CHAPTER I

INTRODUCTION:
RESOURCES AND RICHES OF AMAZONIAN RAINFORESTS
AND ENVIRONMENTAL ISSUES
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AND ENVIRONMENTAL ISSUES

The Amazon Rainforest is the largest tropical forest in the world; holding known treasures of bio-diversity resources, geological riches and human cultures.\(^1\) Ever since the discovery by Portuguese navigator and explorers in the sixteenth century, Amazon has aroused human curiosity about whatever lies as-yet-unexplored in the vast expanses. In his book Land of the Amazons published in 1885 Baron de Santa-Anna Nery assessed the Amazon as the 'virgin soil, which awaits the seed of civilisation'.\(^2\) During the 19th century European and American entrepreneurs while exploiting and developing the forest reserves of rubber largely developed the Brazilian Amazon for their own suitability. The fables of its riches since the colonial times and the recent interest of the westerners in them made Brazilian rulers and governments look at the region as belonging to the Brazilian nation, and vital for its national definition and identity.

In more contemporary times, it is since around the 1950s that Brazil began opening extensively the rainforest to exploitation of land and its natural resources for national economic development purposes. Developmental needs and plans also led to the creation of mega-projects for infrastructure. Admittedly, conservation programmes have also since been formulated but in a limited way; and have often been neglected or sacrificed in view of the primary importance given to the goal of rapid economic development.

From the 1970s, more particularly after the 1972 Stockholm Conference, which had for the first time underlined the need to take aspect of environment into the making of economic development strategies, environment gradually became one of the key issues in the Brazilian economic policy-making, national politics, and national

\(^1\) For the simple reason of emphasis, the word rainforest begins with “R” wherever the term Amazon Rainforest occurs in the text.

security considerations. After resisting the idea for decades especially under the military regime (1964-84), Brazil has, more so under the democratic governments since 1985, also embraced international cooperation in its endeavours to protect the country’s rainforest. So much so that today, Amazon occupies one of the foremost places not only in domestic politics and economic-policy making process but also in Brazil’s foreign policy and relations.

What are these tropical rainforests? What is their importance both in environmental and economic terms? In other words, what are the known and prospective resources in the region like; and how these tropical rainforests are important for maintaining regional and global ecology? At the same time, what are the key problems involved in their conservation; and how exploration and exploitation of natural resources can be carried out for meeting the economic developmental needs without adversely affecting the environment and the ecology?

**Defining Rainforests and their Importance**

The fundamental issue involved in defining and understanding the importance of rainforests is that of value system; which has avowedly become so important that human-kind can ignore it only at its own peril. In a major review of the value and problems of tropical rainforests, the noted scholar-cum-activist D.J. Chivers, (1989) on the basis of his study of rainforests in Southeast Asia, has surmised that the equatorial rainforests play a vital role in environmental stability; in maintaining climatic, water and soil balance; and, as a reservoir of bio-diversity, support an immense genetic variety of plants and animals—many of which have significant economic potential if managed sensibly. Looking at it from a different value perspective, even the economic contribution of rainforests under sustained

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3 During the UN Conference on the Human Environment at Stockholm it was for the first time that world attention was drawn towards the need to preserve natural habitats to produce a sustained improvement in living conditions for all, and the need for international cooperation to achieve this. The Conference led in the same year to the establishment of the UN Environmental Programme (UNEP), based in Nairobi, Kenya.

management in perpetuity is certainly in orders of magnitude greater than the one-off contribution from timber extraction or forest clearance—for some form of agriculture. The latter option normally means not only an uneconomic and unsustainable monoculture, but also one which helps escalate climatic instability.

Tropical rainforests are nature’s long-term answer to poor soils. The complex vegetation and the wildlife that they sustain are juggling the nutrients continuously. If one removes the trees, most of the nutrients are also removed; for, the tree roots bind together the poor soil. Commercial plantations, such as rubber and palm oil, are structurally too simple to hold the soil effectively. These are also too simple to replicate the rainforest’s role as a sponge, mopping up water in the rainy season and letting it out slowly during the dry season. As forest covers have dipped below fifty per cent in many tropical countries, climatic changes are becoming noticeable. For instance, it is noted, that rain falls less often but more heavily while the annual total remains unchanged in some regions. Similarly, in other, less maritime, areas rain may markedly decrease but the erosive and flooding effects are increasing dramatically. In between such episodes are also the prolonged droughts and long-burning fires causing severe environmental and economic damage, which were previously unheard of in these ever-wet regions. In sum, the vagaries of the eco-system lend a unique feature to the tropical rainforest regions.

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6 Monoculture is a menace in Brazil. Single-crop and single livestock practices make the food chain very susceptible to being wiped out by pathogens. In agriculture, the term *monoculture* is used to describe planting of a single species of a plant over a substantial area. Monoculture is criticized by the proponents of environmental movement because of their susceptibility to disease and insects, because of the large amount of chemical inputs often required to sustain them, and because of their low biodiversity.


8 Admittedly such problems can be tackled without affecting developmental processes or human habitations. The solution lies in (i) protecting key areas of forest—watersheds and unique lowland ecosystems, which, being on better soils, tend to be richer; (ii) in the efficient management of extensive buffer zones to the forest sanctuaries for sustained yields of the great variety of plant and animal products—many of which still remain undiscovered; and (iii) the more efficient use of land, already cleared of forest for agriculture or housing and industry, with the development of agro forestry and reforestation projects where possible.
What are the unique physical features and environmental resources of the Amazon Rainforest like? In the first place, it would be pertinent to define Amazon Rainforest and spell out its characteristics? A brief description would admittedly help in identifying particular issues concerning the environment and the paradox of developmental thinking and strategies for the Amazon region. At the outset however, it needs to be stated that the complexity and challenges of defining Amazonian rainforest arises to an extent from the fact that it is one of the least studied ecosystems; and a very large majority of the species of the rainforests are yet to be identified.

Amazon, or Amazonia, is in its entirety the most complex and richest in species among all the forest eco-systems of the world. It also includes the largest river system of the world. Rainforest is defined, in broader terms, as forest that grows in constantly wet conditions. These forests can occur wherever the annual rainfall is more than eighty inches. There are abundance of trees, shrubs, vines, ferns and other plants—all growing to form a complex system of layers. In general, plants of the Amazonian rainforest grow in four layers. Towering above all the other plants in the forest are giant trees called emergent, which grow to heights of 115 to 150 feet. There are only one or two of these emergents per acre; and characteristically they have small leaves, umbrella-shaped crowns and tall, slender trunks. The variety includes rubber trees, mahogany, purple velvet etc. which are the source of the world's finest lumber. The Kapok Tree which can grow up to 200 feet tall and whose trunk can be 10 or 11 feet in diameter is the biggest tree of the Amazon rainforest.

Just below the ‘emergent’ layer, lies a thick green carpet, the ‘canopy’ layer, which is formed by flat crowned trees that are 65 to 100 feet above the ground. The canopy layer, along with the ‘emergents’, forms a near continuous covering over the forest, and acts like a giant umbrella. The giant umbrella catches most of the sun-rays, allowing only two to five per cent of it to slip through to the forest floor. Below the canopy is the third layer, comprising of small trees that usually do not grow to heights

9 Wherever the term Amazonia occurs, it refers to the rainforest and the area drained by the Amazon river.
of more than fifteen feet or so. Finally, there is a shorter layer of very young canopy
trees and shrubs. The trees and shrubs in the fourth layer together constitute the so­
called 'under-story'. Many trees in the 'under-story' have elongated crowns. On the
forest floor, the air is very still, humidity is almost seventy per cent, and the
temperature remains constant. Ferns are very common to the Amazon floor. Strewn
over logs and other wet places are moss which are extremely small plants that live in
damp, humid places. Other plants are the bromeliads (the most well-known bromeliad
is the pineapple) and the orchids. The floor is free of decayed dead leaves because
high temperatures and humidity aid billions of micro-organisms living in the soil to
decompose plant and animal debris very quickly. This fast and continual recycling of
nutrients is what keeps tropical rainforest system working so efficiently despite their
shallow, relatively infertile soil.  

The soil underlying the forest is extremely poor in quality. It has been
estimated recently that laterite occurs in only seven per cent of the tropical world and
probably in less than two per cent of the Amazon. Tropical soils are said to be old,
leached, acidic, poor in nutrients, and capable of being cultivated for only a couple of
years. Three major soil types predominate in the humid tropics of Amazon: oxisols,
altsols and ultisols. The most extensive are the oxisols, characterised by an oxic
horizon; that is, it consists of hydrated oxides of iron and/or aluminum. Altsols and
ultisols are soils with a sub-surface clay horizon found in humid areas, but are less
weathered than oxisols and commonly result from weathering of basic rocks

Rainforests shelter multitude of plants and animals in different layers of forest.
Each organism is a highly specialised inter-dependent member of a balanced eco­
system. Scientists believe that relatively small changes in the atmospheric
temperatures, at various altitudes, can disrupt the entire eco-system and lead to the
extinction of hundreds of species. These species belong to different kinds of families,
from bacteria, to plants, to great mammals and many are already endangered

11  A. Van Wambke, and R. Duda, "Macrovariability Of Soils Of The Tropics", in M Stelly , ed.,
Additionally, there is a lot of illegal trade of biological species. There are two kinds of illegal biological trade; one is of the living animals that go to private collections, usually in Europe and United States, and the other goes to laboratories for research. This usually happens in Europe and United States where the big pharmacy corporations have their headquarters.

Besides, rainforests are also home to millions of people and the sole source of their livelihood. The forests have natural resources from which large incomes accrue viz., tapping rubber, collecting fruits and medicinal plants or even farming cash crops. In more recent decades, the pressure of supporting large populations has, to say the least, put these eco-systems in jeopardy. Significantly, most of the population living in the basin is not rural, but urban.12

Rainforest had once covered about twenty per cent of Planet Earth's land surface. Today, they cover less than seven per cent. Although rainforests grow in more than 50 countries, about half the total rainforest area is contained in just three countries. Brazil alone accounts for some 33 per cent of Earth's rainforest while Zaire and Indonesia hold about 10 per cent each.13 Notably, the Amazon Rainforest extends over nine Latin American countries—Brazil, Bolivia, Colombia, Ecuador, French Guiana, Guyana, Peru, Surinam, and Venezuela. The presence of the Amazón Rainforest has an important bearing on the ecology of all these countries; and therefore formulation of appropriate, even common, policies has been a preoccupation with all the Amazonian countries. It dominates their internal as well as their external policies, with governments according different weightage, depending on the size and resource endowment in the Amazonian rainforest under their national jurisdiction.

The countries, which between them make up Amazonia are all under-developed with strong features of economic dependence. That means, export of resources is important for economic development and the well-being of their

13 n.10, p.2.
populations. The present predicament of environment in all the Amazonian countries is related directly to the dependency syndrome, which insists on unhindered and continuous exploitation of natural resources for exports and for mitigating the conditions of under-development at home. Most critical aspects of poverty, underdevelopment, and the deterioration of the environment are all related in a vicious circle in which each factor is reciprocally the cause and effect of the other. With environment having become one of the foremost agenda both in the domestic policies and external relations of all the Amazonian countries, it has become accordingly very important to devise pragmatic and realistic policies which could balance and blend the conflicting economic, social and ecological components into, what nowadays is broadly called, sustainable development. Besides, each one of these countries, especially as and when they were ruled by the armed forces, have been motivated by their respective geo-political perception which has invariably led to efforts to physically occupy the forests through building of roads and dams, etc. Admittedly, these have had adverse consequences for environment.

Though the entire Latin American region seems to be arousing concern, the focus of this monograph is Brazil due to certain limitations. Therefore, before looking into the above-mentioned aspects, it is relevant here to continue with the description and an examination of the specific characteristics and problems afflicting the Brazilian parts of the Amazon.

**Brazilian Amazon: Features and Assets**

The Treaty of Tordesillas (1494), which had demarcated the Portuguese and Spanish sovereignty over the South American mainland, had itself established Portuguese sovereignty over most of what eventually became the Brazilian national territory including the Amazon.14 Penetration of the Amazon basin had begun as early

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14 This agreement signed at Tordesillas, Spain, by which Spain and Portugal divided the non-Christian world into two zones of influence. In principle the treaty followed the papal bill issued in 1493 by Pope Alexander VI, which fixed the demarcation line along a circle passing 100 leagues W of the Cape Verde Islands and through the two poles. This division gave the entire New World to Spain and Africa and India to Portugal. However, the Treaty of Tordesillas shifted the demarcation line to a circle passing 370 leagues W of the Cape Verde Islands and thus gave Portugal a claim to
as 1616 with the building of the Forte do Presepio on the river estuary, around which grew the city of Belem, to guard against British, French and Dutch naval incursions. It was however the Treaty of Madrid (1750) that had defined the boundaries of Brazilian Amazonia much as it is today.

Brazilian Amazon has been defined and divided in two very different ways: the 'classic' and the 'legal' Amazon. The 'classic' Amazon is the region that is linked to the basin. It includes the states of Amapa, Pará, Roraima, Rondônia, Amazons, and Acre. 'Legal' Amazon is essentially a political definition, which has been adopted by the Brazilian state for administrative purposes. The 'legal' Amazon includes all the states of the 'classic' Amazon, plus parts of the states of Mato Grosso (north of parallel 16°), Maranhao (west of the meridian 44°), and Tocantins (north of the parallel 13°).15 It is one-third larger than the 'classical', and covers an area of five million square kilometers, or 60 per cent of Brazilian national territory.16 The definition of 'legal' Amazon does not include a uniform eco-system. Nevertheless, the 'legal' Amazon comprises of about a third of the Earth's remaining tropical forests; equally important, it also consists of a very large portion of Earth's biological diversity. In terms of ecological and geographical features, the Brazilian Amazon is not flat; nor is it entirely covered by rainforest. Approximately 15 per cent of the 'legal' Amazon is made up of grass-lands (campo), up-land savannah (cerrado), and annually-flooded wetlands (varzea).

The Brazilian Amazon has all the features that pertain to rainforests in general. However, it has its own unique features too:

(i) In terms of climate, the region has two distinct seasons—a dry season from May through September and rainy season from December to April. Most areas receive

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200-300 cm of rainfall per year and the average daytime temperature is over 32°. A
cold wave occurs in the dry season, which can lower temperature by 9-14° C.

(ii) Amazon is hot, humid, and rainy, drained by a dense network of large, year-round
rivers, mostly debauching into the Amazon River—which alone accounts for about
one-fifth of all the fresh water discharged into the world's oceans. Although there are
many different eco-systems in Amazonia, most of them fall into two major groups:
those of the várzea (floodplains) and those of the terra firme (uplands). About one-
third of the world's tropical rainforests are located in Amazonia, mostly within
Brazilian territory. Those on the highly leached soils of the terra firme exhibit a
number of adaptations to their oligotrophic milieu. The fertile soils of the várzea,
where traditional agriculture is carried out, are rejuvenated by yearly flooding and are
occasionally subjected to catastrophic inundations.

The vast plain formed by the erosion of Amazon River and its tributaries
consists of these two major sections—terra firme and várzea. Terra firme is a vast
area, accounting for 98 per cent of the entire Amazon basin, of relatively flat or gently
undulating landscapes. It is very diverse in environmental conditions. The annual
precipitation varies from a low of 1,500 mm to a high exceeding 3,600 mm with
considerable micro-ecological variations. The average monthly temperatures do not
fluctuate annually by more than 3° C, but the daily variation can be greater than 15°
C. Soils in terra firme include some of the poorest and some of the richest in the
world. The richest soils are the alnicos and the moll sols.

Várzeas, in geological antiquity, was a fresh-water gulf created due to the back
flow of Amazon and the resultant alluviation. These flood-lands called várzeas
occupying a total area of 154,400 square kilometer in Brazilian Amazon are home to a

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(Manaus), vol. 3, no. 3, p. 32.
18 Eneas Salati, “The Climatology and Hydrology of Amazonia”, in G.T. Prance and T. Lovejoy, eds.,
19 Toshie Nishizawa and Juha I. Uitto, eds., The Fragile Tropics of Latin America : Sustainable
20 Nishizawa, n. 19, p. 54.
complex aquatic fauna.\textsuperscript{21} They are covered by grass-lands \textit{(campos de varzea)} and forests and some of these are permanently inundated \textit{(igapos)}. They contain the region’s most productive eco-system.

The Amazon River extends roughly 3,900 miles across the northern part of South America. It is the largest river in the world flowing mainly across Brazil. The entire network of the Amazon River is the only means of penetrating both the north and west parts of Brazil. The sources of the Amazon River are many and scattered. The generally acknowledged source is high in the snow-capped Andes mountain of Peru. Their icy mountain streams find their way into the Apurimac and Maranon rivers. The Amazon in its main course is not a meandering river like Mississipi and many other larger rivers. It is broad, and its more or less straight channel is dotted with lens-shaped islands that vary greatly in length and width.

The principle tributaries are themselves full-fledged rivers. The largest right bank rivers, or the northward flowing tributaries, including their lengths are: the Xingu (2900 kilometer), Tapajos (1800 kilometer), Madeira (2380 kilometer), Purus (3220 kilometer) and Jurua (2400 kilometer). The main left bank tributaries are the Japura and the Negro Rivers. Some of the tributaries like Rio Negro resemble the Amazon in that they do not meander. Others like Purus and Jurua have however pronounced meander patterns.

(iii) When considering the resources and assets, one cannot overlook the most important of all assets, viz. the human inhabitants of the Amazon region. This resource lends a unique characteristic to the region because of their mode of living and their pattern of forest utilization. Amazon is home to an outstanding cultural diversity—indigenous communities, the racially-mixed \textit{caboclos}, miners, and forest-dwellers—some of which are living there since times immemorial.\textsuperscript{22}

\textsuperscript{21} Nishizawa, n.19, p. 124.

\textsuperscript{22} The largely undocumented rural population of mixed blood in the Amazon is often referred to as \textit{caboclos} by urban dwellers and the White elites. The meaning of this term has changed, and currently the various recognised meanings range from de-culturated Amerindians who no longer live in their own integrated society, to persons of mixed ancestry, to anybody who lives in a rural part of Brazilian Amazonia. In the Lower Middle Amazon, the term is used as a racial pejorative to
shaped cultures based on the environment in which they have lived. Living from nature and on nature, and lacking the technology to dominate their environment, native peoples had learned to watch their surroundings and understand the intricacies of the rainforest. They learned the importance of living within their environment and came to rely on the countless renewable benefits that forests provide. Their knowledge and understanding of rainforest is now considered an asset; and is presented by many environmentalists as constituting a model in 'alternative development'.

The indigenous population of the Amazon is situated almost exclusively along the Amazon River. The largest population cluster is at the mouth of the Amazon River, centered on Belem and Manaus. The dominant groups are the so-called Amerindians. Who account for one per cent of the population, of which the major tribes are the Tupi, Ge, Garib, Arawak and Nambicuara. They have at least four hundred separate communities with important cultural and social variations. In the northern-most state of Roraima are found two of the world’s most important indigenous groups—Yanomami and Macuxi. The other bulk of populations are the result of fusion between Amer-Indians, Europeans and Africans. The indigenous populations make their living from fishing, hunting, gathering, extractivism and shifting cultivation.

In the Amazon region the Amerindian lands account for about 15 percent of the territory. Some of the largest areas were set-aside during the Collor administration in 1992. The best known and largest of these is the 9.6-million-hectare Yanomami Indigenous Park, located in the northern states of Amazonas and Roraima, along Brazil's border with Venezuela. Gold miners and their diseases have had an adverse impact on the Yanomami. The Caiapó in southeastern Pará became widely known both for their traditional environmental management and their controversial

denote the rusticity, backwardness, laziness and lack of ambition of people living in riverine areas. The notion of 'hybridity' states such people are of mixed descent, often having indigenous (great) grandparents (mostly mothers), and trace their European blood through Italian and Portuguese immigrants, or in some cases from Northeastern Brazilians, who came during the time of the rubber boom in the last half of the nineteenth century.
concessions to gold miners and lumber companies. Other indigenous areas include the Xingu Indigenous Park and other parts of Amazônia, including the western section of the Amazon along the Rio Solimões, Roraima, northern Amazonas, Rondônia, Acre, Amapá, and northern and southeastern Pará. The Northeast (Maranhão) and Center-West (western Mato Grosso, Mato Grosso do Sul, and Goiás) regions also have large indigenous areas.

Some of the oldest and the largest indigenous communities, who live on some of the largest territories, include the Tucano, the Tikuna, the Urueu Wau-Wau, the Surui, the Waimiri Atroari, and the Yanomamis. Policies of modernization, and especially the military governments' drive to physically occupy the region, have directly and often adversely affected these communities. It was not until the 1988 Constitution that collective rights, including land rights, of Brazil's approximately three hundred thousand Indians, were recognised.

Although, military government had set Fundação Nacional do Indio (FUNAI -- National Indian Foundation) whose task included carrying out surveys, studies and scientific research on the indigenous communities ostensibly to protect their interest in view of the fact that developmental programmes and opening of Amazon for land occupation brought incalculable harm to the indigenous including to their cultures and livelihood. They were never considered as full citizens; besides, military regimes were obsessed with filling up the population void, which they did by encouraging all kinds of predatory forces to move into the Amazon. Be that as it may, it is feared that the free-for-all kind of predatory capitalism might have already caused immense losses to the world of anthropology and cultural studies. In fact, it was this virtual extermination of Indian cultures and peoples that had first aroused international indignation—something which successive Brazilian governments have tried to avoid.

Endowed with immense resources, this region began being exploited economically by those in power. The onset of external debt crisis in the 1980s and the need to promote exports brought yet another wave of occupation and exploitation of Amazonian land and resources. In consequence of various developmental imperatives,
Amazon is today subject to varieties of economic activities. Modern economic activities had begun developing since the 1950s but it was the military government that had really thought of Amazon as providing unlimited resources for national economic development. The following section identifies the principal economic activities and presents some broad data so as to indicate the level and extent of resource exploitation in the region.

**Principal Economic Activities in the Amazon**

By early 1980s, Brazil had become the largest among the Third World debtors. While the successive governments looked at the Amazonian natural resources as new export products that could bring in the much-needed foreign exchange, the vast multitude of impoverished and victims of harsh austerity programmes began turning to the forests to eke out a living. In sum, forest resources came under severe strain and incalculable exploitation from various ends and for various purposes. A splurge in activities began because Amazon Rainforest was considered a treasure of raw materials. Logging, agricultural crops, pastoral activities, mining and petroleum exploration, extractivism, hydro-electric projects, eco-tourism, and drug-trafficking were all present in varying degrees in the region. However, the need to earn more foreign exchange by promoting exports of ever-large quantity and number of products brought unbridled and unplanned exploitation of resources in the Amazon. Some of the activities and the extent of their assault have been dealt with in the subsequent paragraphs.

(i) Brazil's annual lumber exports constitute generally under 5 per cent of the world's total production; and the total lumber production has been estimated at approximately US $ 600 billion. The United States and Europe are the largest importers not only of wood but also of nuts and latex products; whereas, it is some of the major Asian companies that are engaged in logging in the Amazon. Logging is one of the principal known causes of Amazon Rainforest destruction; in fact, of destruction of rainforests everywhere. Despite improved logging techniques, and greater international awareness and concern for the rainforests, unsustainable logging of tropical
Rainforests is on the increase. Logging firms, particularly Malaysian, Indonesian, and Korean, have rapidly moved into some of the last remaining undisturbed forest areas in the Brazilian Amazon, where some 30 million acres (12 million ha.) of forest were under concession by 1996.\(^{23}\)

Antônio Carlos do Prado, a high official within the Ministry of Environment, told *O Estado de S. Paulo*, one of Brazil's largest newspapers, that the arrival of Asian logging companies from Malaysia and China in the Brazilian Amazon is a positive fact and that with their presence it will be easier to control logging in the region. But many informed Brazilians were asking a very legitimate question. "What can guarantee us that these Asian companies that had no respect for their own national forests will do any different in Brazil?" World renowned scientist and former Secretary of the Environment, José Lutzenberger was also very concerned about the arrival of the Asian loggers, "It will be very difficult to control their insatiable demand," he said.

Most of the logging companies carry out their work for maximum immediate economic efficiency and with little regard for environment. For example, Malaysian and Indonesian firms are notorious for neglecting elementary principles of sustainable forestry and leaving logged lands seriously degraded. All kinds of other problems have also been noticed. Protected tree species are routinely harvested; firms log outside of their areas under concession; and unnecessarily intrusive logging roads are constructed. These tropical logging operations also widely fail to safeguard timber stocks for future harvests; and fail to protect forests from fire, loss of bio-diversity, over-hunting, and subsequent conversion of lands for agriculture or pasture use. A commonly-held view among environmentalists is that rainforests are of more value when left standing rather than when they are felled. Such a viewpoint, of course, also encompasses the monetary aspect; for example, the income is generated from products

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23 The Brazilian government confirmed that the three Asian logging companies present in the Brazilian Amazon are: WTK Group and Samling Organization, both of Malaysia, and Fortune Timber of China. WTK and Samling established themselves as forces in the world timber trade through massive logging concessions in the Sarawak region of Malaysia, where indiscriminate forestry techniques have decimated what used to be virgin jungle.
such as fruits, nuts, and cosmetic oils. But it is part of the ‘alternative development’ paradigm including another value system.

(ii) It is generally known and understood that Amazonian soils are not adapted for intensive agricultural exploitation or cattle-raising activities. Once the vegetation is removed, these lands lose their fertility quickly. Nevertheless, both agricultural and pastoral activities are both extensive and intensive on these lands.

Agricultural areas are found generally close to the cities. In-land, large-scale subsistence cultivation, mainly of cassava, rice and corn, also takes place. Rice is cultivated in holms. Cassava is cultivated in firm ground areas, and is generally planted soon after forest removal. Cassava and corn cultivation follow some primitive patterns: after some two years of cultivation, the area is abandoned and the cultivator seeks another forest area, where there begins a new cycle of forest removal, burning, and crop cultivation. Apart from degrading the soil, such ‘itinerant’ agriculture produces a clearing in the forest, and allows secondary vegetation growth; that is, vegetation which is without the primitive characteristics where low plants and shrubs had prevailed.

Brazil is the second major exporter of agricultural products after US. New agricultural areas have been formed for cash crop cultivation. With soy emerging as one of the main exports, in the state of Tocantins, soy culture has expanded greatly; and in Rondônia and in the north of Mato Grosso states, new colonisation projects have attracted farmers from several parts of the country. In fertile areas of these states, coffee, cocoa, soy and corn have been introduced on hugely large estates.

(iii) No gainsaying, the expansion of the agricultural activity in Amazon is being accomplished by great deforestation, soil erosion and eco-systems destruction, to which no less is the contribution made by pastoral activities. In the vast cleared areas of Amazonia, it is the cattle-raising that has become the dominant land-use practice.

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24 The holms are areas with height less than 10 meters. In wet season, the rivers flood these lands, and deposit typical sediments of the rivers onto the plain of Amazon. In holms the peasantry cultivate rice and jute.
Military governments in particular had encouraged pastoral activities; and it is estimated that by 1985, pastoral activity had accounted for one-quarter of the total agricultural production of the states of Pará and Rondônia. Cattle-raising has also become one of the principal economic activities in Mato Grosso, Goias, and Maranhão, where most public lands have been allocated to individually owned ranches or to large corporations. Here, a great part of Brazil's livestock is found.

Cattle-raising has for too long been an attractive proposition in many frontier areas of Latin America, including the Amazon, for a number of reasons: cattle are a highly liquid investment; cattle can be easily walked long distances to market, even when roads are in poor condition; sales can be delayed without major losses in most cases; the cost of establishing pasture after cropping is relatively low for smallholders; and finally ranching is a low-risk operation compared to crop farming. In particular, in the wake of the debt crisis, pastoral activities expanded greatly as pastoral exports became the major foreign exchange earner for servicing the huge external debts.

In reality, the contribution of the agricultural production from the Amazon region towards the overall national agricultural production had always been small; for instance, it was only 7 per cent in 1980. Greater part of agricultural production, however, came from the large properties that participated in pastoral activities by diverting agricultural land towards creating pastures. Raising cattle was the chosen activity because it is self-productive, demanding a minimum of capital and labour for its maintenance, that which allows capitalisation in short periods and, at the same time, justifies the appropriation of great amount of land, using State subsidies.

(iv) Amazon has always had those dependent on, or those who got interested for commercial reasons in the extraction of rubber and collection of Brazil nut and guarana, etc. Many non-timber forest products (NTFP) have a great contribution

in the role of extractivism for attaining sustainable development in the Amazon.
Together rubber and the Brazilian nut stand out by representing two-thirds of the
value of NTFP from the northern region. Extractivism employs a large number
of hands; and, in a sense, still moves the Amazonian regional economy. Two
principal types of extractivism are predominant, and it is very important to know
their difference: the non-conservationist is a kind of exploitation that contributes
directly to the deterioration of rainforest and destruction of forest vegetation.
Then, there is the conservationist type, which is a kind of activity that preserves
the vegetation and thereby the bio-diversity and the eco-system. Apart from
collection and extraction of products like Brazil-nut, rubber, and guarana, there
also still prevails subsistence-level, primitive agriculture, hunting and fishing
activities.

Non-conservationist type of wood exploitation complements the land-use for
agriculture or for pastoral activity. In other words, wood exploitation is carried out
without concern for proper forest handling, and involves highly aggressive extraction
methods. Large firms, including many foreign companies, which are engaged in
commercial crops such as soy or cattle ranching with hundreds of thousands of animal
heads, clear the forested areas. They just use the log’s noble part; and the scraps, that
could have several uses, are simply burned or not used at all. At the same time, small
farmers have found in wood an alternative source of income. They generally sell the
wood at very low prices to the so-called wood ‘middlemen’, or exchange it for
services.

Wood extraction in holms is carried out on plant populations, which are
generally located at rivers borders, or in easily accessible areas where exploitation can
be done by traditional methods. In firm ground forests, the extraction is generally
carried out by log-men, who have minimum infrastructure. Besides, the vertically
integrated wood companies carry out wood extraction as an industrial activity. Most
of such wood companies extract (or buy) wood exclusively from lands owned by

27 Willem Assies, Going nuts for the rainforest : Non-Timber Forest Products and Sustainability in
farmers, while a very small number of them use their own lands. The operations are, in general, highly automated; and, in the process, significantly alter the forest covering.

The most commonly followed practice is simple wood extraction in areas which have been colonized, or which have been earmarked for large agricultural projects. In short, wood extraction is carried out with minimum investments, and with no concern for the sustainability of forest production. In fact, cultivated forests are hardly seen in Amazon; and the few areas so designated generally grow some exotic fast-growth species only for the market. In more recent years, some reforestation with native species has been undertaken under pressures of environmentalists or the local communities. Such reforestation drives however remain incipient, and the survival and productivity of native species remain uncertain; besides, it is virtually impossible to restore biodiversity in reforested areas.

(v) Mega hydro-electric projects in the Amazonia are a testimony of environment having long been subordinated to the imperatives of economic development. Hydro-electric power stations have had some of the greatest impact on environment; and, as well on the success or otherwise of development strategies. Most of them were initiated during the military rule. These projects have created some kind of an artificial eco-system, profoundly affecting not only the environment but also the social and economic activities. The reservoirs change the whole landscape; and the flooded areas alter the characteristics of the original eco-system in many ways. To take just one example; reservoirs make the animals move to areas where other populations already exist in balance. The new arrivals make the balance break down; and problems like food competition begin. Dam-building has also hurt and hampered the reverie flora and fauna. A number of fish which are commercially important such as jaraqui (Semaprochilodus spp.) and catfish (Brachypolatystoma flavigans, B. filamentosum) migrate from Amazon River to spawn in its tributaries. Now, natural spawning grounds have simply disappeared.²⁸

²⁸ Smith, n.25, p. 24.
From economic point of view, it is necessary—but nobody has ever done—to estimate the costs of the loss of agricultural production in the space of the rivers and in the areas flooded by the reservoirs, as well as the value of the wood and minerals in the submerged forests. Besides, these mega projects have created acute social dislocation as local communities; mainly indigenous, are uprooted; and either migrate or are relocated elsewhere. The life of those communities especially which live off fishery gets terribly disrupted. The apparent and hidden ecological costs of constructing major dams have never been taken into account. Particularly during the period of Brazilian economic ‘miracle’ between 1968 and 1976, military governments had launched many mega hydro-electricity projects. As the first oil crisis after 1973 had threatened to slow down the ‘miracle’, the oil import-dependent economy had come to depend even more on hydro-electricity as the source of energy.\(^9\) No doubt, hydro-electricity is always an attractive proposition for development planners, but it needs to be noted that most of the electricity generated in Amazonia comes from the diesel-powered turbines.

An intense debate has persisted over the merits or otherwise of large versus small dams. Some argue that large hydro-electricity projects bring large benefits. For instance, the Tucurui dam has benefited Belem and its environs with reliable electricity and many new jobs in the industries, such as at the aluminium smelting plant at Bacarena. Others have advocated smaller dams both for environmental and economic reasons. It is suggested that they might prove more benign to the environment without adversely affecting the economic yields. To supply power to the pulp mill at Jari, for example, a proposed hydro-electric plant at the Santo Antonio Falls will divert part of the river through a turbine and thus will not involve any flooding.\(^{30}\)

(vi) *Amazonia* possesses known large mineral reserves of iron, bauxite, manganese, calcareous, cassiterite, gypsum, lignite, copper, kaolin, diamond, nickel and gold. Although mineral deposits, chiefly gold, were known to be present in Brazil in the

\(^9\) Smith, n.25, p. 29.

\(^{30}\) Smith, n.25, p. 30.
sixteenth century, commercial exploitation had begun only a century later with the
discovery of rich deposits in the states of Minas Gerais, Goiás, and Mato Grosso. In
the eighteenth century, production in these areas and others made Brazil the largest
producer of gold in the world. The discovery of a vast mineral province in the Amazon
region not only encouraged large mining companies establish themselves in the region
but also led to the construction of highways connecting the northern region with south­
central Brazil, and to the introduction of large colonisation projects. Massive
migration of labour in the region with barely an infrastructure has also contributed to
the environmental problems such as the devastation of the rainforest and the
degradation of the soil, and displacement of rubber-tappers and the indigenous
communities.\(^{31}\) An estimated 4,500 square kilometers of forest is likely to be cleared
in order to access all exploitable mineral deposits in Amazonia.\(^{32}\) Settlement and other
developments connected with mining will of course have much wider impacts.
Different mining activities have different implications for environment, and it is
important to know their differences.

(a) Since the 1980s, mining of gold has emerged as a major activity, which has
environmental implications. Two basic processes in gold extraction are predominant
in the Amazon region: gold is recovered from soils and rocks; and, secondly, gold is
extracted from the sediments using dredging systems in many Amazonian rivers. In
both the methods, mercury is used to separate thin gold particles through a gold-
mercury mixture. To recover gold, the mixture is burned, frequently outdoors,
releasing mercury vapour into the air. During the gold-mercury mixing process, a
variable amount of metallic mercury also gets lost in rivers and soil.

Small-scale gold mining by the informal sector, called garimpagem, has been
part of the Brazilian folklore since the eighteenth century when gold deposits were
discovered in the areas in and around Mato Grosso. The modern period of

\(^{31}\) Teresinha Andrade, “Environmental Issues in Brazilian Tin Production” in Teresinha Andrade
Minning and the Environment: Case Studies from the Americas (Canada: International Development
Research Centre, 1999), p. 3.

Garimpeagem's long history began around 1979, when escalating international price of gold set off a 'gold rush' throughout the Amazon basin. The rapid growth of the informal mining sector in the 1980s and its almost equally rapid decline in the 1990s have often been described in pathological terms like 'gold fever', and 'mines scarring the landscape'.

As the Table 1 shows, in 1980 the formal sector had accounted for some 10.9 per cent of officially estimated total gold production. Most of the increase was achieved through the opening of small- and medium-sized mines in Amazonia, generally by moving in on deposits that had been abandoned by the informal sector miners, as the more easily available alluvial gold was mined out. The shift from the informal to the formal however also involves a significant technological shift. Garimpo technology, characterized by the use of sluices and small dredges, is replaced by the leaching system, which use cyanide compounds in closed circuits. Leaching of pits can be environmentally hazardous, as was demonstrated by the leaking of cyanide into the Essequibo river in Guyana. This form of mining is more easily regulated, thanks to the size and permanence of mining installations and the formal sector status of the companies that operate them. However, the regulation is more in principle; in practice, there are only few rules that also are observed more in breach.

Garimpo production had its spectacular decline in the 1990s. From the peak of 72 per cent in 1988, the informal sector accounted for only 36.4 per cent of national gold production in 1995. When it fell below the 1979 level, the total garimpo gold production was estimated at only 25 tonnes. The singular factor behind the decline was the technology employed by garimpeiros. Garimpeagem technology is well adapted to mine alluvial deposits, which are also relatively easy to prospect. Even in alluvial deposits, however, garimpeiros do not have the technology to mine any deeper than 20 meters or so. They thus tend to exploit shallow alluvial deposits, moving on to ore deposits though with much greater difficulty after exhausting the

33 The Essequibo River is the longest river in Guyana, and the largest river between the Orinoco and Amazon. Rising in the Acarai Mountains near the Brazil-Guyana border, the Essequibo flows to the north for 1,000 kilometres through forest and savanna into the Atlantic Ocean.
alluvial options. After the mid 1980s, the easily available alluvial deposits began to be depleted out. For a time, it was possible to compensate for this, to an extent, by seeking out new deposits, but by the early 1990s even this had become difficult. Be that as it may, garimpagem is a tradition that would not die despite decline in the alluvial gold production. Interior Amazon has attracted all kinds of forces, suffering ‘gold fever’, which continue to scar the landscape.

**Table 1**

*Gold Production in Brazil, 1980-95 (metric tonnes)*

<table>
<thead>
<tr>
<th>Year</th>
<th>Formal Sector</th>
<th>Garimpo (regd.)</th>
<th>Real Garimpo (estd.)</th>
<th>Total</th>
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<tr>
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<td>11.12</td>
<td>35</td>
<td>39.09</td>
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<td>37.90</td>
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<td>61</td>
<td>68.34</td>
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<td>22.00</td>
<td>65</td>
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<td>75</td>
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<td>40.95</td>
<td>21.47</td>
<td>23</td>
<td>64.42</td>
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</table>

Source: *Sumario Minera, Annual Volumes, 1981-1996, (Brasilia: Ministerio das Minas e Energia.)*

(b) Another mining operation, which creates a different set of problems, is that of bauxite. Bauxite mining requires the removal of large amounts of topsoil; and often sediments are washed by the water run-off. At one point, seven miles of Lake Batata near Rio Norte on the Trombetas had been filled up with reddish-brown soil,
destroying trees and killing fish and wildlife habitats. Efforts at restoration of soil and forestation are far and few but generally prove very costly.

(vii) Western Amazon is rich in oil reserves; and oil prospecting has been carried out in several other parts of the basin for the past thirty years. Some water pollution occurs around the extraction sites, thus the damage being usually localised. Roads created to facilitate petroleum extraction help settlers penetrate the rainforest.

The arrival and expansion of large mining and petroleum operations has created a host of linked environmental issues. Importantly, most mining in the Amazon is done in the northern region, where the authority of the government is weak due mainly to distance from the centre, difficult accessibility, large size of the area and low density of the population. Besides, mining companies themselves prefer lenient environmental rules to avoid over-stretching of production costs. It is this aspect of indiscriminate exploitation of the region that has often aroused the question of un-governability and the urgent need for major environmental management.

(vii) The simultaneous increase in environmental consciousness and special tourism during the 1980s has given rise to eco-tourism all over Latin America. Many find it a good blend of nature conservation and economic development; and often, eco-tourism is presented as one of the strategies of sustainable development in the rainforests. Ironically, however, eco-tourism is not without its negative environmental consequences as was discovered during the presidency of Jose Sarney (1985-90). It

35 Mineração Rio Norte, which operates the bauxite mine along the Trombetas, replants areas scraped to gain access to the aluminum ore. Topsoil is stockpiled and then spread back for the restoration of the land. The manganese field at Serra do Navio in Amapá has been mined by ICOMI since the early 1960s, and is nearing the end of its economic life. The ore is taken by rail to Porto Santana, a deep-water port on the northern bank of the Amazon. Sizeable oil-palm plantations and small-scale settlement have sprung up along the railroad. The manganese mines, still operating in the vicinity of Serra do Navio, are well managed and do not provoke any significant ecological damage. Oil-palm plantations along the railroad are well adapted to the climate and soils of the region and also provide good ground cover.
36 Gradwohl, n.34, p.172.
was found that the eco-tourist industry has directly contributed to large-scale disruption of wildlife, pollution and degradation of soil by the indisposed garbage, which flows down millions of miles of Amazon tributaries, and intrusions in the cultural life of the indigenous. As global concerns about the impending destruction of Amazon grew in the 1990s, it has brought only more tourists to the rainforest. It is easy to sell words such as ‘eco-tourism’ but proves costly if proper infrastructure is not put in place beforehand. In the first place, eco-tourism is, like any other industry, driven by profit motive and ironically remains unencumbered by all ecological considerations. Controlling tourism in the Amazon is like checking gold prospectors. Worst, like garimpage, eco-tourism is bereft of ecological values. Unregulated fishing, a related activity of tourism, is so extensive that many districts are nearly depleted of some rare species. The intrusion of hordes of tourists has made wildlife fauna sparser, with the so-called eco-tourists often poking and throwing stones on wild animals to make them react. Worst, illegal hunting and poaching in the garb of eco-tourism has increased. To make matters worse, free-lance jungle guides solicit travelers at airports and ports, luring them with inexpensive trips into the Amazon’s so-called Stone Age communities; and pilots offer flights to restricted Indian reserves. In the words of the interior minister of Brazil under Jose Sarney, “tourism can no longer be separated from other man-made disruptions of the ecology, such as mining and deforestation”.

(viii) All the world’s cocaine is produced from coca plantations on the eastern slopes of the Andes. The seemingly endless appetite for drugs in the rich and advanced countries has spurred coca plantings in areas formerly in forest or meant for growing food crops. A mild stimulant, cocaine had only some ritualistic importance or relaxing effects for certain indigenous groups of western Amazonia. Now, large quantities of coca leaves are processed into concentrate cocaine in Amazon region. Coca cultivation is also spreading further into the Amazon lowlands, including Brazil.

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38 Harrington, n.36, p. 215.
Deforestation, coca eradication exercises, and the dumping of chemicals used in processing coca leaves into paste are some of the latent environmental problems produced by the coca business. Large tracts of tropical forest, which have been earlier cleared by the miners or the itinerant farmers, have fallen to coca cultivation by small farmers. Poppy fields are as well sprouting in the Andes in response to a resurgent demand for opium and a desire by drug cartels to diversify their product lines.

One of the most serious environmental issues associated with coca in Amazonia is the nature and quantity of chemicals used to process coca leaves. It involves the use of sulphuric acid, quicklime, kerosene, toluene, and carbide. If these chemicals—many of which are imported from US and other industrialized countries—are not eliminating fish populations, they render them unsafe to eat. Such compounds may also trigger mutations in at least some of the fish species. Besides, narco-traffickers have developed elaborate communication and transportation hubs in the inaccessible areas of Amazon in the face of US military and coast guards interdicting drugs in the Caribbean sea.

**Environmental Consequences of Varied Economic Activities**

Environmental consequences of various economic activities have been briefly mentioned earlier. But there are various side- and long-term effects of these activities.

(i) Informal sector gold mining has had varieties of serious effects on and implications for environment including spread of diseases. By far the most important environmental consequence of *garimpagem* is malaria. Alluvial gold mining creates a prefect micro-environment for the propagation of the disease. Diggings get filled with water where mosquitoes breed; and infected miners then move rapidly from one mining region to another, bringing new strains into areas where indigenous inhabitants may have some resistance to local varieties but none to new imports. Some of the affected indigenous communities, such as the *Yanomami* of Roraima and the *Waiapi* of Amapa, associate *garimpeiros* with malaria outbreaks.
(ii) The magnitude of mercury contamination in Amazonia is a particularly difficult to assess. The implications of uncontrolled mercury use in informal sector gold mining have been a source of worry; however not all mercury in Amazonian eco-systems comes from gold mining. Burning releases mercury, and it appears there are varying background levels of mercury in different regions of the Amazon Basin. In the first place, mercury released in the water and air poses public health hazards. Some mercury vapour is inhaled by miners themselves when mercury/gold amalgam is burnt at the end of the production process; besides gold traders and other residents also do so when amalgam is re-burnt when sold.

Fairly high levels of mercury have also been found in fish along the Amazon River system. Contamination of Amazonian food chains through the uncontrolled spillage of mercury during mining operations has been noted. Mercury lying in river sediments is ingested by bottom-feeding fish, which, in turn, become prey for carnivorous fish. Mercury ingested by fish in this way undergoes a chemical transformation called methylation. It becomes methyl-mercury, which is organic mercury compounded by several orders of magnitude, and is more toxic than inorganic mercury. Since fish is the basis of the diet of many riverine Amazonian populations, and fish migrate, the concern has been that large-scale mercury contamination from mining operations, going on for long, pose a serious threat to the public health of fish-eating, riverine caboclo (local traditional communities), who are otherwise far removed from the mining zones.

(iii) Mining operations routinely run their tailings into the nearest available body of water, relying on currents to wash away the material so that it does not cover land that might be mined in the future. At the same time, detergents are used in areas of fine-grained gold, and fuel of all kinds is often spilt into rivers during the normal course of mining operations. In any area of garimpagem, therefore, watercourses suffer and undergo alteration, both in the short and long term. A certain amount of deforestation is always associated with informal sector mining. Forest clearing is often the first step in opening up a mining operation. Paths are cut to work-fronts from residences, and
some agricultural activity invariably accompanies garimpagem, with patches opened up for cultivation of manioc, beans and corn.

Garimpeiros have often made up the advance guard of Brazilian society to encroach upon the indigenous space and culture; and many indigenous groups, especially the Kayapo, the Mundurucu, the Wayapi, the Yanomami and the Macuxi, have been dealing with garimpeiros now for decades. As the ‘gold rush’ began in the 1980s, it virtually took the form of large-scale invasions on indigenous reserves, which brought equally large-scale environmental and cultural damage in their wake. The Kayapo of southern Pará were able to control an influx of garimpeiros; and also levied a tax on the gold produced. The Kayapo have been in close contact with the representatives of branco (white) society including the Christian missionaries since the early part of the twentieth century. The Kayapo have been much more successful than many other indigenous communities in defending the physical integrity of their reserve. The Yanomami, on the other hand, who live in remoter areas, have far less experience in dealing with branco society. They have suffered a much larger-scale of invasions on their lands and have suffered more by contacting modern diseases.

The above-mentioned economic activities have led to a great degree of deforestation, the extent and nature of which is difficult to measure. Some of the causes of deforestation have been noted earlier. What however needs reiteration here is that none of the varied activities and forces would have penetrated the Amazon without military governments’ liberal tax laws in relation to land ownership; availability of easy agricultural credit; and laws granting titles to lands. In other words, the government adopted certain policies that have been specified below which facilitated the destruction of the rainforest.

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40 Interestingly, the wealth thus acquired was used by the indigenous leaders to acquire aero-planes and an ostentatious living style. For details see David Cleary, “Small-Scale Mining in Brazilian Amazonia”, in Anthony Hall, ed., Amazonia at the Crossroads: the Challenge of Sustainable Development (London: ILAS, 2000), p. 72.

(i) For sustainable development, it is argued that the value of all goods and services must be measured including non-use values, e.g. for climatic stability; aesthetic value, etc; and that these values have to be applied in terms of social equity as well as economic efficiency. For example, beef benefits go to a few, whereas the cost of forest loss is borne by all. There has to be charge on users to conserve threatened species—plants or animals—for ultimately conserving the threatened eco-systems. The approach has to address all features—ecological, economic, institutional and developmental. One may rightly find such a proposition idealistic and therefore impracticable; but looking at the tax laws in Brazil, there is no doubt that the military government particularly was rewarding those who were destroying the forests. Such in fact has been the structure of taxes on agricultural income. Corporations and individuals respectively are entitled to exclude up to 80 and 90 per cent of agricultural profits from their taxable incomes under the various provisions of the tax code. Under the two prevailing systems, either an individual can be taxed on the 10 per cent of his gross agricultural income; or the cost of modernization of capital can be subtracted from gross agricultural income. Fixed investments, animals, buildings and machinery can be depreciated fully in the first year; as well as several times over in the subsequent years. Under such a system, up to 80 per cent of income could be lawfully sheltered from taxation. This is when demand for land becomes extremely high over the years, as agricultural projects become extremely attractive to corporate and private investors. Such a system has generally benefited the large landowners and has harmed the small farmers, since the low tax rate level becomes capitalised into the price of land, reflected in high land prices, making tilling the lands unprofitable for the small farmers. It forces the small farmers to move further into the Amazon in search of cheaper and unclaimed lands, which brings into play the rules of land allocation which in turn contribute to further deforestation. and the cattle herd nearly doubled from 26.2 million in 1991 to 51.6 million in 2001 the world's major beef exporter.

(ii) Besides supporting through the taxation system, cheap agricultural credit has attracted more and more interests onto the Amazonian lands. Real interest rates on

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official credit for agriculture were negative until 1991. Interest rates on agricultural 
loans were much lower than on loans for non-agricultural activities. This difference in 
the availability of easy and cheap credit again allowed capitalisation into the price of 
land. Small farmers, usually unable to obtain farmlands, were again forced to search 
deep into the Amazon for unclaimed lands, making large tracts available to big 
landowners and firms.

This is how large mechanised farming for cash crops emerged in the Amazon.

(iii) Finally, no less astonishing have been the laws granting titles to the land; and the 
way the system has contributed to deforestation. By 1991, large corporations had built 
routes into the forest to capitalise on the lenient tax laws; and only limited land was left 
that could be appropriated by the landless peasantry and others. For the landless, the 
most common method by which to claim land has been squatting. Under the practice 
that dates back to 1850, squatters gain usufruct rights to 100 hectares of lands after 
one year. After occupying a plot of land for five years, the inhabitants get legal title to 
that land.43 Of course, different regions of Brazil use different sets of rules pertaining 
to the amount of land to which one can win title through squatting. In general, total 
land obtainable is a function of the amount of land originally cleared.

        Still, there are no two opinions about the fact that deforestation remains the 
chief preoccupation of the environmentalists and the government in Brazil and even 
outside. On the basis of available data, the following examines the principal impacts 
and extent of deforestation.

The Problem of Deforestation

Deforestation is not amenable to an easy definition; equally challenging is the 
measurement of the extent of deforestation. In common parlance, deforestation means 
the cutting down of forests and the transfer of the land to some other type of eco-

43 Binnswanger, n. 26, p. 831.
system, or use as cropland or pasture. One serious definitional problem arises in describing the original land cover, which often varies from source to source; and also, one can never know the loss of bio-diversity resources. Also different analyses use different statistics to measure deforestation. Thus, depending on the interpretation, the same basic information can yield to different analyses and perspective.

At the request of the Brazilian government, Instituto Nacional de Pesquisas Espaciais (National Institute for Space Research--INPE) has used satellite imagery to make a systematic study of Amazon deforestation since April 1989. INPE’s projects related to Amazon include use of remote sensing satellite images for deforestation surveys; evaluation of environmental impact of informal mining activities, including associated unauthorized construction of small dams and landing strips; monitoring of indigenous reserves and geological studies. Other data about water cycles and mining in Brazil are also available.

Satellite images have also been used by INPE in the localization of forest and bush fires and to research water cycle in tropical rainforests. Computer modelling is used to study effects of deforestation on climate. Atmospheric consequences of burning are analyzed by means of measurements both within and outside affected areas. Since 7 July 2003, INPE has presented in its website digitalized data on Amazon Rainforest deforestation. It shows deforestation place and rate with accurate data. Deforestation data in the Brazilian municipalities will be collected and a general view of Amazon Rainforest deforestation will be defined and be made available at the end of 2004.

Deforestation data from Landsat Thematic Mapper (LANDSAT-TM) imagery, released in early 1988, had indicated that 530,000 square kilometers of forests had been cleared by 1987. By 1988, it had reached an estimated 547,000 square

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45 Land Remote-Sensing Satellite, operated by the US Earth Observation Satellite Company (EOSAT) is a series of satellites (formerly called ERTS) designed to gather data on the Earth's resources in a regular and systematic manner. Objectives of the mission are: land use inventory, geological/mineralogical exploration, crop and forestry assessment, and cartography. The large area
kilometres. The data suggests that of the originally forested area, some 82 per cent of the clearing had taken place since the construction of the Transamazon Highway in the 1970. One limitation of the data based on LANDSAT -TM images prior to 1988 was that the satellite imagery could not distinguish between cerrado and the cleared forest.

Returning to the issue of extent of deforestation, the following Table II presents annual estimates of deforestation in the Amazon region, particularly since 1990.

### Table 2

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<th>Year</th>
<th>Deforestation [sq. miles]</th>
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<tr>
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*For the 1978-1988 period the figures represent the average annual rates of deforestation.

Source: National Institute of Space Research—INPE, (Brazil, 2005)

of the Brazilian Amazon necessitates a straightforward and accurate method of measurement. Landsat Thematic Mapper photo products are inexpensive and of sufficient spatial and spectral resolution for the determination of deforestation. Analysis with visual interpretation techniques produces quantitative results similar to digital processing of full- resolution, multispectral data from the Thematic Mapper.

Fearnside, n.15, p. 11.
Deforestation had perceptibly declined since 1988. The decline is explained largely in terms of the deep economic recession during the period, as ranchers did not have easily available state credit to expand by clearing the forests. The governments had also lacked funds to continue building highways and human settlements.\(^{47}\)

How to assess the impact of deforestation? At least, three principal areas need to be examined—loss of biodiversity; ‘greenhouse’ gas emissions; and loss of water cycling. Tropical rainforest are important components of the global hydrologic cycle. Much of the absorbed solar radiation captured by the forest enters the atmosphere by the process of evapotranspiration. Water is vaporized by this process from the tree leaves. The humid tropics contribute 58 per cent of the earth’s total water vapour available.\(^{48}\)

The solution lies in (i) protecting key areas of forest—watersheds and unique lowland eco-systems, which, being on better soils, tend to be much richer; (ii) the efficient management of extensive buffer zones to these sanctuaries for sustained yields of the great variety of plant and animal products—many as yet undiscovered do that such forests have to offer; and (iii) the more efficient use of land already cleared of forest for agriculture or housing and industry with the development of agro forestry and reforestation projects where possible.

Why was the Brazilian government doing what it did? What were the compulsions or otherwise which led them towards penetrating into the threatened rainforest? Could it possibly be that the financial instability made the government look up towards the Amazon Rainforest as magic potion for the economic malaise? Since then, several measures have been adopted by the Brazilian government to boosts the economy of Amazonas and neighbour States. The rate of deforestation was alarming and it startled all the statesmen and forum within and outside Brazil. But the most

\(^{47}\) Fearnside, n.15, p. 13. The decline cannot be attributed to Brazil’s tough measures such as the helicopter surveillance, confiscation to chainsaws, and fining land owners caught burning without permission from Brazil’s Federal Environmental Control Agency (IBAMA).

forceful cause to explain the frenzy was the economic crisis. Indebted and cash-striped that Brazil was, it had no other option but to take recourse to use the resources of the Amazon Rainforest. The economic crisis, it’s making, the solutions that were prescribed and those that were adopted have been treated at length in the following chapter.