CHAPTER 4

PRESENT CONDITIONS OF THE FOREST AND DEGRADED AREAS

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4.1 Conditions of the Forest Areas

4.1.1 General Characterization of the Forests in Brazil

Brazil has a territory of 8,460 thousand km^2, where the forests occupy a total area of 5,510 thousand km^2 as of 1995 (FAO, 1999), representing 65% of the national territory. Furthermore, the Brazilian forests represent 67% of the forest areas of the South America tropical region. In 1990, Brazil had 5,640 thousand km^2 of forests, thus it can be said that there was a deforestation of 13 million hectares in the period 1990 to 1995, at a pace of 2.6 million of hectares a year. The proportion of deforested areas every year in Brazil is 0.5%, smaller than the average in other countries in the region (0.6%). However, the Brazilian deforestation represents 55% of the annual deforestation in the whole region considering the immensity of the total area.

From the Brazilian forests, half (52%) is composed by the humid tropical forest. Besides, there is also the deciduous foliage forest (35%) and the arid forest (5%) (FAO). The Brazilian tropical forest which major part is in the Amazon region has 3.5 millions km^2. This means that Brazil alone has 30% of all the world tropical forests (Mahar, 1989).

4.1.2 General Characterization of the Amazon Region Forests

The Amazônia Legal region, a political division defined considering the importance of implementing the development policy in the Amazon region encompasses all the extension of the 7 States of the North Region, including Tocantins, the Mato Grosso State in the Center-West Region, and the Maranhão State in the Northeast Region, with a total territory of approximately 5 millions km^2, i.e, 60% of the national territory. The population estimate in the region is of 19 millions inhabitants (IBGE), representing only a little more than 10% of the total population of Brazil, with a density of around 4 inhabitants per square kilometer. However, the population growth is recently going faster.

The Amazon region has forests basically classified as Terra Firme (upland) and 2 types of forests subject to floods that are the Várzea and the Igapó. The Terra Firme is subdivided into Dense Forest and Open Forest, and the first one constitutes the typical Tropical Forest of Amazon region.

On the other hand, in terms of vegetation, the Amazon region has great diversity of large scale bushy and arboreous species, classified into 4 types of vegetal coverage: 1) dense forest with high vegetal diversity (1,900 km^2, 38%); 2) open forest in which the vegetation of lianas and palm trees is found (1,800 km^2, 36%); 3) cerrados, which is characterized by herbaceous-bushy vegetation (700 km^2, 14%); and natural fields constituted by several species of gramineous (600 km^2, 12%: including altered areas. EMBRAPA, 1999).

It is estimated that the Amazon region contains at least half of all the living species in the planet. 60 thousand of vegetal species, 2.5 millions of arthropod species, 2 thousand species of fish and

more than 300 species of mammals were already identified (MMA/SCA, 1997). The Brazilian diversity is the highest among all the superior plants, fresh water fishes and mammals, the second in amphibian, the third in birds, and the fifth in reptiles (MMA/COBIO, 1998).

According to EMBRAPA, almost 88% of the soils in Amazon have low fertility, with only 12% of eutrophic soils appropriate for agriculture. Despite the low percentage, the fertile soils in the region sum up to approximately 50 millions of hectares (Santana *et al*. 1997).

4.1.3 Deforestation in the Amazon Region

Each year, an average of 50 millions m^3 of wood are extracted from the Brazilian Amazon. Data from the Brazilian Amazon Forest Monitoring Project by Satellite (PRODES) of INPE indicate, until 1997, a deforested area of 532 thousand km^2, the State of Pará outstanding.

4.1.4 Characteristics of the Deforestation

The deforestation in the Amazon region is characterized by the fact that the main causes are the utilization of forestry resources and their transformation into cultivation and pasture areas for the production of food. The economic and social factors such as the inequality in the distribution of land and income, the inadequate fiscal and credit system for the agricultural activities, the inadequate land ownership system, as well as the institutional fragility also contribute for the deforestation process.

4.2 Forests in the Study Area

4.2.1 Forest Vegetation

Pará State, that has a territory of 1,250 thousand km^2, representing 24% of the Amazon region, has 1,140 thousand km^2 of forest areas, which are composed of terra firme, areas subject to flood such as várzea and igapó, cerrados, natural fields and swampy areas.

The micro region of Marabá, according to the PROJETO RADAM survey (Phytoecological Map-1974), has the vegetation influenced by 4 (four) different phytoecological formations (Table 4.2-1).

Table 4.2-1 Forest Vegetation in the Study Area

Ecological Regions		Legend	Ecosystems	Municipalities	Samples of the Inventory
Cerrado Region	Subregion of the Tocantins Basin depression	Sc	Cerrado	Palestina do Pará	
Contact Strip	Contact area	Fal	Latifoliate Open Forest	Palestina do Pará	A-2 A-3
		Fam	Mixed Open Forest	Palestina do Pará and Brejo Grande do Araguaia	

Ecological Regions		Legend	Ecosystems	Municipalities	Samples of the Inventory
Region of Dense Forest	Subregion of the Araguaia dissected surface	Fdn	Sub-mountain Flat Forest	Brejo Grande do Araguaia, São João do Araguaia, São Domingos do Araguaia and Marabá	A-10
		Fal	Latifoliate Open Forest	Brejo Grande do Araguaia, São João do Araguaia, São Domingos do Araguaia and Marabá	
		Fam	Mixed Open Forest	Brejo Grande do Araguaia, São João do Araguaia, São Domingos do Araguaia and Marabá	
	Subregion of the razed surface of Serra dos Carajás (Carajás Mountain Range)	Fdn	Sub-mountain Flat Forest	Marabá	A-18
		Fdt	Sub-mountain Uneven Forest	Marabá	A-19
Region of Open Forest	Subregion of razed surface of the Medium Xingu/Iriri	Fdt	Sub-mountain Uneven Forest	Marabá	
		Fal	Latifoliate Open Forest	Marabá	
		Fam	Mixed Open Forest	Marabá	A-33
		Ap	Agriculture and Animal Husbandry	São Domingos do Araguaia and Marabá	

Source: DNPM, Projeto RADAM – Volume 4 – Pará 1974.

4.2.2 Forests of the Marabá Microregion

The distribution of the Marabá municipality areas that occupy ¾ of the whole territory of the Study Area is presented as follows.

Table 4.2-2 Distribution of Areas

Classification	Area (km^2)	Percentage (%)
Dense Forest of Terra Firme (upland)	10,468.05	69.06
Open Forest with Lianas	103.07	0.68
Urban Area	30.31	0.20
Internal Waters	100.05	0.66
Anthropogenic Areas including Secondary	4,456.42	29.40

Forest		
Total of Marabá Municipality	15,157.90	100.00

Source: CPRM, 1996

The forest area in the municipality of Marabá, with the predominance of Dense Forest of Terra Firme, occupies approximately 70% of the municipality total area. In the Serra dos Carajás, in the western region of Marabá municipality, there is the large National Forest of Carajás. Other natural forest areas do not have a significant size, being distributed only in the forest reservations along the water streams, mountain ranges and hills. Besides, these natural forest areas are surrounded by secondary forests affected by logging and fires.

4.3 Degradation Conditions

4.3.1 Definition of Degraded Areas

The definition of degraded areas, as well as the concept of recuperation, varies considerably. The degraded areas are basically classified into two types: 1) agricultural degradation, concerning to the loss of economic productivity in agricultural, animal husbandry and forestry terms; and 2) environmental degradation, concerning to the damages and losses of native species populations, animal or vegetal (degradation of biodiversity), or the loss of critical functions of the ecosystem, for instance, modifications in the stored carbon, quantity of transpired water, or retention of nutrients (degradation of the ecosystem).

4.3.2 Causes of Degradation

The main land uses that are causing agricultural and environmental degradation in the Amazon are as follows:

(1) Animal Husbandry Activity

The activity responsible for most of the agriculturally and environmentally degraded ecosystems in Amazon is the animal husbandry. Approximately ¾ of the current deforested land in Pará, were deforested for the implementation of pastures. Currently, 25 to 50% of the original pasture land in the Oriental Amazon are abandoned and/or degraded. The main factors that lead to the abandonment plows the follows: 1) it refuses of soil fertility; 2) competition of invading plant species (weeds); 3) exhaustion of pastures due to overgrazing and 4) lack of credit.

(2) Shifting Cultivation

The traditional agriculture carried out in the Amazon region is the shifting cultivation system. This practice of slash-and-burn is intercalated with fallow periods, thus the existing nutrients in the biomass have to be utilized. Soon after the slash-and-burn, the cultivation of annual crops is carried out. After their use, the areas are abandoned, when the secondary system of vegetal succession starts. Although the secondary forest can perform an important role in ecological terms, this manner of agriculture is one of the main causes of the agricultural degradation from the view point of the agricultural production.

(3) Extraction of Wood

The extraction of wood affects, each year, a vast area of the primary forest, although these effects are difficult to detect because they do not result in the complete removal of the forest canopy. The intensive extraction of wood as carried out near Paragominas can result in the removal of 50% of the canopy, in long term modifications in the evapotranspiration and precipitation reductions during the rainy season, and in the increase of favorable conditions to fires. Fortunately, the forests regeneration rapidly takes place after the extraction of wood, unless the fire spreads out in these forests.

(4) Other Land Use

The industrial mining and the extraction of non wooden forest resources are other manners of land use that influence the Amazon ecosystem. The mining industry is exploited in a smaller scale (around 10,000 ha), and the environmental extraction can be benign, taking into consideration the total preserved area (Carajás). Besides this, the submersion and removal of forests for the construction of dams' reservoirs and roads also affect the ecosystem.

4.3.3 Vegetal Succession

The vegetal succession starts with native species when the areas utilized for agriculture and/or animal husbandry activities are abandoned for some years. The causing factors of the abandonment of land used for production are many times the drop in productivity due to the occurrence of diseases and pests, and the soils deterioration due to the frequent use of fires. The high cost of control of invading plants of native species also contributes for the land abandonment. These situations motivating the land abandonment are consequences of the degradation process classified as agricultural degradation. The secondary system of vegetal succession starts in these abandoned areas.

The vegetal succession, regarding to secondary vegetation in the Amazon region, presents a progress according to the following phases.[1]

(1) First Phase

In this initial phase, the vegetal succession starts through the colonization by very primitive pioneer families, as the case of Pteridophyte, such as samambaia, and of Graminae, such as capim sapé (*Imperata brasiliensis*), that practically restart the formation process of the soil organic horizon. The species of this phase reach almost 2 meters of height. During this phase, families such as Leguminosae and Verbenaceae among others start to appear.

(2) Second Phase

This phase that does not necessarily have to go through the first phase, most of the times, since depends on the conditions in which the land was abandoned after the agricultural cultivation, is popularly known as juquira. This phase presents Leguminosae of the genus Cassia such as mata-pasto, and Solanaceae of the genus Solanum such as jurubeba and/or lobeira, and other species of herbaceous bushes and liana small bushes. Then, depending on the soil degradation

[1] The document found in IBGE, 1992, Technical Manual of Brazilian Vegetation was complemented and modified in order to reflect the results of field survey.

rate, there is the dominance of liana plants such as Compositae of the genus Baccharis such as assa-peixe, and Melastomataceae of the genus Miconia such as quaresmeia, this last one observed in the more steep topography of the region. The species of this phase reach around 3 meters of height.

(3) Third Phase

This phase presents a more developed vegetation, with little occurrence of herbaceous and with the occurrence of several wooden and/or subwooden species. This phase is denominated as "capoeira rala" by Veloso (1945). This phase presents a land coverage with medium scale plants that reach around 5 meters of height, with large spacing among them. As indicators of this phase with can mention the imbaúba (*Cecropia sp.*). Depending on the regeneration conditions, we can observe the ingá (*Inga sp.*), paricá (*Schizolobium amazonicum*), lacre (*Vismia sp.*), among others, as trees of the young phase of pioneer species.

(4) Fourth Phase

This phase was called by Veloso (1945) as "actual capoeira". The vegetation of this phase is very complex and reaches 5 to 10 meters of height. Among the species we can mention imbaúba (*Cecropia sp.*) as an indicator plant of this phase. We observe the fast growth of some pioneer arboreous species of Leguminosae such as ingá (*Inga sp.*), faveira (*Parkia sp.*) and paricá (*Schizolobium amazonicum*), and of other families such as the quaruba (*Vochysia sp.*), pará-pará (*Jacaranda copaia*) and lacre (*Vismia sp.*), among others. We also observe in this phase the intense reduction of some herbaceous plants.

(5) Fifth Phase

This phase is dominated by trees over 10 meters high. This is a predominantly wooden phase, without emerging plants, but very uniform as for the height of dominant elements. In this phase we can also find species of Leguminosae, Vochysiaceae and or Bignoniaceae, also present in the fourth phase. Some species of the families Lecythidaceae such as castanha-de-macaco (*Cariniana sp.*), Annonaceae such as envira-branca (*Xylopia sp.*) and Euphorbiaceae such as seringueira/rubber tree (*Hevea sp.*), among others also occur. In this phase, there are fewer imbaúbas (*Cecropia sp.*). This is a community called as "capoeirão" according to Veloso (1945).

(6) Sixth Phase onwards

This phase represents the secondary forest, with tree heights around 25 m in consequence of "capoeirão" succession after a considerable period of time and under certain conditions. In this phase, it presents a fixed form of vegetation composed by large scale arboreous species with uniformed heights, without allowing the invasion of small scale herbaceous. Through the succession progress, this phase will lead to the formation of a new forest with height over 30 meters, reaching the maximum succession.

Table 4.3-1 Characteristics of Succession in Each Phase

Phase	Elapsed Time	Vegetation Height	Characteristics
First Phase	3 months to 2 years	Up to 2 m	Presence of Gramineous herbaceous, Samambaias, etc.
Second Phase (juquira)	6 months to 5 years	Around 3 m	Leguminosae as of the genus Cassia, Solanaceae as of the genus Solanum.
Third Phase (thin Capoeira)	1 to 10 years	Around 5 m	Presence of the genus Cecropia, Ingá, Schizolobium, Vismia etc.
Fourth Phase (Capoeira)	2 to 20 years	5 to 10 m	Presence of the genus Cecropia, Ingá, Pariká, Vochysia, Jacarandá, etc.
Fifth Phase (Capoeirão)	10 to 80 years	10 to 20 m	Presence of the genus Cariniana, Xylopia, Hevea, etc.
Sixth Phase (Secondary Phase)	40 to 150 years	20 to 30 m	Transitory phase for the new forest
Seventh Phase (New Forest)	60 to 300 years	30 to 45 m	Climax of the new forest.

The agricultural cultivation areas or abandoned pastures present a progress according to the vegetal succession above described, evolving from juquira to capoeira and capoeirão, finally attaining the natural forest recuperation.

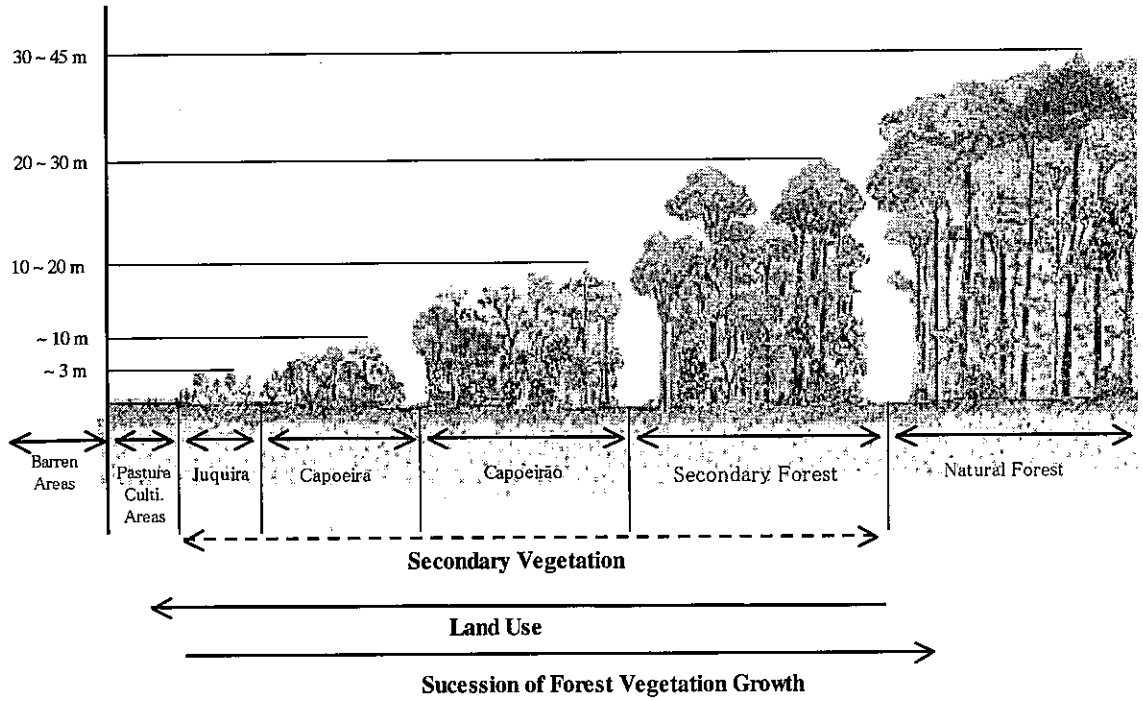

Fig. 4.3-1 Degraded Areas and the Vegetation Succession Process

4.3.4 Degradation of Pasture

(1) Pasture in the Study Area

The deteriorated and/or degrades pastures in the Study Area found mainly in small producers properties, that realizes the cattle breading. More that 70% of those properties are dominated by

hard leves and stalk when adult, and present an accentuated taste declination. This tendency appears mainly in the municipalities of São João do Araguaia, Brejo Grande do Araguaia and São Domingos do Araguaia.

The most utilized pasture species by the small producers are Braquiária (*Brachiaria decumbens*) and Quicuio-da-amazônia (*Brachiaria humidicola*) that have being traditionally utilized. Those species become weak during the dry season, depreciating the land with pasture. In this circumstances, the fire is the most common practice as an easy way to control the weeds.

On the other hand, large and medium farmers have being substituting the traditional pastures by new ones that are resistant to the drought and have good production, as the Tanzânia and Mombaça, that stay green even in the dry season and guarantee the pasture utilization. The pasture of the producers of this class also are invaded by babaçu and shrubs, but they periodically applies herbicides and removes the weeds manually. Moreover, the large producers that own large properties tend to abandon the pastures invaded by babaçu and shrubs to maintain those areas as conservation areas.

(2) Pasture Degradation Mechanism

It can be deduced that the pasture degradation can be caused by the following reasons and actions:

a. Investment Lack

The improvement or cultivation of pasture needs new investments. Most of the small producers in the Study Area have minimum direct investment on the pasture because they don't have immediate income and need long time for the return. So, major part of the small producers utilizes pasture seeds with low quality and cheap, that are mixed with weeds and present low germination rate. As a result, those pastures are infected by weeds, contributing to accelerate the degradation.

Expensive seeds with high quality can reduce the amount necessary per hectare, that results in economy. By the way, this fact is not comprehended by the small producers.

Table 4.3-2 Standard and Prices of Pasture Utilized in the Study Area (Case of Quicuio da Amazônia)

Standard	Price	Quantity by ha	Rate of Mixing with Weeds	Unit Price by ha
VC-40	2.3 R$/kg	12 kg/ha	Baixa	276 R$
VC-32	1.8 R$/kg	20 kg/ha	Média	360 R$
VC-24	1.5 R$/kg	25 kg/ha	Alta	375 R$

Obs. : VC=Cultural Value, that is a coefficient in function with the cultivation value, germination rate and mixing with weeds. The more the number, the less the mixing rate with weeds improving the quality of the germination rate.

b. Lack of Initial Control of Weeds

The improved pasture and forage cultivation demand an appropriate management, that is not being realized by the small producers in general due to the lack of techniques. Weeds are relatively easy to be controlled in the initial stage. But major part of the small scale producers

do not control them because they don't have conscience of the importance of such control.

c. Insufficient Technical Assistance

Even if the small scale producers wanted to improve the pasture and cultivate forage, there is a lack in knowledge and cultivation technology, that make impossible the selection of appropriated species and the management of the pasture after the sowing. Moreover, major part of the small producers comes from the northeast part of the country, with low experience in agricultural and livestock activities. In this circumstance, the technical assistance is indispensable referring to the improvement of pasture and forage cultivation. But, this assistance and the rural extension are insufficient for the small scale producers. Also, it can be observed a lack in pasture knowledge between the technicians of the government organization.

d. Fire without Control

The small producers always put fire without control in the last half period of the dry season to eliminate weeds. On the other side, this traditional practice contributes to renovate the weeds and shrubs, specially the babaçu. Fires are in a sense, useful and easy as a method to control weeds, but causes the declination of the soil's fertility and facilitates the renovation of weeds resistant to the fire, contributing consequently to a accelerated degradation.

e. Deterioration of Pasture caused by Continuous Grazing

Many small producers realizes the continuous grazing, where the cattle stays in the same pasture for a long time. In this practice, the pasture never rests to recover its productivity, becoming impossible to increase the efficiency continuing the pasture degradation.

f. Unrealized Reform of Pasture

The continuous grazing by a long period causes a productivity decay of the pasture and induces the weeds infestation once the pasture becomes less competitive. The cattle do not eat this weeds, eating only the remaining pasture, resulting in the increase of the weeds and decrease of the pasture. Moreover, the incidence of damages on the pasture roots increases because they are trampled by the cattle due to the over grazing. The pasture renewal is possible by the weeds elimination, plowing and reimplantation of the pasture, but the small producers do not have conditions to reform the pasture due to the lack in equipment and financial resources.

g. Succession of Forest Vegetation

All phases mentioned before are multi-related in the pasture degradation process. The repeated phases initiate the vegetal succession of Juquira and Capoeira from the second and third year of the pasture implantation. But the pasture can be utilized for more time, above 7 to 8 years, in case of large and medium producers because they utilize seed with better quality that have less rate of weeds mixed in it, realizing an appropriate management of the pasture.

4.4 Description of Degraded Areas

4.4.1 Degraded Areas Object of the Study

The degraded areas are interpreted, for this Study, as the land that suffers the negative consequences of anthropogenic interventions on the structure and functioning of an ecosystem (or part of it), i.e., losses of soils productive capacity (biomass productivity) and of biodiversity (fauna and flora), and of environmental functions. The degradation has a quantitative aspect in the loss of soils productivity and a qualitative aspect in the loss of biodiversity and of environmental functions which transcend the affected areas, such as impacts on the hydrological cycles, accumulation of sand on rivers, local and regional climate. Furthermore, the degradation also results in economic losses such as the reduction of forest products possible to be extracted and the loss of crops and pastures productivity. At last, the Degraded Areas are interpreted as the land that suffers drop in its productive capacity.

4.4.2 Classification of Degraded Areas

The abandoned areas basically present all the vegetal succession process, from the first to the seventh phase, since they are not affected by strange factors. In the vegetation phases from the first to the third phase, it is difficult to visually identify if the area is already going through an agricultural degradation process or if it is at the start and/or middle of the fallow period. If the referred area is in a programmed fallow for future use, the area can not be considered as a degraded area.

However, among the abandoned areas in the Amazon region, very little are in this stage of programmed control, based on a planed agricultural exploitation. As a matter of fact, several areas are inevitably abandoned due to economic and/or technical reasons. In this case, the area can be considered degraded, since it is not being utilized for an agricultural enterprise, despite not being abandoned. In these areas, the ecosystem tends to be unbalanced, being potentially abandoned areas.

According to the analysis results about the appearance of degraded areas confirmed in the vegetal succession process, the degraded areas are classified into 4 types: juquira, capoeira, capoeirão and bare land.

(1) Type 1: Juquira

This vegetation occurs generally in cultivation or pasture areas utilized for some years after preparation through the use of fire. In case the land is abandoned after few years of use with cultivation, the succession process for the next phase (capoeira) takes place quite rapidly. In the specific case of pasture, in which the soil becomes weak after several years of use, the tendency of this vegetation in staying static for longer time is observed.

(2) Type 2: Capoeira

Capoeira is the type of degraded area resulting from the succession of juquira, being classified as thin capoeira and actual capoeira. In thin capoeira, new trees of the genus imbaúba are predominant, while in the actual capoeira, the pioneer species of ingá and others are predominant.

Capoeira presents different characteristics between the eastern and western regions of the Study Area. In the eastern portion of the municipality of Marabá, and in the other 4 municipalities, areas with a long anthropogenic influence, there is a slight dominance of babaçu palm trees in the capoeira phase. On the other hand, in the western portion of Marabá municipality, where the native forest area is larger, the occurrence of useful and pioneer species in the secondary succession such as paricá (*Schizolobium sp.)* and others, including young trees is higher. Besides, there is a reduction of the babaçu palm trees presence. The presence of imbaúba (*Cecropia sp.*), a typically pioneer species, is also observed in large amounts. In this phase, there is also a reduction in the herbaceous species.

(3) Type 3: Capoeirão

This vegetation is typical in degraded areas after the capoeira succession process, being a more compact vegetation phase. Most of the capoeirão found in the Study Area has less than 30 meters. The following vegetation were registered: 1) Vegetation composed by arboreous species such as castanha-de-macaco (*Cariniana sp.*) of Lecythidaceae and/or envira-branca (*Xilopia sp.*); 2) Vegetation mainly composed by the babaçu palm tree and/or inajá (*Maximiliana inaja*); and 3) Vegetation composed of arboreous species such as paricá, palm trees, etc., which proportions among different species vary. This phase is formed of a fixed form of vegetation with uniformed heights around 18 meters. The presence of herbaceous is strongly reduced.

(4) Type 4: Barren Areas

Barren areas are mainly found in mining areas. In the Study Area, there was mining of gold and diamond, and experimental extraction of lime, both in small scale. Therefore, this type of degraded area is not considered to appear in a significant amount.

4.5 Distribution of Degraded Areas and their Transition along the Time

4.5.1 Distribution of Degraded Areas

According to data obtained from the executing agency, the micro region of Marabá has a total area of 19,971 km^2. The area calculated upon the satellite images analysis is of 19,933 km^2, being 38 km^2 smaller than the existing data, i.e., with a difference of approximately 0,2%. The possible cause of this difference is the determination of municipal limits formed by rivers. However, this difference is considered within the tolerance limits. The distribution of areas classified into 12 types according to the land use is presented as follows.

Table 4.5-1 Areas according to the Satellite Images Analysis, as of 2000 (in km^2)

Classification / Municipality	Marabá	São João do Araguaia	São Domingos do Araguaia	Brejo Grande do Araguaia	Palestina do Pará	Total
River / Lake	144	112	0	16	41	313
Natural Forest	5,489	133	404	176	348	6,551
Exploited Forest	1,435	47	151	37	68	1,738
Capoeirão	806	21	102	28	42	1,000

Classification / Municipality	Marabá	São João do Araguaia	São Domingos do Araguaia	Brejo Grande do Araguaia	Palestina do Pará	Total
Capoeira	505	11	50	15	23	604
Babaçuzal	382	640	64	343	50	1,478
Juquira	196	7	35	22	29	290
Crops / Pastures Areas	3,388	289	590	519	403	5,189
Bare Areas	0	0	0	0	0	0
Sand Accumulation	2	2	0	0	2	6
Urban Area	38	2	3	1	1	44
Reservations	2,720	0	0	0	0	2,720
Total (a)	15,105	1,265	1,400	1,156	1,008	19,933
Source (b)	15,158	1,275	1,365	1,185	988	19,971
(a) / (b)	1.00	0.99	1.03	0.98	1.02	1.00

In the municipal district of Marabá, which occupies approximately 76% of the Study Area, forests represent 64% (including 18% of reservations), degraded areas 13%, and cultivation areas and pastures 23%. The western portion of the municipality is occupied by natural reservations, and most of the degraded areas are concentrated along the Carajás railway and the State road PA-150. In particular, along the PA-150, babaçu palm trees and capoeirão are distributed with relatively large areas. Besides, the degraded areas are spread out mainly on the region between the railway and federal road. Also along the State road that extends from east to west, bordering to the north of the western portion of the Study Area, some recent degraded areas are observed.

Among the 4 municipalities located at the east of the Marabá municipality, the municipality of São João do Araguaia has only 17% of forest areas, and approximately 54% are occupied by degraded areas. In particular, in the area between the Araguaia river and the federal road BR-230, which connects the urban areas of Marabá and Estreito, located by the federal road BR-10, the degraded areas are scattered in the shape of fish spine along the north-south road. This region is dominated mainly by babaçu, which allows to infer the development pressure occurred in the past. The pasture areas occupy 23% of the total municipal territory.

The municipality of Brejo Grande do Araguaia present similar situations to the municipality of São João do Araguaia. In the area between the Araguaia river and the federal road BR 230, at the northern portion, degraded areas dominated by babaçu area spread out, occupying approximately 35% of the municipality total area. The proportion of pastures is higher, being of approximately 45%, showing the historical exploitation of animal husbandry. The forests represent only approximately 18%.

The municipalities of São Domingos do Araguaia and of Palestina do Pará present a similar tendency, where the forest areas represent 40% and 41% respectively, occupying almost half of the total area of each respective municipality. The cultivation areas and pastures occupy 42% and 40% respectively, representing more than 80% together with forests. The degraded areas represent 18% and 14% respectively, being spread out in the surroundings of pastures and at the border with forests.

In a general view, at the center-southern portion of the municipality of Marabá, in most of the São João do Araguaia municipality and at the northern portion of the municipality of Brejo Grande do Araguaia, the large scale degraded areas are spread out. The total area of the

degraded areas found in these 3 municipalities is of 2,976 km^2 (14.9% of these municipalities' total area), and this is larger than the total area of any of the 4 municipalities, except Marabá.

4.5.2 Transition of Degraded Areas Along the Time

Table 4.5-2 shows the size of degraded, forest, agricultural cultivation and pasture areas identified through the analysis of satellite images obtained in 3 different periods. The distribution of degraded areas, elaborated upon the analysis of satellite images, is shown in Figures 4.5-2 a 4.5-4. In order to facilitate the lecture of degraded areas transition, juquira, capoeira and capoeirão were illustrated in orange.

Observing the transition in the 4 periods, we can observe the transformation of forest areas into degraded areas or cultivation or pasture areas. The degraded areas increased approximately 1,300 km^2 in 14 years between 1986 and 2000, recording an increase of approximately 1,000 km^2 in 6 years between 1986 and 1992. On the other hand, the cultivation and pasture areas also increased 2,700 km^2 in 14 years between 1986 and 2000, recording an expressive expansion of approximately 1,500 km^2 in 6 years between 1992 and 1998.

The municipality of Marabá has the higher proportion of forest areas. Observing its transition in the 4 periods, the forest areas at the eastern portion of the municipality were transformed into degraded areas, with a tendency of degraded areas progress to the west. However, the extension of these areas are varying considerably each year, and the babaçu areas increased more than 100 km^2 in the two periods from 1986 to 1992, and from 1992 to 1998. On the other hand, the natural forests deforestation reached 2,400 km^2 in 14 years. The agricultural cultivation and pastures areas also presented an expansion tendency, recording an increase of approximately 1,980 km^2 in 14 years.

In the municipality of São João do Araguaia, the degraded areas are increasing while the forest areas are diminishing. It is specially remarkable the expansion of babaçu palm trees areas, with an increase of 570 km^2 in 14 years, from 1986 to 1998, even representing more than 94% of the degraded areas in 2000. The degraded areas are mainly concentrated along the federal road, with a tendency of spreading out at each year. On the other hand, the agricultural cultivation and pastures areas have not changed so much in the 4 periods.

The conditions in the municipalities of São Domingos do Araguaia and Palestina do Pará is characterized by the expansion of agricultural cultivation and pastures areas. In 1986 and 1992, a large increase was not observed. However, in 1998, in both municipalities, an increase of approximately 200 km^2 was observed, this expansion tendency also persisting in 2000. The degraded areas, including babaçu palm trees areas, did not present a significant difference during the 4 periods. The agricultural cultivation and pastures areas present an expansion tendency along the federal road.

In the municipality of Brejo Grande do Araguaia, there is an accentuated deforestation and the degraded areas are expanding, and from 1998 on most of it was dominated by babaçu. As for the agricultural cultivation and pastures areas, there was no significant transformation between 1986 and 1992, although the expansion was of approximately 160 km^2 in 1998. A tendency of gradual expansion of degraded areas of agricultural cultivation and of pastures can be observed along the main federal roads.

Table 4.5-2 Transition of Degraded Areas (km^2)

Classification	Marabá	São João do Araguaia	São Domingos do Araguaia	Brejo Grande do Araguaia	Palestina do Pará
in 1986					
Degraded Areas	1,174	178	213	321	162
Forest Areas	12,402	734	875	480	603
Crops / Pastures	1,404	249	311	341	204
Total	14,980	1,161	1,399	1,142	969
in 1992					
Degraded Areas	1,907	225	306	348	296
Forest Areas	10,915	720	802	452	448
Crops / Pastures	2,139	211	291	340	224
Total	14,961	1,156	1,399	1,140	968
in 1998					
Degraded Areas	1,731	675	258	408	133
Forest Areas	10,277	212	605	235	441
Crops / Pastures	2,968	267	535	497	399
Total	14,976	1,154	1,398	1,140	973
In 2000					
Degraded Areas	1,889	679	251	408	144
Forest Areas	9,644	180	555	213	416
Crops / Pastures	3,388	289	590	519	403
Total	14,921	1,148	1,396	1,140	963

Figure 4.5-5 shows the areas transformed between 1986 and 1992 through the overlapping of the 1986 image over the 1992 image. The forest areas without transformation in 1986 and also in 1992 are shown in green. If some transformation is observed, this is shown in another color, according to the land use identified in 1992. The orange color indicates the transformation of forest areas into degraded areas including capoeirão, capoeira, babaçuzal and juquira. The parts in black were not submitted to comparative evaluation since these areas were not forests anymore in 1986.

In the municipality of Marabá, the forest areas were reduced to approximately 88%. The transformation of forest areas into degraded areas along the time was of 162%, while the transformation into agricultural cultivation areas and pastures was of 152%. Particularly in the eastern portion of the municipality, along the Carajás railway and where the railway meets the federal road, there was a remarkable transformation into cultivation areas and pastures.

In the municipality of Palestina do Pará, the forest areas were reduced to approximately 74%. The transformation of forest areas into degraded ones was of 183%, while the transformation into cultivation areas and pastures was of 109%. These transformations are concentrated along the State road PA-459.

The other 3 municipalities present a similar tendency. In the municipalities of São Domingos do Araguaia, São João do Araguaia and Brejo Grande do Araguaia, a significant transformation of forest areas into other land use was not observed. This transformation took place only in less than 10% of the area, and the transformed areas are spread out, with no outstanding large area degraded area.

Figure 4.5-6 shows the areas transformed between 1992 and 1998, confirmed through the overlapping of the 1992 image over the 1998 image. The forest areas without transformation in 1992 and also in 1998 are shown in green. If some transformation is observed, this is shown in another color, according to the land use identified in 1998.

In the municipality of Marabá, the reduction of forest areas is observed both in the eastern and western portions, reaching 94%. The transformation into agricultural cultivation areas and pastures is also observed in both eastern and western portions, with an increase of approximately 830 km^2. The cultivation and pastures areas at the eastern portion are spread out along the federal road. The degraded areas are distributed mainly on the eastern portion. Those degraded areas observed in 1992 on the central portion of the municipality were reduced, contributing for the total reduction of 180 km^2 of degraded areas in the whole territory of Marabá municipality.

In the municipalities of São João do Araguaia and Brejo Grande do Araguaia, the increase of degraded areas, which are dominated by babaçu palm trees, is observed. In São João do Araguaia, these areas are distributed in the whole municipality territory with a total area of approximately 560 km^2. In Brejo Grande do Araguaia, the degraded areas are concentrated at the northern portion of the municipality with a total area of approximately 220 km^2.

In the municipality of São Domingos do Araguaia, the forest areas gave place to agricultural cultivation and pastures areas in a total area of 240 km^2. This transformation is remarkable mainly along the federal road BR-153. However, no significant increase of degraded areas was observed.

In the municipality of Palestina do Pará, the agricultural cultivation and pastures areas increased in 180 km^2. Similar to the municipality of São Domingos do Araguaia, this expansion is remarkable along the federal road BR-459. Considering the fact that the degraded areas were reduced in 160 km^2 and that an insignificant reduction of forest areas is observed, we can infer that the degraded areas were mainly transformed into cultivation and pastures areas.

Figure 4.5-7 shows the areas transformed between 1998 and 2000, identified through the overlapping of the 1998 image over the 2000 image. The forests areas in 1998 without changes in 200 are shown in green. If some change is observed, then this is shown in another color, according to the land use identified in 2000.

In these 2 years, no large-scale activity of complete logging was confirmed, although smaller deforested areas were found in the moth-eaten pattern. This tendency is particularly identified in forest areas with the form of an island. In larger extension forest areas, the forest opening is taking place in the form of fish spine.

In the municipality of Marabá, the forest areas were reduced in approximately 94%. The transformation of forest areas into agricultural cultivation areas and pastures increase approximately 14%, while the degraded areas increased 9%. The deforestation of forest areas is characterized by the expansion to the west, along the municipal limits at the northern and south portions. On the other hand, along the municipal limits at the northern and southern portions, and at the historically developed eastern portion, the increase of roads is remarkable.

The reduction of forest areas in the municipality of São João do Araguaia was of 15%, representing the strongest reduction tendency in the Study Area. The areas dominated by

babaçu still occupy large areas at the eastern portion, without showing any change in their extension. On the other hand, the remaining forest areas in the municipality of São João do Araguaia, and at the western portion of São Domingos do Araguaia, are suffering the expansion of deforestation in the form of fish spine what leads to the forecast in which these forest areas shall disappear in the following years.

In the 3 municipalities of São Domingos do Araguaia, Brejo Grande do Araguaia and Palestina do Pará, the areas transformation present some similarities, tending to a small increase of degraded areas and agricultural cultivation and pasture areas. The forest areas were reduced almost 10% in 2 years.

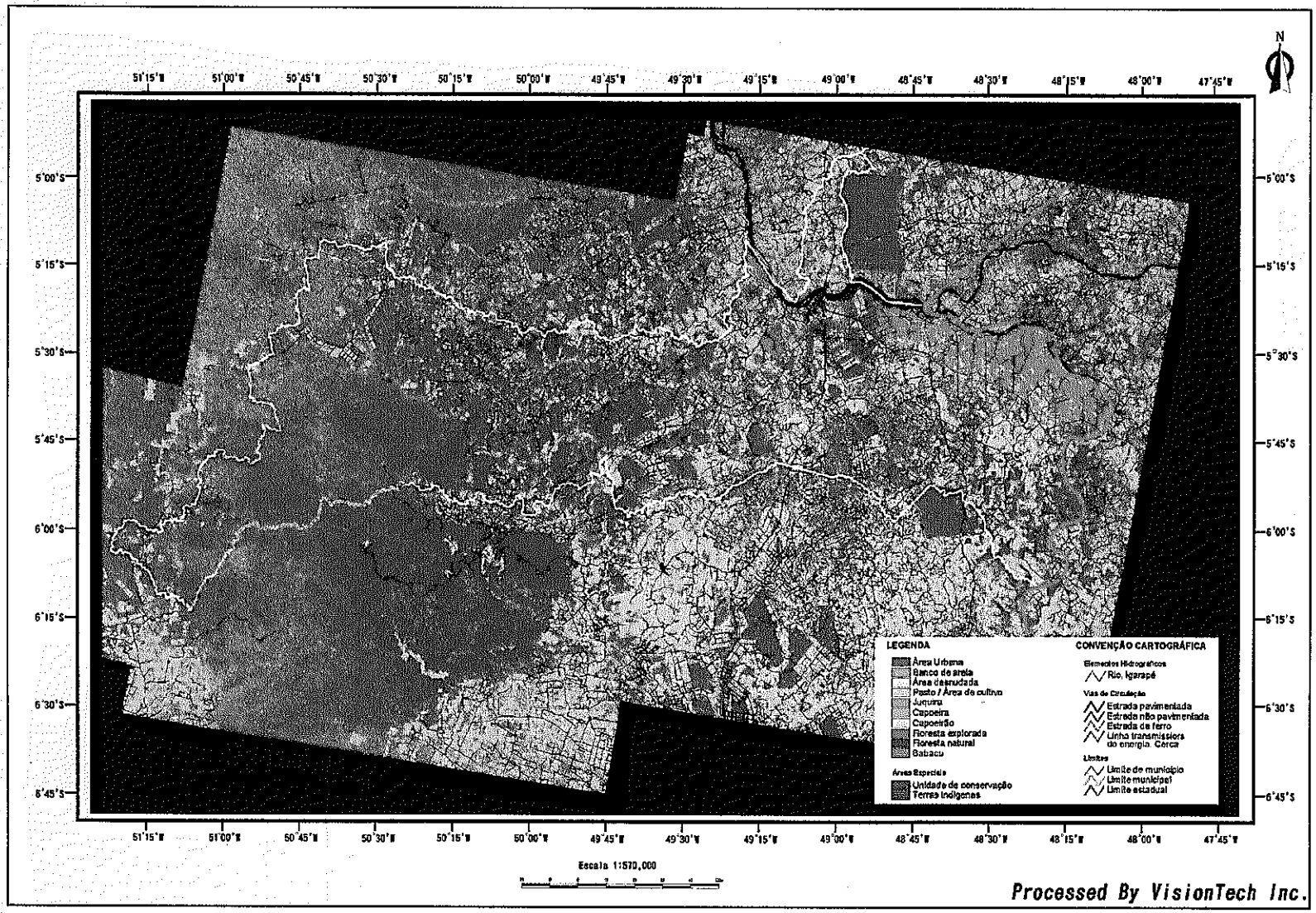

Fig. 4.5-1 Map of Existing Conditions of the Degraded Areas (2000)

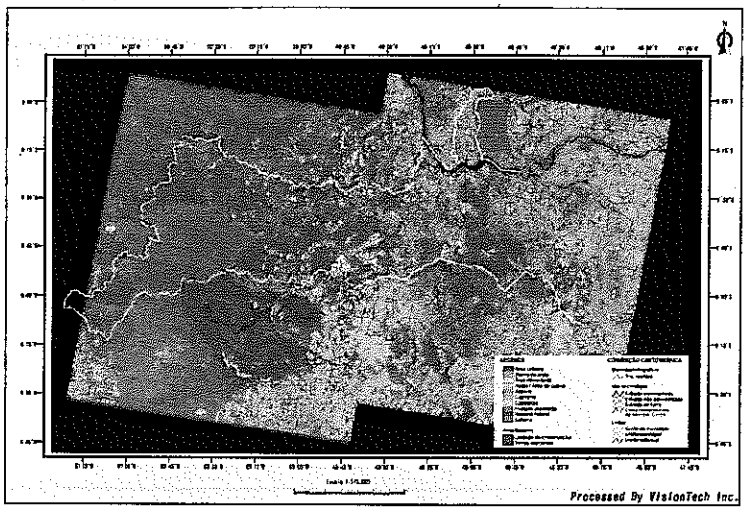

Fig. 4.5-2 Map of Existing Conditions of the Degraded Areas (1986)

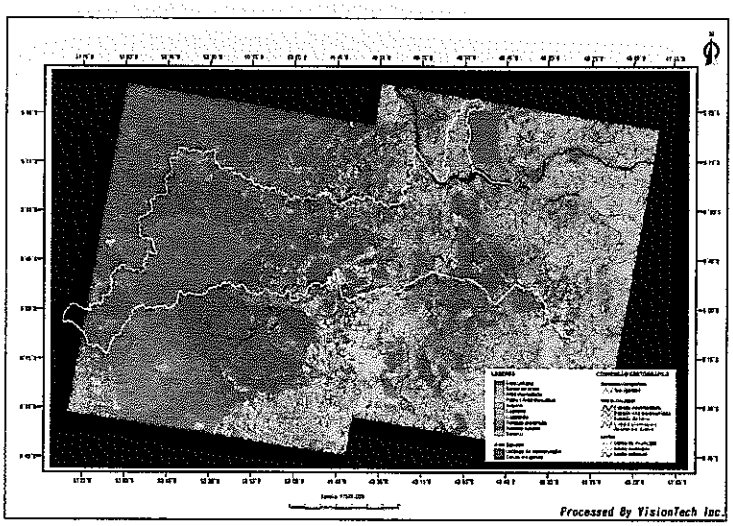

Fig. 4.5-3 Map of Existing Conditions of the Degraded Areas (1992)

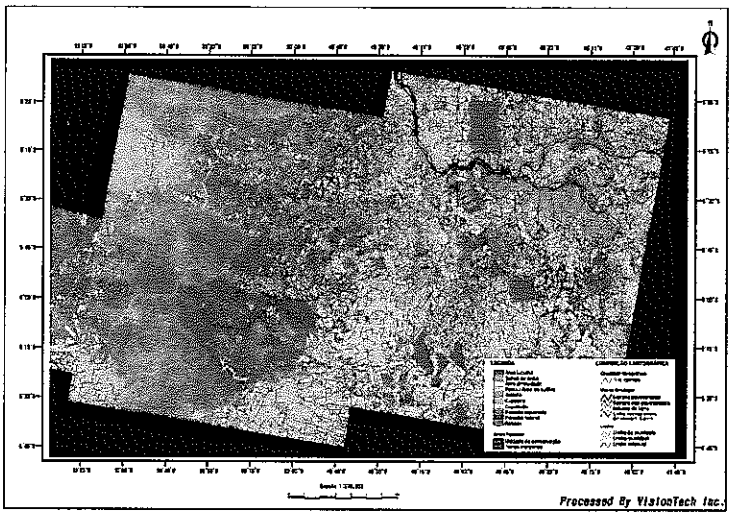

Fig. 4.5-4 Map of Existing Conditions of the Degraded Areas (1998)

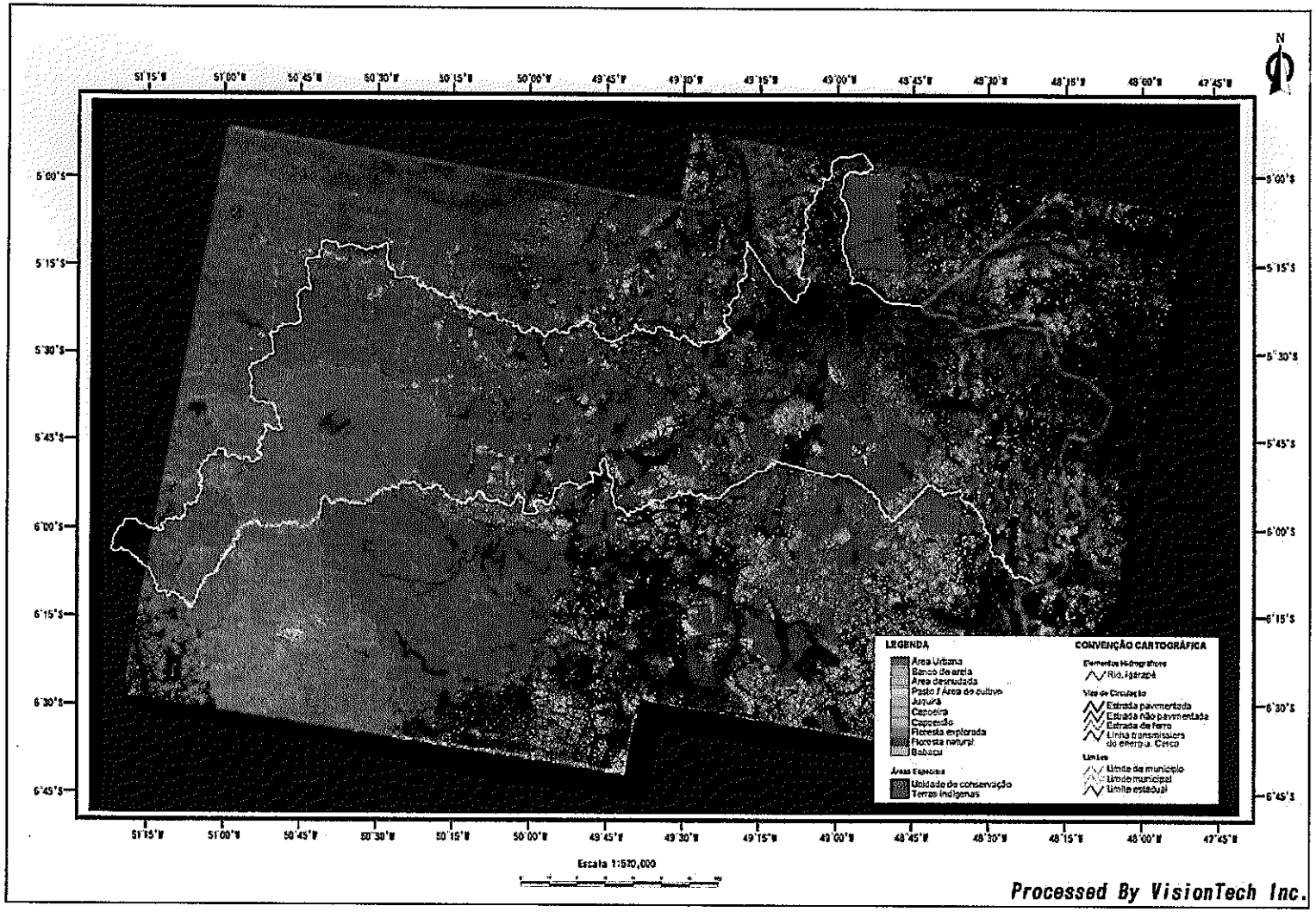

Fig. 4.5-5 Difference between the Images of 1986 and 1992

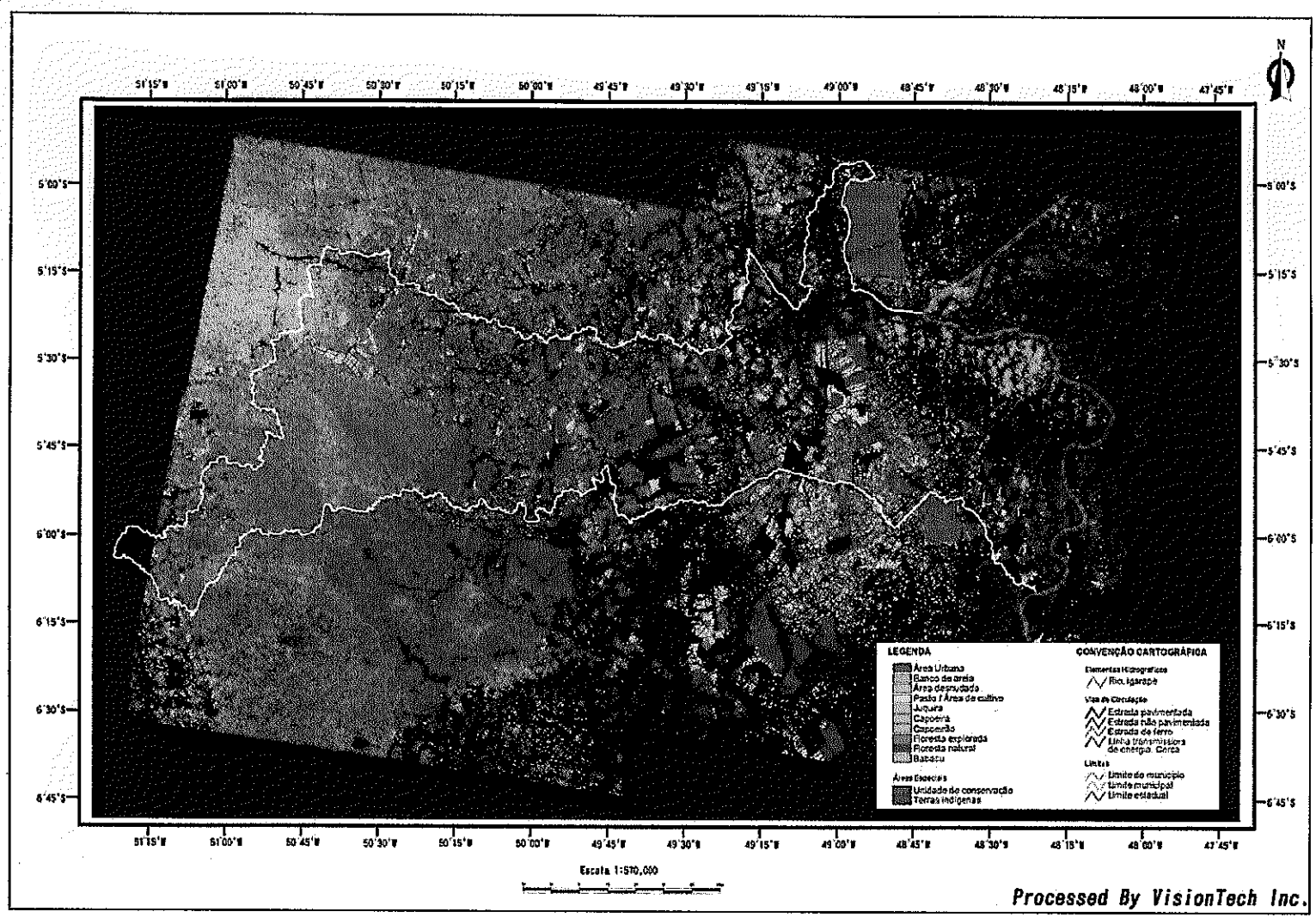

Fig. 4.5-6 Difference between the Images of 1992 and 1998

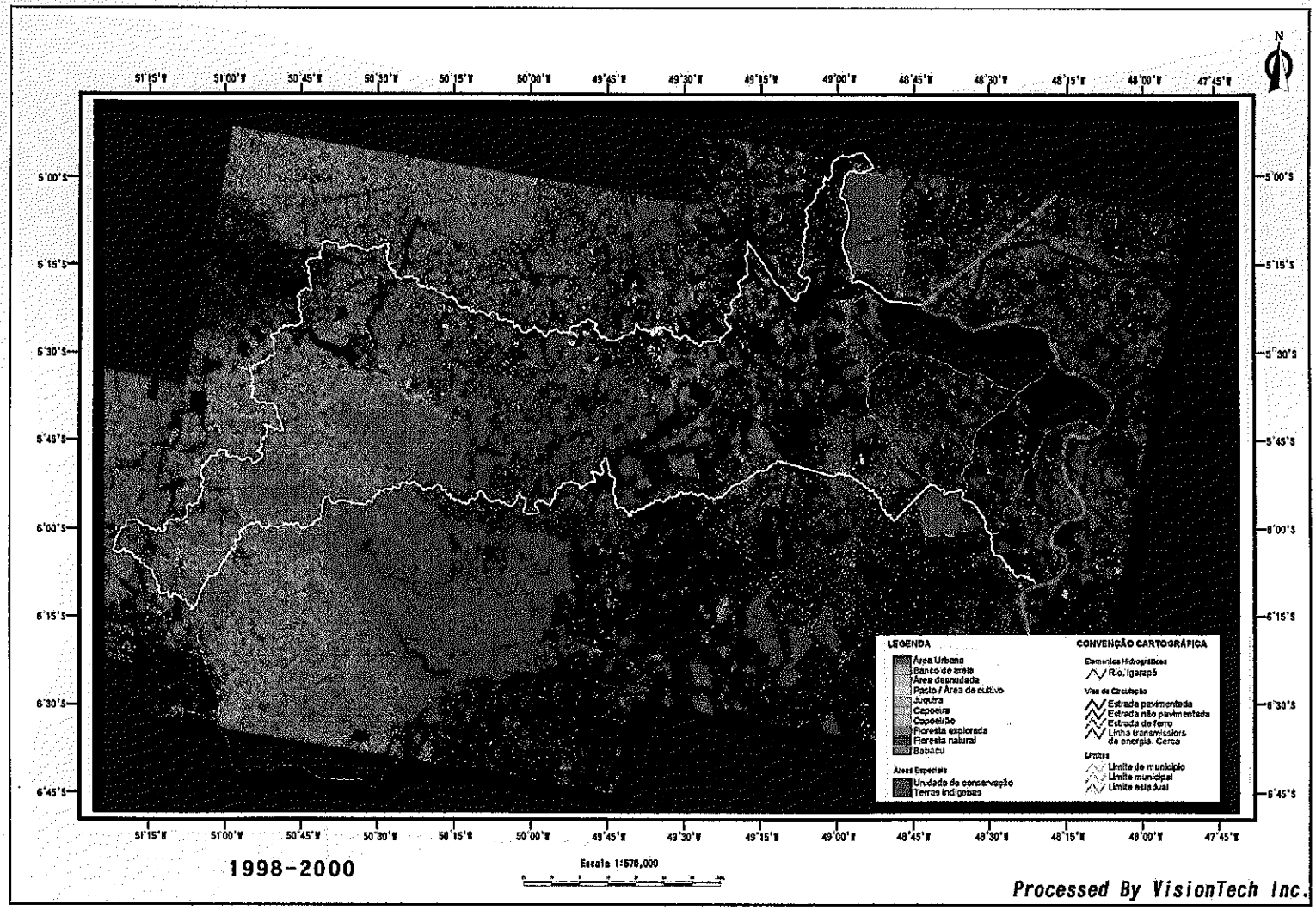

Fig. 4.5-7 Difference between the Images of 1998 and 2000