional integration, which in turn will favour the interchange of products and mobilisation of assets for production such as labour. This plan will contribute significantly to the operation of the Union of South American Nations (Unión de Naciones Suramericanas; UNASUR).

Public policies are aimed at improving social services. The State improves income distribution indicators and contributes to the reduction in poverty levels on the basis of economic growth and stable public policies. The decisions made by social stakeholders have, at times, been criticized for their short-sightedness in obtaining benefits over the short-term, and the lack of consideration of the long-term environmental consequences of such decisions. However, the opportunities offered by the market facilitate a platform to rescue the Amazonian population from poverty.

As for the regulatory framework, there has been some improvement in normative development, even if there are still limitations in the implementation of inter-institutional management and coordination tools. But the most important thing is that public policies exist and work to promote the arrival of more investments for the region, and not hinder its progress. There is scant compliance with regulations and the system of sanctions has limited effectiveness and efficiency. Nevertheless, the countries do promote self-regulatory actions by companies and individuals.

The greatest and most common concern in some Amazonian countries is internal armed conflict near their border zones. The region has not been capable of eliminating these conflicts despite its economic advances.

Science, technology and innovation have shown limited development due to the restriction of financial and human resources in the public sector. However, the contribution of the private sector is expected for spreading of advances in productive efficiency, as well as in the use and care of eco-systemic services.

The development of economic activities in the region, within a framework of regional integration, has significantly favoured the development of mega-projects infrastructure.

Science, technology and innovation have shown limited development due to the restriction of financial and human resources in the public sector.

Unsustainable productive systems have grown significantly, favouring an increase in productivity without consideration for the environmental consequences of their agricultural practices.

Environmental Situation

In the year 2026, the Amazonian region is beginning to pay the cost of decades of public policies devoid of the environmental dimension, based solely on the provision of economic services and infrastructure. The forces of an unregulated market limit the effectiveness of the few environmental policies being executed. Furthermore, the establishment of an integrated information system to evaluate environmental performance is one of the areas that have received limited public attention and contributions. Environmental authorities, without adequate institutional strengthening, find their capabilities overwhelmed and they only process requests of environmental impact assessments that correspond to new projects and economic initiatives, without the capacity to monitor and sanction non-compliance.

Erosion and biodiversity loss, including ecosystem fragmentation and deforestation, are still critical environmental problems. Soil degradation and vegetation cover loss are more acute due to the expansion of monoculture farming (for example, conventional soybeans and transgenic crops), and the increasing production of illicit crops, even though the later is more localized in certain countries and has less relative importance as a causal factor of the environmental problems in Amazonia. Thus, unsustainable productive systems have grown significantly, favouring an increase in productivity without consideration for the environmental consequences of their agricultural practices. The use of transgenic seeds is generally accepted as necessary for regional development and used without restriction. The expansion of ranching and agricultural activities is perfectly correlated to increasing imports and use of agrochemicals in all Amazonian countries. Furthermore, hydrocarbon spills and the disposal of toxic wastes in the watercourses are more frequent. Additionally, control mechanisms are ineffective in the face of informal markets and corruption. This will affect soil support service, as well as water quality, recording an increase in the region's Disability-Adjusted Life Years (DALY) rates for environmental factors (World Health Organization and Pan-American Health Organization 2007).

Productive systems will be surrounded by social conflict due to land occupation, since the property rights system is not fully organized in the region. Therefore, selective extraction and trafficking in species, illegal logging, de facto land occupation, all worsen the region's social and environmental problems. Moreover, limited attention to conservation and appreciation of Amazonian culture worsens the social exclusion process.

Economic growth at the expense of environmental degradation affects eco-systemic services and reduces the possibilities of sustaining traditional ways of life; thus, it favours rural to urban migrations. Environmental problems worsen due to the dominance of market forces and a lack of disposition to pay for ecosystem services. These environmental problems have global, regional, national and local impacts. While some transnational companies take advantage of the region's open investment policies, international pressures regarding Amazonian countries' difficulties in maintaining the globally important region's ecosystemic integrity also increase, particularly from international NGO's and some European countries. For example, deforestation magnifies the effects of climate change, since the carbon retained by the Amazonian forest is not absorbed at expected levels. Furthermore, deforestation has a severe effect on convection systems, which recycle 50% of Amazonia's rainfall, making the dry season markedly longer (Killeen 2007). The impact from this phenomenon inside and outside Amazonia increasingly attracts the attention of researchers.

In 2015, ten years after establishing the goals for access to water, these have been met. However, subterranean water is found to be contaminated due to limited control over hydrocarbon extraction and artisanal mining activities, as well as growing and untreated effluents, which affect the bodies of surface water in and around cities. Hydroelectric dams are not considered viable options, because of rapid sedimentation in the watercourses, due to deforestation and earth movements by several of the mega-projects. The disruption of aquatic ecosystems affects the reproduction of hydrobiological resources, resulting in the decline of this important source of protein for the local population.

"INCHING ALONG THE PRECIPICE": THERE HAS BEEN MITIGATION IN THE POVERTY INDICATORS, BUT THE SEARCH CONTINUES FOR SHORT-TERM BENEFITS.

MIGUEL BELLIDO / EL COMERCIO

ANTONIO ESCALANTE / EL COMERCIO

"Light and shadow": there are more consistent public social policies, but poverty indicators show no significant improvement.

This limits the capacity to respond to climate change and makes the region more vulnerable to the impacts of this global phenomenon. Scientific, technological and innovative development is limited, creating voids and asymmetry in the availability and access to new alternative technologies that promote sustainable production processes, and responses to mitigate and adapt to climate change. Finally, in 2026, economic and human activities have greater operating costs due to the reduction in availability and quality of environmental services.

The guidance of the sustainable development process for Amazonia was never incorporated in a cross-sectional manner into national or regional development planning, and it is acknowledged as a twentieth century utopian concept.

"LIGHT AND SHADOW" SCENARIO

Demographic growth in the Amazonian countries has showed a moderate and stable trend for almost three decades, as a response to growth in different economic activities, stimulated by market incentives in the globalization process and regionally integrated public policies regarding migration and land-use planning. The global growth in green business and brands, including certification and green labelling, translated into a growth in innovative entrepreneurial initiatives in the region that take advantage of these investment opportunities to promote social-environmental sustainability.

Nevertheless, traditional productive activities, such as mining and large-scale ranching and agriculture, have maintained their relative importance with the main objective of achieving short-term benefits by taking advantage of the dynamism of the national and international markets. The operation of the productive activities responds to market incentives, which favours the purchase of products at lower prices.

Public policies are aimed at improving social services, increasing coverage of basic services and improving levels of environmental training and education. However, national and regional infrastructure investments, such as communications and energy projects, have had mixed results in their scope, and countries are less interested and more wary of executing mega-scaled integration projects. As a result, poverty and inequality indicators have not shown any significant improvement in recent years.

As for the regulatory framework, although there are still limitations in the implementation of the instruments for managerial and institutional coordination, there has been certain improvement in regulatory development. Regulatory compliance is limited, particularly in social and environmental issues, and the penalty system has a limited scope.

Nonetheless, Amazonian countries have paid a great deal of attention to developing science, technology and innovation (STI) to promote a sustainable development process, after a long period of stagnation that lasted into the early 21st century. To that end they have assigned important public resources and promoted programs and projects of a regional scope in order to stimulate integration and scientific and technological exchange in the greater Amazonian region. International cooperation funds can be applied for on the basis of a joint effort among countries, allowing for co-financing of large-scale STI projects. ACTO is a facilitator of diverse initiatives, together with UN agencies, international cooperation and multilateral organizations.

Efforts are also articulated to strengthen alliances between the public and private sectors, so as to have an adequate dialogue among science, business undertakings and local needs. Moreover, regional and local governments coordinate closely so that joint strategies are designed and implemented to promote sustainable and innovative development on the basis of productive chains and strengthened social capital. In addition, this scientific and technological development process is carried out in a harmonious and synergic manner with traditional knowledge. To that end, there is a transparent and efficient system for local communities to participate in the benefits derived from the use of traditional knowledge and biodiversity. Science, technology and innovation have contributed to closing gaps and they have become a bridge between sectors and disciplines that have traditionally worked in isolation from each other.

Environmental Situation

In the year 2026, the Amazonian region is still starting down the road to sustainable development. The region's main traditional environmental problems, such as erosion, biodiversity loss (especially due to introduced species) and deforestation still subsist, but they are under control and will start to decline in coming years. This has happened because of the role played by public policies, which are dedicated to improving the social conditions of the population (basic services, health and education coverage), and promoting the development of science, technology and information systems, such as the detection of illegal logging in real time. This system is at work in all Amazonian countries, using the technology first developed by Brazil and later adopted and improved by other countries.

The scientific and technological development in the region now offers greater knowledge and alternatives for the introduction of more efficient productive processes, leading to a reduction in production costs and adverse environmental impacts. Recently, the development of new products has been directed to the international markets, but more and more products are developed to satisfy the demand from emerging and socio-environmentally responsible markets within these regions. STI development contributes to the creation of a greater and enhanced knowledge of the natural wealth of the greater Amazonian region, while it generates technological alternatives that promote its sustainable use. Furthermore, this scientific and technological development process is carried out in a harmonious and synergic manner with traditional knowledge. This is achieved by means of a transparent and efficient system for local communities to participate in the benefits derived from the use of traditional knowledge and biodiversity. Finally, scientific and technological development allows a response to the impact of climate change, reducing the region's vulnerability to this global environmental problem.

ERNESTO RAEZ

"Light and shadow": local communities are benefiting from the use of traditional knowledge and achievements in science and technology.

A majority of public policies are well defined and stable, and committed to improving management and implementation of projects and other initiatives, as well as, processes that evaluate and monitor their environmental performance. These management improvements favour pollution control, with a positive impact in the administration of water resources.

Initiatives for the valorisation of ecosystem services and internalization of environmental costs in production have not been very successful. However, public policies are aimed at promoting each dimension of the sustainability of productive activities, hence, they promote STI. This provides a clear signal to private investment about the convenience and advantages of investing in environmental protection in order to become more competitive in participating markets, as well as to diversify to other markets.

The main Amazonian stakeholders contribute to strengthening the public-private alliance that encourages profitable economic activities capable of promoting both improvement in the population's living conditions and ecosystem balance.

"THE ONCE-GREEN HELL" SCENARIO

According to the latest national household censuses, the Amazonian part of each country is the area that has registered the largest demographic growth. Public policies are fragmented and inconsistent, and institutional weakness is still the common characteristic in different public institutions that are relevant for the administration of Amazonia. They are also foreign to the development of adequate frameworks for mitigation of environmental degradation, as well as, to the promotion of city planning.

Existing regulations are from the end of last century, and they have a limited scope to regulate or control new environmental issues and "development" activities already underway in the region. The establishment and application of management instruments is very limited, due to lack of institutional capabilities, rampant corruption and insecurity in mega cities and human settlements, some of which transboundary. The myth of "empty Amazonia" is still deeply ingrained in the thinking of officials and citizens in general in the Amazonian countries.

In 2026, little was achieved in the most recent meeting of the Chancellors of the ACTO member countries, in terms of reaching a consensus to solve the issue of environmental insecurity and economic disparity among and within the Amazonian regions of the member States. The region's socioeconomic situation is at a critical point. Poverty is more acute among the Amazonian population and the gap in inequality is at its greatest historical point. A large proportion of the population is excluded from basic public services such as electricity, water, sewerage systems, health and education.

Poverty is more acute among the Amazonian population and the gap in inequality is at its greatest historical point. A large proportion of the population is excluded from basic public services such as electricity, water, sewerage systems, health and education.

More and more frequently, the media tell of the rising number of socio-environmental conflicts and their intensity. There are even frequent violent armed conflicts for access to resources. Opinion makers state that these problems are a result of public policies implemented since the late 20th century, which favoured rapid economic growth without taking into consideration the social and environmental dimensions.

Opinion makers state that these problems are a result of public policies implemented since the late 20th century, which favoured rapid economic growth.

There are road networks and communications and electricity generating infrastructure that have been built at a brisk pace in order to better connect the different markets within the framework of Amazonian regionalization and integration. These undertakings produced certain short and medium-term benefits, in terms of local employment created, but for the most part did not take into consideration their influence on local socio-economic processes, or their environmental consequences within each project's area of influence, including, development of precarious human settlements that lack services and, thus, create even more pressure on ecosystem goods and services. As a result, some projects have been stopped due to frequent confrontations with the communities and international pressure regarding the viability of the works to generate the expected socioeconomic benefits. There has not been a single new road or power project, because international banks and other agencies consider these initiatives in the region to be "high risk".

With regard to social fragmentation, on the one hand, part of the population appropriates the resources needed to subsist precariously, and on the other, business undertakings that appropriate resources, even violently, expelling the possessors. The lack of an effective presence of the State leaves the population exposed to processes of dispossession and marginality. Similarly, the appropriation of traditional knowledge without payment and biopiracy increase and affect the cultural legacy of the native populations.

The Once-Green Hell: irreversible deterioration of natural wealth.

GERMÁN FALCÓN / EL COMERCIO

SEBASTIÁN CASTAÑEDA / EL COMERCIO

Although there are opportunities in the world market where the Amazonian environmental services are appreciated, limited institutional capabilities in the public sector and a limited scientific, technological and innovative development in the Amazonian countries have not facilitated a timely and strategic incorporation of key regional issues in the international agenda. Ecosystems are now degraded and fragmented. The jobs created are mostly precarious, and there are even slave-like forms of exploitation in the local populations. Other still lucrative activities include monoculture agriculture and the use of transgenics due to the increasing world food demand.


ENRIQUE CÚNEO / EL COMERCIO

The Once-Green Hell: accelerated biodiversity loss.

A STUDY BY THE UNIVERSITY OF SCIENCE AND TECHNOLOGY (ETH ZURICH) POINTS OUT THAT AMAZONIA WILL SUFFER 13 YEARS OF EXTREME DROUGHT BETWEEN THE YEARS 2071 AND 2100.

These conditions have driven ethnic communities away from their original territories, and numerous indigenous groups have disappeared in the past ten years. Academic and research institutions have attempted to, at least, organize documentation on traditional languages and knowledge of these endangered or recently disappeared communities, but in this case as well, lack of public support and regional coordination hinders their advance.

Environmental Situation

The environmental situation in Amazonia reveals an accelerated degradation process leading to an irreversible loss of natural and cultural wealth and of ecosystemic services. National actions and international attention to the threats to the integrity of the Amazonian ecosystem have been insufficient and the existing ones have been ineffective in stopping the forces of deregulated markets. An enormous and important carbon sink is being wasted and it is, rather, contributing to accentuate climate change impacts, leading to a rise in the vulnerability of local populations to extreme weather events, such as drought and floods due to the loss of vegetation cover.

In this respect, the prediction from a study by the Amazon Institute for Environmental Research (IPAM) in Brazil in 2007, published twenty years earlier was confirmed. It estimated that between 30% and 60% of Amazonia would become grasslands as a consequence of a rise in temperature between 2 and 3°C and a reduction in rainfall. This has caused drought over wide areas, particularly southern Amazonia, where extreme drought situations a gradually appearing. The prognostics from a study of the University of Science and Technology (ETH Zurich), by scientists Michele Bättig, Martin Wild and Dieter Imboden, points out that Amazonia will suffer thirteen years of extreme drought between the years 2071 and 2100.


ENRIQUE CASTRO MENDÍVIL / PRODAPP

"Once-Green Hell": the conversion of Amazonia into savannahs is a reality.

Countries such as Brazil have made important advances in STI to tackle priority environmental issues in the region, including, monitoring deforestation and climate change. Regrettably, there was no consensus at the regional level for the harmonious use of technological instruments. Because of the restrictions in relation to availability and access to information, as well as uncertainty regarding recognition of intellectual property and appropriate use of information, the number of applied investigations in Amazonia has dropped drastically in recent years. The few reports available correspond to studies paid for by private companies in order to explore possible mineral and hydrocarbon reserves.

The evaluation made by the Amazon Institute for People and the Environment (IMAZON) Institute in 2007 on the advance in achieving the Millennium Development Goals (MDG) in Brazilian Amazonia, concluded that even if most of the indicators evaluated recorded improvements in relation to 1990, it confirmed that the deforestation indicator has worsened (Celentano and Veríssimo 2007). If public policies do not promote sustainable management of natural resources, combined with a limited investment in science, technology and innovation, the acceleration of deforestation will become a sad reality. None of the Amazonian countries could satisfy Goal 7 of the MDG when 2015, the deadline for compliance of most of the goals, came around. A quarter century later (2040), an estimated one million square kilometres of Amazonian forest will be lost and 33,000 million tons of carbon dioxide will be released in that region, the equivalent of almost five years of global emissions (Moutinho 2007).

The rise in deforestation severely affects the regional hydrological cycle, reducing rainfall and increasing the duration of the dry season. There is ample evidence of modifications in ecosystem services, many of which are irreversible in Amazonia. A consequence of these changes with a continental scope is the reduction in the availability of water in the adjacent basins south of Amazonia, where ranching and agricultural activities are an important part of national income. The Amazonian forest is fragmented (spots of different sizes and composition), accompanied as well by fragmentation in biodiversity. Community forests and some protected areas are the places that have best preserved the original compositions of the Amazonian ecosystem, which was still intact in the early 21st century.

In 2026, the prediction from a study by IPAM in Brazil in 2007, published twenty years earlier was confirmed. It estimated that between 30% and 60% of Amazonia would become grasslands as a consequence of a rise in temperature between 2 and 3°C and a reduction in rainfall.

INCREASES IN DEFORESTATION SEVERELY AFFECT THE REGION'S HYDROLOGICAL CYCLE, REDUCING RAINFALL AND INCREASING THE LENGTH OF THE DRY SEASON.

The main causes of environmental degradation include: building of trans-border highways, without planning and mitigation of socio-environmental impacts; the development of extractive activities; monoculture agriculture, and large-scale cattle ranching.

These activities put pressure on bodies of water as well; to wit, sedimentation increases and water quality loss is accelerated, affecting its physical and chemical characteristics. Pollution of water sources is severe, which has an effect on the health of human settlements, where the inhabitants depend on wells as their main source of water during the dry season.

To ease access to markets and insure maximum benefits in the short term, governments facilitate access to land at the headwaters of the Amazonian basin, where mega-structures such as dams have been built to secure access to water for ranching and agricultural development, improve water management and use it for electricity generation. This affects connectivity and superficial watercourses, altering aquatic biodiversity habitats and productive activities like artisanal fishing.

Therefore, the quality of life of the world's population and in Amazonia in particular, is diminished, due to the reduction in the quality and quantity of the resources for the development of economic activities, limiting income and food sources. The health of the population deteriorates, expressed in a rise in diseases like malaria, tuberculosis and Chagas' disease.

6.4 | EMERGING THEMES

Emergent themes are those having importance in the future, due to the consequences they generate over the medium and long run. These issues include the environmental changes caused by human activity in the short-term, but whose effects extend over time and frequently establish a vicious circle between environmental degradation and its adverse socio-economic impact.

The advantages of identifying emergent themes are the following: to generate awareness among the citizenry of the interrelationships between the local and global environment; to act ahead of time to guarantee adaptation and to avoid crises; to better orient research and to compile data systematically; to promote the comprehension of the relationship between human activities and the environment; and finally, to integrate scientific knowledge with public administration.

A few of the emergent issues, critical to Amazonia, that are identified in this report are as follows:

Competitiveness through technological innovation: within a framework of dynamic, varied and demanding markets, it is necessary to have a strategic vision on the exploitation of Amazonia, which recognizes and values the heterogeneity of its natural, human and cultural resources. The concept of competitiveness, as suggested by Porter (2007), demands consideration and an efficient management of the environmental dimension. Therefore, public policy requires an integral approach to provide adequate incentives to the different stakeholders. In this context, it is appropriate to increase the knowledge base on the ecosystem services the region provides, the diverse markets in which participation is possible and the instruments that provide incentives for its use and conservation.

Technological innovation also enables the development of new products with higher value added, capable of satisfying the demands of the different markets, and contributes to improving the efficiency of the productive processes, based on the conservation of ecosystem services.


MIGUEL BELLIDO / EL COMERCIO

Introduction of species and expansion of transgenic crops: these are growing pressures on Amazonia, which lead to altering Amazonian ecosystems that are fragile by nature. Market expansion demands more products for foodstuffs and industrial development, with lower prices, and it offers incentives for expanding cultivation, plantations, and growing species that are not native to the region.

The process of species introduction has begun in Amazonia; however its impact on the functioning of Amazonian ecosystem services is, as yet, unknown. Therefore, it is important to regulate the process in order to minimize the environmental impact. It is also important to acknowledge that the decisions we make on the subject, will have consequences over the regional ecosystems, which recognize no political boundaries.

Biofuels: the growing demand for biofuels, sought by the global energy crisis, is an important pressure that encourages a change of forest land usage to land for agricultural production. In developed countries, land for such purposes is very limited. For that reason the developing countries, and this includes Amazonia, are seen as suitable areas for the production of crops from which to elaborate biofuels. For this reason the potential competition for land to cultivate food and crops from which to generate biofuels is an emergent theme that the Amazonian countries must continue to monitor, with the objective of evaluating the consequences in their economic, social and environmental contexts.

> The accelerated changes in Amazonia require conducting constant monitoring and analysis of the future situations that could befall the region, in order to improve the capacity for intervention.

Infrastructure for sustainable development: infrastructure expansion is a reality in the region. It makes possible undertaking of new economic activities and facilitates market access. However, it is important to have a strategic perspective regarding this aspect of development, within a framework of integrated land-use planning in the different projects and activities. This implies that the different government entities promote sustainable investments in infrastructure, to wit, that both the benefits and social environmental costs be recognized and considered.

National policy and regional Amazonian cooperation and integration: Amazonia is undergoing accelerated economic, political and institutional changes, promoted primarily by each country's national and individual interests. In this context, there is little security regarding the scope of inter-governmental organizations to consolidate an intelligent and balanced development of Amazonia for long-range benefit and from an integrated regional perspective.

Regional Amazonian prospectus: the accelerated changes in Amazonia require conducting constant monitoring and analysis of the future situations that could befall the region, in order to improve the capacity for intervention and to adjust the processes that pressure the environment and natural resources of the region. Several Brazilian institutions have accumulated experience on the matter and are using models that allow for analyzing environmental outlook in Legal Amazonia. However, it is also important to activate this type of effort in other Amazonian countries, and eventually to stimulate their interaction, both to channel existing capacities for use in their respective Amazonian region and to exchange information, adding and articulating efforts to resolve current environmental problems and emergent regional issues.

6.5 | CONCLUSIONS

This chapter has presented four possible future scenarios for Amazonia through 2026. The scenarios are defined fundamentally by three regionally important forces that are considered as most powerful and, at the same time, most difficult to predict in terms of regional influence.

In reality, the future of Amazonia, a little less than 20 years from now, will surely include elements of each of the hypotheses indicated in this chapter, in addition to many others. It is also possible that some of the countries will have a future similar to some of the hypotheses and that others might await a totally different future.

Generally speaking, preparing hypotheses for scenarios like these is done by using a long-range time horizon that varies between 50 and 100 years. It is important to stress the importance of the timeframe elected by the regional stakeholders for Amazonia: only two decades. What does the selection of that horizon signify for Amazonia? It reflects the fact that Amazonia is changing at a rate that makes it irrelevant to think in a time horizon greater than that suggested.

None of the hypotheses presents a utopian situation. To wit, it has not been possible for the Amazonian stakeholders to imagine a future in which public policies, the market, and science and technology, all develop simultaneously in such a positive manner that would allow for promotion of the sustainable development of Amazonia. Sadly, the chosen development styles for the Amazonian countries and their citizens are undermining both the options for future sustainable development and the hope for belief in an alternative future for Amazonia. There can be no doubt that it has become impossible to conserve the integrity of the entire Amazonian ecosystem (or "standing Amazon", as it was called in "Amazonia without myths"). However, different decisions made today are critical in determining how much the trade-off between environmental degradation and socio-economic development will be acceptable for the Amazonian citizens.

The visions of the future in this chapter should influence today's decisions and the vital urgency for action. Finally, it is important to point out that the discussion on possible options and the adoption of decisions on the future of Amazonia are in the hands of the decision-makers and of the citizens themselves of the Amazonian countries.

None of the hypotheses presents a utopian situation. There can be no doubt that it has become impossible to conserve the integrity of the entire Amazonian ecosystem. How much of the trade-off between environmental degradation and socio-economic development will it be acceptable for the Amazonian citizens?

SERGIO AMARAL / OTCA

IN 2026, THEY WILL BE THE DECISIVE STAKEHOLDERS IN BUILDING AMAZONIA.

ENRIQUE CÚNEO / EL COMERCIO

GEO AMAZONIA

needed to create images for the four scenarios described by the experts, so a group of school children who are members of the Ecological Child Reporters' Brigade from the San Eulogio School in Comas-Lima-Peru were invited to take part in a drawing exercise. The children gathered were between 11 and 13 years of age, most of them children of migrants who had left Amazonia in search of better job opportunities in the capital city. They were shown the scenario matrix proposed by GEO Amazonia, and in a daylong exercise, they digested each scenario line of the report thinking about images that would support it: **"There will come a time when there are more cattle than native animals", "if there are more cows, that means that there will be fewer trees","in the first scenario lets put monkeys, jaguars and toucans", "concrete will dominate the last scenario", "there won't be any dialogue…"**

IN 2026, THESE CHILDREN WILL BE AROUND 30 YEARS OF AGE. They will live in a democracy, will have the right to vote, and certainly will have exercised this right in some electoral process. Probably, when electing their president, they will have kept in mind, among other things, electoral agenda on ecology and sustainable development. Some of them are sure to walk down the opposite path their parents followed and, contracted by private enterprise, will return to Amazonia to work. Perhaps one of them, after completing his or her studies in mechanical engineering, will be in charge of designing new machinery will minimise the harmful effects on the environment, when it is sued alongside of old machineries.

AFTER A WEEK, GEO AMAZONIA received a set of resounding drawings that were both clear and precise in picturing Amazonia in 2026, a future that will be lived by the children of today when they will be grown-ups.


AMAZONIA 2026
The sun is shining brightly, but since there are trees, it doesn't dry out the earth.
Human settlements have grown but there are still more trees than houses.
There are protected areas.
Deforestation is controlled.
People promote dialogue and talk about their problems.
Indigenous peoples have a space to live as they please.
Native animals RUN FREE in the forest.
"EMERGENT AMAZONIA" SCENARIO
Cities grow and vegetation has less and less room.
Fewer indigenous people
MORE cement
Smoke
Underground waters are polluted. There is plenty of water, but it isn't drinkable.
Instead of pumas, parrots and toucans there are COWS.
There are more SOYA FIELDS that impoverish the soil.
"INCHING ALONG THE PRECIPICE" SCENARIO
MORE cars, MORE factories, MORE cement and MORE PEOPLE.
Parrots have nowhere to go.
WE HAVE LOST OUR BIODIVERSITY.
People from the forest join to promote profitable economic activities, like tourism.
"LIGHT AND SHADOW" SCENARIO
SMOKE AND GASES.
Natural and cultural wealth has been lost.
Too many HIGHWAYS.
The companies contaminate too much.
Rivers are full of dead animals.
We can ONLY SEE forest animals in the ZOO.
WE DON'T HAVE ANY MORE TREES.
"THE ONCE-GREEN HELL" SCENARIO

7

7.1 CONCLUSION

7.2 LINES OF ACTION

THE POSSIBLE AMAZONIA

Amazonia is a vast region in South America's humid tropics, which is blessed with abundant wealth and natural and cultural contrasts interacting in a space that has been occupied since the distant past. ON THE ONE HAND, AMAZONIA IS HOME TO A TREMENDOUS VARIETY OF FLORA AND FAUNA SPECIES, WHICH HAVE SET WORLD RECORDS FOR BIOLOGICAL DIVERSITY. IT IS ALSO AN IMPORTANT AREA OF ENDEMISM, WHICH MAKES IT A GENETIC RESERVE OF GLOBAL SIGNIFICANCE FOR THE DEVELOPMENT OF HUMANITY. Likewise, it houses mineral and energy (petroleum and gas) resources. On the other hand, Amazonia is also synonymous with cultural diversity, which has resulted in a historical process of land occupation and interaction among groups of varied ethnic and geographic origins. The interaction between mankind and the Amazonian ecosystems presents a series of contrasts. ON THE ONE HAND THERE ARE SUSTAINABLE MODELS OF PRODUCTION AND CONSUMPTION FAVOURING THE UTILISATION AND CONSERVATION OF BIODIVERSITY AND, ON THE OTHER, MODELS OF PRODUCTION THAT GENERATE PROCESSES OF ENVIRONMENTAL DEGRADATION AND DETERIORATION OF NATURAL RESOURCES. For example, one can find sustainable activities such as aquaculture, animal farming and timber and non-timber forestry, while at the same time there are extensive monoculture, ranching and shifting agriculture, to name a few. AMAZONIA SHOWS A COMPLEX DYNAMIC OF INTERRELATIONS AMONG THE NATURAL AND HUMAN SYSTEMS, WHICH SERVE AS FEEDBACK TO EACH OTHER, AFFECTING THE ECOLOGICAL BALANCE. IN THIS SENSE, IT IS DIFFICULT TO RECOGNISE ONE-WAY CAUSE-AND-EFFECT RELATIONSHIPS, WHICH COMPLICATES THE DIAGNOSTIC AND/OR THE SOLUTIONS FOR THE DIFFERENT SITUATIONS. The decisions made today regarding Amazonia will have a long-term impact and will condition the environmental situation and human well-being in the region into the future. ●

7.1 | CONCLUSION

Amazonia demonstrates a growing process of environmental degradation expressed in the advance of deforestation, the loss of biodiversity and localised impacts from climate change. Regarding deforestation of the natural forest, as of 2005, the accumulated deforested area covered 857,666 km^2, with a yearly increase of 20,550 km^2/year for the period 1990 – 1999, rising to 27,218 km^2/year in the period 2000 – 2005.

The current situation of the Amazonian ecosystem can be explained by the set of driving forces that direct its land occupation and the use of its resources, such as socio-demographic, economic and political–institutional aspects; and pressures, like that of climate change and natural events..**The way these factors have affected the Amazonian ecosystem are associated with the incentives provided by public policies or the processes of globalisation that translate into the variations in demand for products originating in the region.** Furthermore, the limited knowledge about how the Amazonian ecosystem functions, as well as regarding its value - the almost non-existent value attributed to environmental services generated by the forest - feed the impulse for predatory practices.

Settlement processes promoted by public policy, as well as migration, explained by a lack of job opportunities in the periphery of Amazonia, promote the development of productive activities, some of which are hardly sustainable. Added to all this is the consequences of the globalisation process that encourages the expansion of monoculture farming covering huge extensions. Examples of this are cattle ranching, soya and coca production, which in some countries are the principal vectors of deforestation, biodiversity loss as well as a cause of water pollution. In addition, there is an obvious multiplication of mega-projects related to petroleum exploitation, the construction of highways and hydroelectric dams. Similarly, migration also drives the development of human settlements and services and communications infrastructure, which requires preparing areas for these purposes and generates change in land use. This change limits the provision of ecosystemic services, such as soil support, provision of goods, recreation and culture and the regulation of the water cycle. This process of land occupation of Amazonia reveals the limited application of land-use management as a tool to administrate sustainable development.

Climate change and external events also generate pressure on the Amazonian ecosystem, increasing its vulnerability. All of the elements mentioned are closely related and generate forces pulling in different directions adversely affecting Amazonia.

Degradation of the Amazonian ecosystem has a variety of impacts on human well-being: it affects the ability to develop future productive activities; it increases the risk of diseases, and generates social conflicts for access to natural resources and due to contamination, to name but a few.

The problems in Amazonian have provoked several types of responses from governments, NGOs, private enterprise, social organisations, those of indigenous communities and the population in general. Governments have promoted programms and projects aimed at improving sustainable forest utilisation, the development of sustainable agro-productive systems, strategies for biodiversity conservation, and economic tools for sustainable resource use, among others. Large infrastructure projects (e.g. highways, electricity) , whose environmental and social impact is yet to be duly quantified, have also been developed. At the same time, initiatives for regional integration to solve environmental problems jointly have been created. All of these policies and measures unfortunately are still limited in their ability to reverse the processes of natural resource loss and the environmental degradation, and to improve the quality of life of its local populations.
Some corporations have implemented processes of forest certification and ecological production and/or have diversified the supply of Amazonian goods and services (e.g. ecotourism and bio-trade). In general, NGOs have contributed to providing better understanding on the functions of Amazonian ecosystem, the distinct social groups living there, and the interrelationship between the two. **Social organisations have also created a space for dialog to deal with Amazonian environmental problems. By the same token, indigenous communities have organised themselves, making them more visible in the discussion forums and allowing for better communication of their vision for Amazonian development.** Finally, the Amazonian populations, through their participation in several regional development initiatives, have attained greater presence in the debate on the problems of Amazonia.

The region is going through a process of accelerated transformation that not only depends on internal forces, but also on changes in the international economy, as well as the heterogeneity and complexity of the natural and human interrelationships in Amazonia. Considering the dynamic associated with these factors, we are faced with overwhelming uncertainty with the future of Amazonian development. The qualitative analysis of the scenarios illustrates that the development style of the countries of Amazonia is limiting the options for sustainable development in the region. Four possible situations that may well occur in the next twenty years have been suggested. The direction taken by the forces of public policy, the market, and the scientific and technological development, will condition sustainable development in the region.

7.2 | LINES OF ACTION

THE ENVIRONMENTAL SITUATION OF AMAZONIA IMPOSES HUGE challenges for the region, which suggests the importance of joint action. The lines of action proposed are the result of both integrated environmental assessment and the process of consultation among the representatives of the eight Amazonian countries, and constitute an effort to promote sustainable development in the region.

Given the magnitude and pace of environmental degradation, immediate action is required, independent of the fact that some of the actions have a long-range horizon of implementation. These responses also require the participation of all social stakeholders in both design and organisational phases as well as those of implementation and monitoring. To account for the progress and continuous improvement of the Amazonian ecosystem, it will be important to consider a system of economic, social and environmental indicators, and their permanent feedback, as part of a process of strategic environmental assessment that should orient policy decisions.

There follow the suggested lines of action:

→ Create an integrated Amazonian environmental perspective and define the role of the region in national development.

This will allow for better comprehension of the interlinkages among the economic, social and political-institutional processes, in order to promote sustainable development and the improvement of the quality of life for the regional population.

The construction of this perspective will be achieved through a process of dialogue among the different Amazonian stakeholders articulated with different levels of government. This process will enrich the efforts of Amazonian countries to establish an integrated environmental perspective. To achieve this, an initial step would be to constitute the Forum of Environmental Ministers of the Amazonian Region, which will facilitate the drafting and implementation of an environmental agenda for joint action and will constitute the first step toward the creation of multi-sectorial discussion forums involving the stakeholders relevant to the development of the countries that share the region.

→ Harmonise environmental policies on matters of regional relevancy.

Considering the particularities of the Amazonian ecosystem, whose functional patterns transcend political boundaries, it is important for public policy among the countries to maintain a certain harmony. For this it will be necessary to create mechanisms that will enable a facilitation of this process, in order to share national experiences, lessons learned, technology developed; and to construct and implement a joint working agenda or a regional strategy for the management of natural resources (forests, biodiversity, water, among others); capitalising the good practices developed and generating synergies in priority environmental management issues.

→ Design and implement instruments for integrated environmental management.

Recognising that the countries have progressed in the development and implementation of tools for Amazonian environmental management, it becomes necessary to join efforts to work with instruments for land-use management and criteria for carrying out environmental impact and strategic environmental assessments. In this regard, the exchange of experiences on progress realised in the respective countries is a starting point for regional discussion on these topics. It is also worth pointing out that the harmonious implementation of these instruments becomes a strategic element for planning Amazonian development with a regional perspective.

→ Design and implement regional strategies that allow for sustainable exploitation of the Amazonian ecosystem.

Considering that the Amazonian countries share a variety of ecosystems, it is important to have joint, or closely coordinated, strategies for the integral management of ecosystem goods and services. To do this it is necessary to concentrate efforts along three lines of action: forest conservation and climate change; integrated water resource management, and sustainable management of biodiversity and environmental services, taking prior progress into consideration. It is also important to share the strategies defined among the stakeholders, in order to obtain their commitment to participate in the achievement of the proposed goals.

To facilitate the implementation of these strategies, it will be necessary to draft a joint strategy for financing. This will allow for the improvement of national technical abilities, for the execution of investment within compatible timeframes in each of the Amazonian countries, and the expansion of the links to international cooperation.

Incorporate risk management into the public agenda.

The heterogeneity and complexity of Amazonia, in a context of growing vulnerability to climate events, demands the design of policies and measures that promote adaptation to climate change. This makes it essential to incorporate risk management, as a part of strategic environmental evaluation, into the definition of Amazonian development strategies. This will allow for avoiding or reducing the costs associated with the occurrence of disasters.

A fundamental element that accompanies risk management is environmental monitoring, based on previously defined indicators. Monitoring also allows for the identification of sources of future risk, which facilitate the functioning of early warning systems.

Strengthen Amazonian environmental institutional structure.

It is important to adequately exploit the existing venues and opportunities for discussion and action on the region's priority environmental topics. To this effect, it is fundamental to bolster the Amazon Cooperation Treaty Organisation (ACTO) and other regional forums that promote dialogue among national, regional, departmental and/or local authorities, as well as with experts on priority Amazonian environmental issues. It is also necessary to promote the participation of different stakeholders from civil society in the decision making process. Furthermore, mechanisms and measures must be designed to make the actions agreed upon viable.

- **Evaluate the appropriateness and viability of reactivating and perfecting the Amazon Cooperation Treaty Organisation Special Commission on Environment.**

- **Design and implement mechanisms, tools, and measures to facilitate and make viable the coordination, execution, monitoring and evaluation of the adopted regional accords.**

Strengthen the efforts for generation and diffusion of environmental information in the region.

Considering the importance of scientific production and the generation of statistics in the countries of the region for adequate environmental management of Amazonian issues, it is important to systematise and articulate the several on-going efforts, in order to design an integrated information system, and, specifically, one for environmental statistics. It is also imperative to expand the links of scientific and technological cooperation among the countries, in order to draft and carry out an agenda of scientific research for the region, with emphasis on applied research.

A strategy for information dissemination and communication should also be prepared for priority environmental issues, considering the different target audiences (policy makers, business sector, academia, NGOs and the general public).

There follow the principal actions suggested for these purposes:

- **Generate an Amazonian environmental information system, taking the currently existing platforms into account (geo-referencing systems, statistics, and others).**

- **Generate scientific and technological research that responds to the region's priority environmental problems, and promote the exchange of experiences and experts.**

- **Develop applied research in social sciences to contribute to an improved design of regional policy.**

- **Strengthen the existing information systems and promote their articulation with the public and private sectors.**

- **Design and implement a dissemination strategy that will allow for adequate communication of Amazonian environmental issues to the different target audiences.**

Promote studies and actions of economic assessment of Amazonian environmental services.

The assessment of environmental services is a matter that will allow for regional unification of efforts, for the purpose of recognising the value of the diverse ecosystem services that Amazonia produces. Based on this, it will be possible to design policies and instruments for retribution that provide incentives for sustainable exploitation of the ecosystem services.

To do so, it is possible to utilise existing regional university networks that can identify issues of common interest, as well as modes of collaboration for the development of studies on economic assessment of issues like water and biodiversity.

Design a system for monitoring and evaluating the impact of policies, programmes and projects.

For the purpose of following up on the implementation of the Amazonian environmental agenda, it becomes necessary to have a monitoring system in place that has clearly defined performance indicators for the different issues contemplated therein. It is also necessary to periodically evaluate goal fulfilment, based on the pre-established indicators. Thus, it is vital that an Amazonian environmental observatory be established, to act as a strategic tool for the formulation of policies and management instruments.

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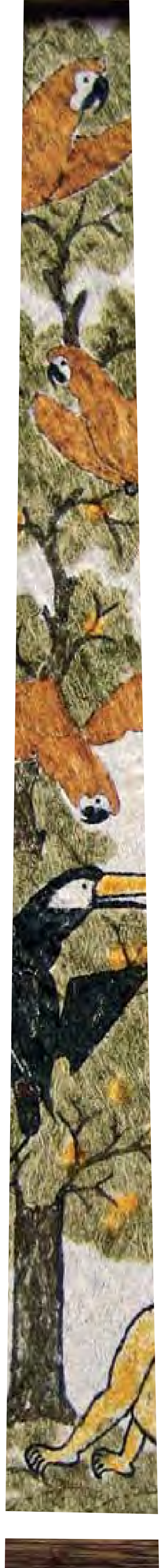

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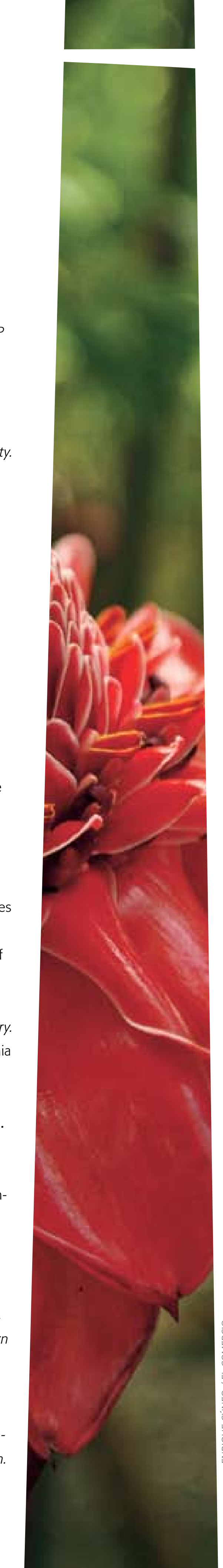

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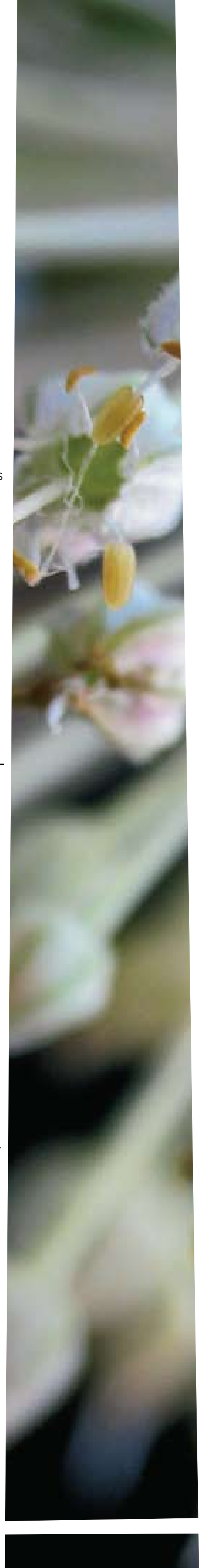

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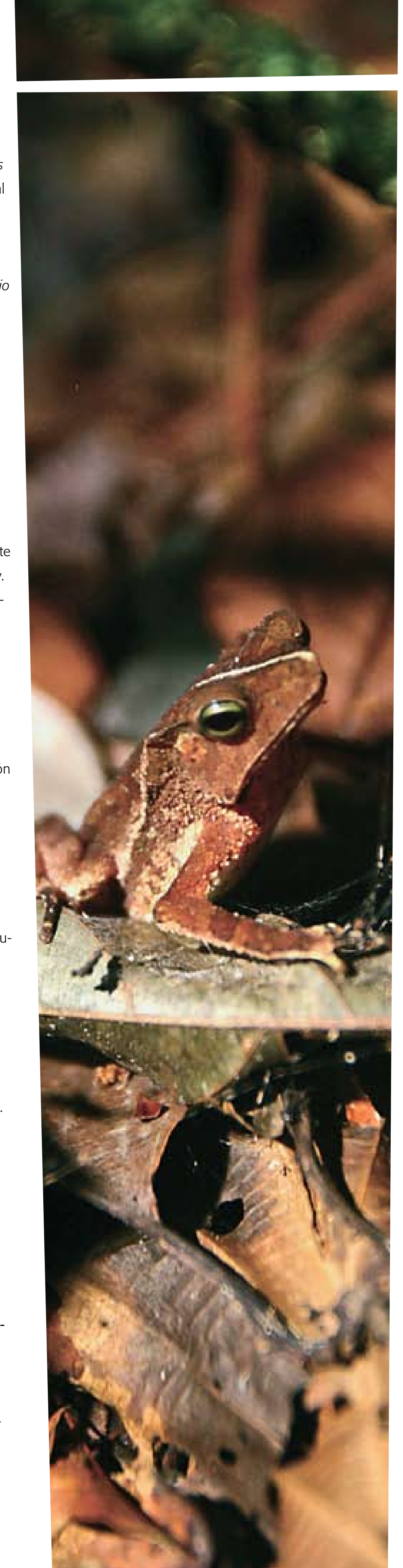

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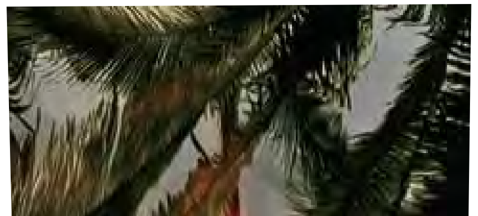

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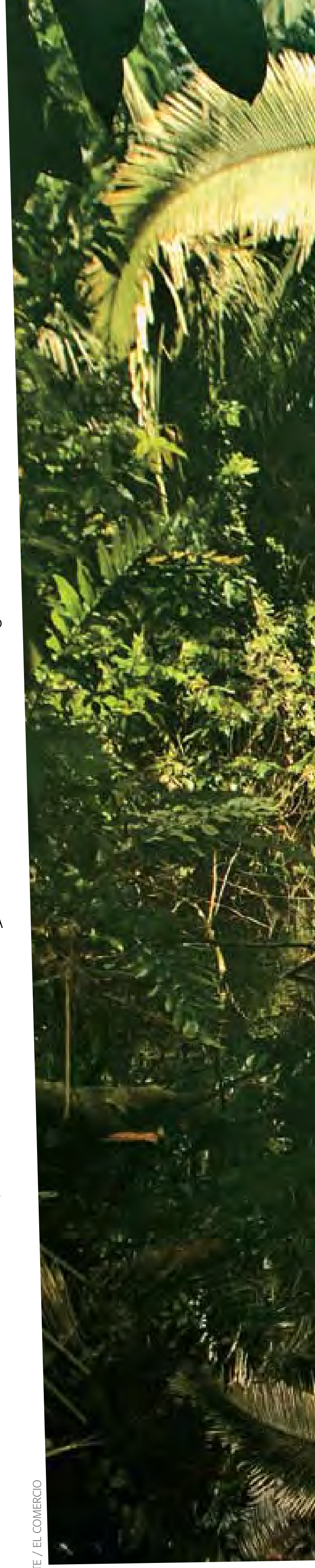

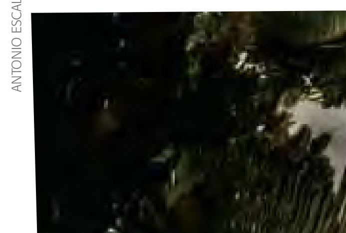

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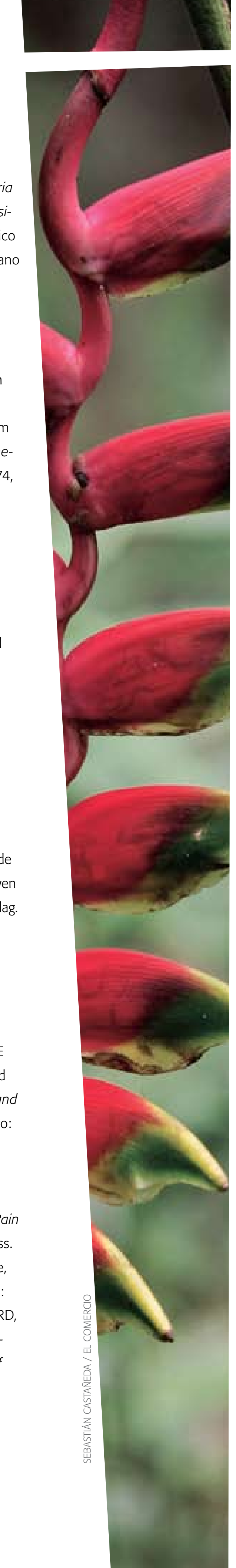

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INDEX OF TABLES

TABLE	CONTENT	PAGE
TABLE 1.1	Area of Amazonia, according to criteria	41
TABLE 1.2	GDP per capita and growth rate of the Amazonian regions	57
TABLE 1.3	Principal productive activities in the Amazonian regions	58
TABLE 2.1	Approximate population of Greater Amazonia and Lesser Amazonia (2005)	67
TABLE 2.2	Population in Amazonia	68
TABLE 2.3	Indigenous populations	72
TABLE 2.4	Brazilian Amazonia: health and the environment	77
TABLE 2.5	Oil mining activity in Amazonia (2006)	87
TABLE 2.6	Principal hydroelectric complexes in the Amazon basin	90
TABLE 3.1	Types of floodplain forests in Amazonia	110
TABLE 3.2	Number of species by group reported in the Amazonian countries	111
TABLE 3.3	Strictly Protected Areas in the Amazonian Basin	115
TABLE 3.4	Number of extinct, threatened and other species in each category of the "Red List", by country (2006)	124
TABLE 3.5	Number of threatened species, by group of organisms, by country	124
TABLE 3.6	Deforestation of the Amazonian Forest during the decades of 1980, 1990 and 2000-2005	137
TABLE 3.7	Principal causes of deforestation and forest degradation	138
TABLE 3.8	Number of fire hot spots in Amazonia	142
TABLE 3.9	Coverage of aqueduct and sanitation services for the Amazonian region	150
TABLE 3.10	Estimate of solid waste and lixivia produced in the Amazon basin	153
TABLE 3.11	Volume of wastewater (brines) originating from petroleum extraction activities in Amazonia	155
TABLE 3.12	Amazonia: Crops and livestock production	166
TABLE 3.13	Amazonian cities with populations greater than 100,000 inhabitants	182
TABLE 3.14	Final disposal of waste in Amazonian regions of Brazil (2000) (in percentages)	188
TABLE 4.1	Arbovirus in Brazilian Amazonia and probable factors for their appearance	204
TABLE 4.2	Total annual mitigation of carbon and the income associated through sustainable agriculture, reduction of deforestation and reforestation (2003-2012)	207
TABLE 4.3	Andean countries: Investment in water and sanitation for the Amazonian region (2002-2015) (in millions of US$)	208
TABLE 4.4	Principal economic impacts by status of water resources and aquatic ecosystems	210
TABLE 4.5	Evaluation of damages in Acre	214
TABLE 5.1	Environmental institutions of the Amazonian countries	226
TABLE 5.2	International conventions and principal national policies	229
TABLE 5.3	Principal national norms by subject	232
TABLE 5.4	Principal community groups in the Amazonian Region	239
TABLE 6.1	Behaviour of the Driving Forces	259

INDEX OF FIGURES

FIGURE	CONTENT	PAGE
FIGURE 2.1	Average annual Amazonian population growth rate per country	68
FIGURE 2.2	Average annual Amazonian population growth rate per country	70
FIGURE 2.3	Amazonia: Urban population (%)	71
FIGURE 2.4	Coca cultivation in Andean-Amazonian countries (hectares)	84
FIGURE 2.5	Published articles per Year	97
FIGURE 2.6	Drought levels in the Amazonian region	101
FIGURE 2.7	Precipitation in the Amazonian region	101
FIGURE 3.1	Distribution of the fire spots in the Amazonian forest (2003-2006)	145
FIGURE 3.2	Percentage contribution of the principal Amazonian hydrographic sub-basins to total basin discharge	148
FIGURE 3.3	Average annual fisheries landings per country during the period 1988-1998 (a) and estimate of fish consumed by rural and riverside populations in Amazonia (b)	158
FIGURE 3.4	Principal species landed in Brazil, Colombia and Peru in the period 1994-1996 and 2000	160
FIGURE 3.5	Annual fisheries exports from the Amazonian basin in the period 1995-2003 (Brazil, Colombia, Peru)	160
FIGURE 3.6	Live fish (units) exported by Brazil, Colombia and Peru from the Amazonian basin	160
FIGURE 3.7	Livestock density in the States of Rondonia, Mato Grosso and Pará (Brazil) 1996 – 2006	168
FIGURE 3.8a	Ecuador: part of the provinces of Orellana – Sucumbíos (1977)	172
FIGURE 3.8b	Ecuador: part of the provinces of Orellana – Sucumbíos (2002) 25 years later; changes in soil usage, intensive deforestation and new islands in the Napo river channel, a sign of growing sedimentation.	173
FIGURE 3.9a	City of Pucallpa-Peru, 1975	185
FIGURE 3.9b	City of Pucallpa-Peru, 2007	185
FIGURE 4.1	Impact on human well-being	202
FIGURE 4.2	Peru: Mahogany exports	206

INDEX OF MAPS

MAP	CONTENT	PAGE
MAP 1.1a	Ecological criterion outline of Amazonia	39
MAP 1.1b	Hydrographic criterion outline of Amazonia	39
MAP 1.1c	Political/ administrative criterion outline of Amazonia	39
MAP 1.2a	Outline of Greater Amazonia	40
MAP 1.2b	Outline of Lesser Amazonia	40
MAP 1.3	Vegetation cover in Amazonia (2006)	41
MAP 2.1a	Population Density in Greater Amazonia and Lesser Amazonia (1990)	67
MAP 2.1b	Population Density in Greater Amazonia and Lesser Amazonia (2005)	67
MAP 2.2	Main highways in Amazonia	88
MAP 3.1	The most important Amazonian cities	183

INDEX OF BOXES

BOX	CONTENT	PAGE
BOX 1.1	Amazon river´s Andean origin	35
BOX 1.2	Amazonia and the Amazon river: most outstanding dimensions	37
BOX 1.3	ACTO countries' Amazonian area, according to three alternative criteria	39
BOX 1.4	ACTO countries' Amazonian area according to combined criteria	40
BOX 1.5	Bolivia: links between Amazonia and the Andes	51
BOX 2.1	Suriname: indigenous peoples and property rights	73
BOX 2.2	Energy in Brazilian amazonia	89
BOX 2.3	Brazil: Sustainable BR-163 highway plan	93
BOX 2.4	Scientific and technological research institutions with headquarters in Amazonia	99
BOX 2.5	Amazonia: climate regulator	102
BOX 3.1	Amazonian managed areas	117
BOX 3.2	Bolivia: Use and exploitation of non-timber forestry resources: Brazil nuts *(Bertholletia excelsa H.B.K.)*	127
BOX 3.3	Coverage in colombian amazonia	131
BOX 3.4	Diversity of vegetation in peruvian amazonia	133
BOX 3.5	Deforestation in Amazonia	136
BOX 3.6	Glyphosate and its mixtures: impact on native fish	154
BOX 3.7	Socio-environmental effects caused by hydroelectric projects: Afobaka Dam in Suriname	155
BOX 3.8	Sediments in Amazonian river	157
BOX 3.9	Alert on the over-exploitation of dorado (Brachyplatystoma rousseauxii) and pirabutón (Brachyplatystoma vaillantii)	159
BOX 3.10	Babazú: opportunities and limitations	164
BOX 3.11	Amazonian riverside agriculture on the Ucayali river (Peru)	165
BOX 3.12	Bolivia: land management and a weak legal-institutional framework	169
BOX 3.13	Brazil: slave labour in agricultural production in Amazonia	170
BOX 3.14	Amazonian cities and areas of influence	178
BOX 3.15	Georgetown: urban development	181
BOX 3.16	Potable water in Suriname	184
BOX 3.17	"Quemadas" (set fires) are the leading cause of air pollution in in Brazilian cities	187
BOX 4.1	Ecuador: The effect of petroleum extraction on the health of Amazonian populations	205
BOX 4.2	Migration and vulnerability	214
BOX 5.1	Amazon Cooperation Treaty Organisation (ACTO)	223
BOX 5.2	The Brazilian State of Amazonas achieved the support of the IDB to improve living conditions in the Igarapés	231
BOX 5.3	The process of ecological and economic zoning in the ACTO countries	234
BOX 5.4	Brazil: Amazonia Fund	235
BOX 5.5	Environmental subject areas for the Amazon Cooperation Treaty Organisation	240
BOX 5.6	Tri-national Programme: Conservation and Sustainable Development of the La Paya-Güeppi-Cuyabeno Corridor of Protected Areas	242
BOX 5.7	Bi-national Development Plan for the Peru-Ecuador Border Region	243
BOX 5.8	Environmental Information Systems in Amazonia: Colombia and Peru	245
BOX 5.9	Community-Based Natural Resource Management – The Wai Wai, Experience, Guyana	247
BOX 5.10	Madre de Dios, Acre and Pando (MAP) Citizen's initiative: a new manifestation of social coordination	247
BOX 5.11	The Yanachaga Chemillén National Park provides quality water: the case of "California's Garden"	248
BOX 6.1	Building scenarios using the GEO methodology	255

ACRONYMS

ACTO: Amazon Cooperation Treaty Organization

BIODAMAZ: Biological Diversity Project for Peruvian Amazonia *(Proyecto Diversidad Biológica de la Amazonía Peruana)*

CAAAP: *Centro Amazónico de Antropología y Aplicación Práctica* – Peru

CAF: *Corporación Andina de Fomento*

CAN: Andean Community of Nations

CBC: Centre for Conservation of the Andean Biodiversity *(Centro para la Conservación de la Biodiversidad Andina)*

CBD: Convention of Biological Diversity

CEDIME: *Centro para la Investigación y el Desarrollo de los Movimientos Sociales del Ecuador*

CENPES: *Centro de Pesquisas e Desenvolvimento Leopoldo Américo Miguez de Mello* – Brazil

CETA: *Centro de Estudios Teológicos de la Amazonía* - Peru

CI: Conservation International

CIAT: International Center for Tropical Agriculture *(Centro Internacional de Agricultura Tropical)*

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora

CLIRSEN: *Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotos* – Ecuador

CMLTI: Multisectorial Commission Against Illegal Logging *(Comisión Multisectorial de Lucha Contra la Tala Ilegal)* – Peru

CO: Carbon monoxide

COAH: Colombian Amazonian Herbarium *(Herbario Amazónico Colombiano)*

COCA: Community Owned Conservation Area *(Áreas de Conservación de Propiedad Comunitaria)*

COICA: Coordinator of the Indigenous Organizations of the Amazonian River Basin *(Coordinadora de las Organizaciones Indígenas de la Cuenca Amazónica)*

CONAM: National Environmental Council *(Consejo Nacional del Ambiente; current Ministry of the Environment)* - Peru

CONAMA: National Council on the Environment *(Conselho Nacional do Meio Ambiente)* - Brazil

CONCYTEC: National Council for Science, Technology and Technological Innovation *(Consejo Nacional de Ciencia, Tecnología e Innovación Tecnológica)* - Peru

CORPOAMAZONIA: *Corporación para el Desarrollo Sostenible del Sur de la Amazonia*

DANE: National Statistics Administrative Department *(Departamento Administrativo Nacional de Estadística)* - Colombia

DIAN: *Dirección de Impuestos y Aduanas Nacionales* - Colombia

EAP: Economically Active Population

ECOAN: *Asociación de Ecosistemas Andinos* - Peru

ECORAE: Institute for Amazon Regional Ecodevelopment (Instituto para el Ecodesarrollo Regional Amazónico de Ecuador)

EEZ: Ecological-economic zoning, or Economic and Ecological Zoning

EIA: Environmental Impact Assessment

EMBRAPA: Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária)

ENAHO: *Encuesta Nacional de Hogares* – Peru

ENSO: El Niño-Southern Oscillation

EPA: Environmental Protection Agency - Guyana

EPS: *Empresas prestadoras de saneamiento de agua potable y alcantarillado* - Peru

FAO: Food and Agriculture Organization of the United Nations

FDA: U.S. Food and Drug Administration

FOBOMADE: *Foro Boliviano de Medioambiente y Desarrollo*

FONCODES: *Fondo de Cooperación para el Desarrollo Social* - Peru

FONPLATA: *Fondo Financiero para el Desarrollo de la Cuenca de la Plata*

FRA: Forest Resources Assessment

FSC: Forest Stewardship Council

FTA: Free Trade Agreement

FUNAI: National Indigenous Foundation *(Fundação Nacional do Índio)* - Brazil

GDP: Gross Domestic Product

GEF: Global Environment Facility

GETAT: *Grupo Ejecutivo de Tierra de Araguaia y Tocantins*

GHG: Greenhouse gas

GOES: Geostationary Satellite Server

GST: General Sales Tax

GTZ: German technical cooperation

GuySuCo: Guyana Sugar Corporation Inc

GWI: Guyana Water Incorporated

IABIN: Inter American Biodiversity Information Network

IALL: Aquaculture Institute of Los Llanos *(Instituto de Acuicultura de los Llanos)* – Colombia

IBAMA: Brazilian Environment and Renewable Natural Resources Institute (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis)

IBGE: Brazilian Institute of Geography and Statistics

ICM: Institute of Marine Sciences - Spain

ICMP: Illicit Crop Monitoring Programme

IDB: Inter-American Development Bank

IDEAM: Institute of Hydrology, Meteorology, and Environmental Studies (Instituto de Hidrología, Meteorología y Estudios Ambientales) - Colombia

IDRC: The International Development Research Centre *(Centro Internacional de Investigaciones para el Desarrollo de Canadá)*

IEPA: *Instituto Ecológico y de Protección de los Animales*

IGAC: Instituto Geográfico Agustín Codazzi - Colombia

IGVSB: Venezuela Simón Bolívar Geographical Institute *(Instituto Geográfico de Venezuela Simón Bolívar)*

IIAP: Peruvian Amazonia Research Institute *(Instituto de Investigaciones de la Amazonía Peruana)*

IIRSA: Initiative for the Integration of Regional Infrastructure in South America

ILDIS: *Instituto Latinoamericano de Investigaciones Sociales*

ILO: International Labour Organization

IMAZON: Amazon Institute for People and the Environment *(Instituto do Homem e Meio Ambiente da Amazônia)* - Brazil

INADE: *Instituto Nacional de Desarrollo*

INCODER: Colombian Institute for Rural Development *(Instituto Colombiano de Desarrollo Rural)* - Colombia

INCRA: National Colonization and Agrarian Reform Institute *(Instituto Nacional de Colonização e Reforma Agrária)* - Brazil

INDECI: *Instituto Nacional de Defensa Civil* - Peru

INE - Bolivia: National Statistics Institute *(Instituto Nacional de Estadísticas)* – Bolivia

INE - Venezuela: National Statistics Institute *(Instituto Nacional de Estadísticas)* – Venezuela.

INEC: National Statistics and Census Institute *(Instituto Nacional de Estadísticas y Censos)* - Ecuador

INEI: National Institute of Statistics and Informatics (Instituto Nacional de Estadística e Informática) - Peru

INGEOMINAS: Colombian Institute of Geography and Mining *(Instituto Colombiano de Minería y Geología)*

INPA: National Institute of Amazonian Research *(Instituto Nacional de Pesquisas da Amazônia)* - Brazil

INPE: National Institute for Space Research

INRENA: National Institute of Natural Resources *(Instituto Nacional de Recursos Naturales)* - Peru

IPAM: Amazon Institute for Environmental Research *(Instituto de Pesquisa Ambiental da Amazônia)* - Brazil

IPCC: Intergovernmental Panel on Climate Change

ISA: Instituto Socioambiental - Brazil

ITTO: International Tropical Timber Organization

IUCN: International Union for Conservation of Nature

IVIC: Venezuelan Institute for Scientific Research *(Instituto Venezolano de Investigaciones Científicas)*

LAC: Latin America and the Caribbean

LBA: *Experimento de Larga Escala en la Biosfera- Atmósfera en la Amazonía*

LPG: Liquid Petroleum Gas

MAP: Initiative Madre de Dios, Acre and Pando

MCT: Ministry of Science and Technology - Brazil

MEA: Multilateral Environmental Agreement

MEF: Ministry of Economy and Finance - Peru

MERCOSUR: South Common Market *(Mercado Común del Sur)*

MMA: Ministry of the Environment - Brazil

MODIS: Moderate Resolution Imaging Spectroradiometer

MPEG: Museum Paraense Emilio Goeldi *(Museu Paraense Emilio Goeldi)* - Brazil

MUNIC: Survey of Municipal Basic Information - Brazil

NGO: Non-governmental Organization

NOAA: National Oceanic and Atmospheric Administration

OAS: Organization of American States

OCIPES: *Organizaciones de la Sociedad Civil de Interés Público*

PAEC: *Plan de Acción Estratégico para la implementación del apéndice II de la CITES para la Caoba en el Perú*

PAMAFRO: Malaria Control in Frontier Zones of the Andean Region: a Community Focus *(Proyecto Control de la Malaria en las Zonas Fronterizas de la Región Andina)*

PANACEA: Andean-Amazonian Plan for Communication and Environmental Education (Plan Andino de Comunicación y Educación Ambiental)

PES: Payment for Environmental (Ecosystem) Services

PNYCH: Yanachaga Chemillén National Park - Peru

PPCP: *Plan Colombiano-Peruano para la cuenca del río Putumayo*

PREDECAN: *Proyecto Apoyo a la Prevención de Desastres en la Comunidad Andina*

PRODES: Programme of Monitoring the Brazilian Amazon Deforestation

PRONERA: National Education and Agrarian Reform Programme *(Programa Nacional de Educação na Reforma Agrária)* - Brazil

RNPS: Pacaya Samiria National Reserve - Peru

SCA/MMA: Secretary of the Amazonian Coordination, Ministry of the Environment - Brazil

SDR/MI: Secretary of Regional Development, Ministry of National Integration - Brazil

SDS/MMA: Secretary of Sustainable Development Policies, Ministry of the Environment - Brazil

SGCA: General Secretariat of the Andean Community

SIAC: Colombian System of Environmental Information *(Sistema de Información Ambiental de Colombia)*

SIAMAZONIA: Biological Diversity and Environmental Information System of Peru (Sistema de Información de la Diversidad Biológica y Ambiental de la Amazonía Peruana)

SIAT-AC: System on Territorial Environmental Information of the Colombian Amazonia *(Sistema de Información Ambiental Territorial de la Amazonía Colombiana)*

SIMCI: Integrated System for Monitoring of Illicit Crops *(Sistema Integrado de Monitoreo de Cultivos Ilícitos)* - Colombia

SINA: National Environmental System (Sistema Nacional Ambiental) - Colombia

SINAMA: Sistema Nacional de Información sobre Medio Ambiente

SINCHI: Amazonian Institute for Scientific Research (Instituto Amazónico de Investigaciones Científicas de Colombia)

SOTE: *Sistema de Oleoducto Transecuatoriano* - Ecuador

SPDA: *Sociedad Peruana de Derecho Ambiental*

STI: Science, technology and innovation

TCA: Amazon Cooperation Treaty

TCFG: Trillion Cubic Feet of Gas

TGP: *Transportadora de Gas del Perú S.A.*

TNC: The Nature Conservancy

TSP: Total suspended particles

UDAPE: *Unidad de Análisis de Políticas Sociales y Económicas de Bolivia*

UFPA: Federal University of Pará *(Universidade Federal do Pará)* - Brazil

UN: United Nations

UNAMAZ: Association of Amazonian Universities *(Asociación de Universidades Amazónicas)*

UNDP: United Nations Development Programme

UNEP: United Nations Environment Programme

UNESCO: United Nations Educational, Scientific and Cultural Organization

USAID: United States Agency for International Development

UTU: *Universidad del Trabajo de Uruguay*

VIDS: Association of Indigenous Village Leaders - Suriname

VOCs: Volatile Organic Compounds

WHO: World Health Organization

WRM: World Rainforest Movement

WWF: Worldwide Fund for Nature

INSTITUTO DE INVESTIGACIONES DE LA AMAZONÍA PERUANA (IIAP)

Upon completing the preparation of this report, a group of students from a basic school in the zone of Iquitos-Nauta, in Peruvian Amazonia, helped us plant seedlings of the pacae or the guaba (Inga feuillei DC), a non lumber yielding forest species that only exists naturally in Amazonia. If no one or nothing else hinders its development, in six years, it will flower, reach a height of 8 to 15 meters, and produce pods, containing black seeds covered with a soft, white, sugary, pleasant tasting pulp, up to three times a year. This tree planting is part of a reforestation programme of regional fruit species that is promoted by the Peruvian Amazonia Research Institute (IIAP).

Assistance:

Buitenlandse Zaken
Ontwikkelingssamenwerking

gtz

Im Auftrag des
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