Chapter 2 – PRELIMINARY ENVIRONMENTAL DIAGNOSIS OF THE MUNICIPALITIES OF ARAGUATINS AND ARAGUAÍNA

2.1. Description of the Physical Environment

2.1.1. Methodology

The reports set out in this document are drawn from thorough bibliographic research on the various themes addressed, focussed particularly on published reports of work carried out in the region under study. This preliminary stage informed the planning of the locations from which soil samples were taken for subsequent laboratory analysis.

The scarcity of research undertaken in the region should be noted here, as well as the difficulty in obtaining information and/or material in respect of the themes addressed in this study.

The contribution of the PCI consultancy which made available data and information as noted in the in-text references is evident. Analyses and interpretations of this data were also used in the study's cartographic revisions.

2.1.2. Climate

Because of the insufficient climatic information available on the municipalities being studied, data from the region's nearest Meteorological Stations, namely Marabá (PA), Conceição do Araguaia (PA), Imperatriz (MA) and Carolina (MA), were used. This data covered the period 1961 - 1990. Data from the Principal Climatological Station in Araguaína covering the period 1988 – 2000 and from the Rainfall Measurement Post in Araguatins covering the period 1996 – 1998 were also utilised.

➢ **Araguatins**

The climate of the region in which Araguatins is located can be characterised, according to the Thornthwaite method which is used as the basis for Ecological Economic Zoning (Seplan, 1999), as humid subhumid with a slight water deficit (C2rA'a').

(a) Rainfall

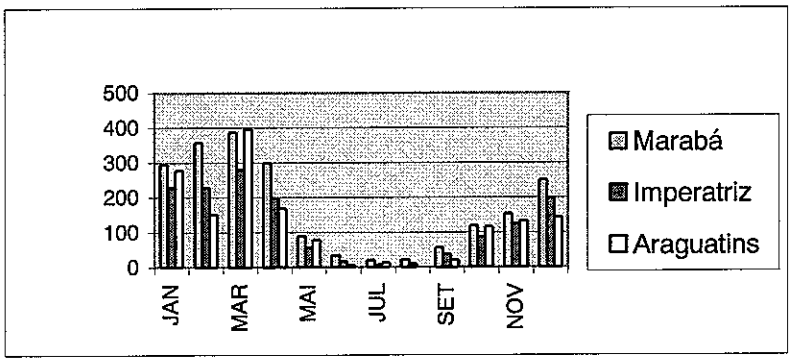
Based on the average monthly rainfall in Araguatins, an average annual rainfall of 1.502,3 mm has been calculated with 84% of the average annual rainfall occurring during the period between November to April. In the months of February and March alone, the rainfall corresponds to around 36% of the annual total.

Table 1. Average monthly rainfall (mm) in Marabá, Imperatriz and Araguatins

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Marabá	294,0	357,0	386,9	298,8	89,3	34,4	20,6	22,4	56,1	119,2	152,9	250,0	2.081,6
Imperatriz	226,5	227,7	279,0	197,3	55,0	16,2	6,4	10,2	37,7	85,5	123,3	198,7	1.463,5
Araguatins	277,1	151,4	396,1	167,7	78,6	5,5	12,7	0,0	20,6	115,5	133,1	144,0	1.502,3

Source: DNAEE - Araguatins (1996 to 1998) and INMET - Marabá(1973 to 1990) and Imperatriz (1976 to 1990)

Figure 1. Average monthly rainfall (mm) in Araguatins, Marabá and Imperatriz



The data on rainfall in the municipalities of Marabá and Imperatriz can be taken as being representative of rainfall in the Araguatins municipality.

(b) Temperature

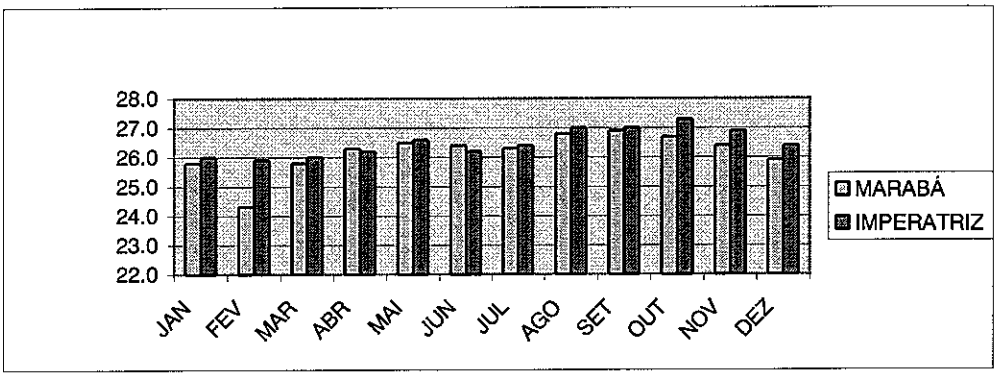
Average annual temperature in the municipality is around 26°C, according to the data available on the municipalities of Marabá (PA) and Imperatriz (MA).

Table 2. Average monthly temperature (°C) in Marabá (PA) and Imperatriz (MA)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Marabá	25.8	24.3	25.8	26.3	26.5	26.4	26.3	26.8	26.9	26.7	26.4	25.9
Imperatriz	26.0	25.9	26.0	26.2	26.6	26.2	26.4	27.0	27.0	27.3	26.9	26.4

Source: INMET – Marabá (1973 to 1990) and Imperatriz (1976 to 1990)

Figure 2. Average monthly temperature (°C) in Marabá (PA) and Imperatriz (MA).



(c) Evaporation

Around 63% of all evaporation occurs in the six months from May to October, with just 37% occurring between November to April, according to data from the municipalities of Marabá (PA) and Imperatriz (MA).

Table 3. Average monthly evaporation (mm) in Marabá (PA) and Imperatriz (MA)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Marabá	59.3	49.1	55.8	58.3	76.0	101.5	124.2	128.5	102.4	83.9	74.3	66.9
Imperatriz	81.5	69.0	79.9	84.7	122.3	151.0	182.8	193.7	159.3	132.6	107.8	96.0

Source: INMET – Marabá (1973 to 1990) and Imperatriz (1976 to 1990)

(d) Humidity

Average annual relative air humidity is around 75% in Imperatriz and 83% in Marabá, reaching up to 87% in the period between January and March.

(e) Hours of Sunshine

The period of lowest rainfall corresponds to the period with the most hours of sunshine. In the months from May to August, when rainfall is low, the average number of hours of sunshine per month is at its highest, at around 270 hours per month.

➢ **Araguaína**

According to the Ecological Economic Zoning (Seplan, 1999), using the Thornthwaite method, the climate of this municipality is classified as humid with with moderate water deficit (B1wA'a'). Average annual evapotranspiration potential varies between 1.400 and 1.700 mm, the values being highest in the summer with values of between 390 and 480 mm recorded in the three consecutive months with the highest temperatures.

(a) Rainfall

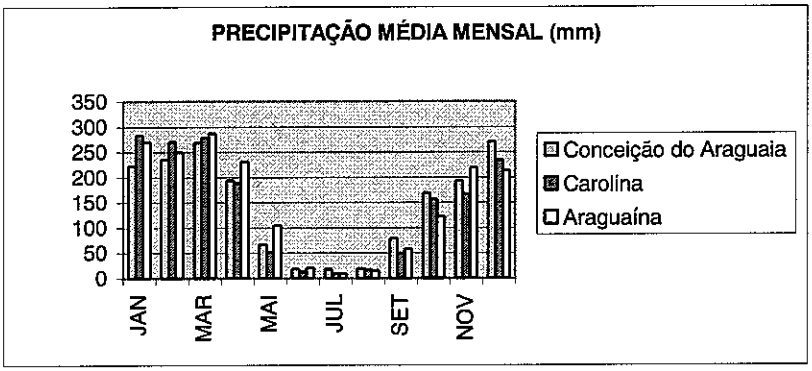
Analysis of the data from the Principal Climatological Station in Araguaína for the period from 1988 to 2000, shows an average annual rainfall of 1800,9 mm with the period between November and April accounting for 81% of average annual rainfall. Around 45% of the annual total occurs in the months from January to March alone.

Table 4. Average monthly rainfall (mm) in Conceição do Araguaia, Carolina and Araguaína.

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Conceição do Araguaia	222,8	235,6	268,6	193,4	66,7	18,6	18,0	19,3	79,1	169,0	193,2	270,6	1.754,9
Carolina	283,0	270,5	278,7	188,6	51,8	12,6	9,0	16,9	49,8	156,7	166,8	234,3	1.718,7
Araguaína	270,5	249,7	287,0	231,2	104,5	20,7	9,7	15,3	57,7	122,0	218,6	214,0	1.800,9

Source: Principal Climatological Station of Araguaína (1995 to 1997) and INMET – Conceição do Araguaia (1966 to 1990) and Carolina (1976 to 1990)

Figure 3. Average monthly rainfall (mm) in Conceição do Araguaia, Carolina and Araguaína



(b) Temperature

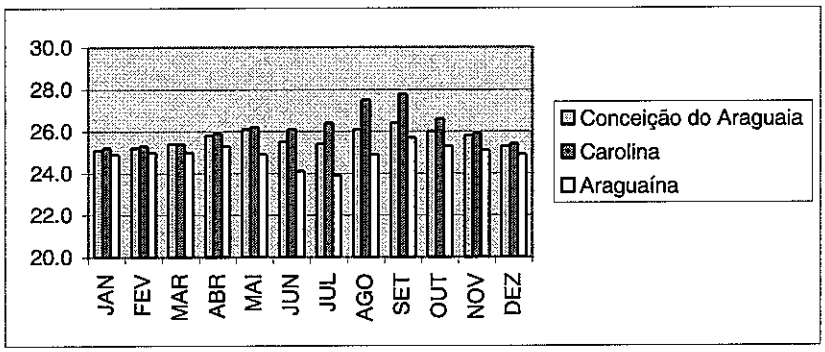
The average annual temperature in the municipality is around 25° C, according to data from the Principal Climatological Station in Araguaína for the period from 1988 to 2000.

Table 5. Average monthly temperature (°C) in Araguaína, Carolina (MA) and Conceição do Araguaia (PA)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Conceição do Araguaia	25,1	25,2	25,4	25,8	26,1	25,5	25,4	26,1	26,4	26,0	25,8	25,3	25,7
Carolina	25,2	25,3	25,4	25,9	26,2	26,1	26,4	27,5	27,8	26,6	25,9	25,4	26,1
Araguaína	24,9	25,0	25,0	25,3	24,9	24,1	23,9	24,9	25,7	25,3	25,1	24,9	24,9

Source: Principal Climatological Station in Araguaína (1995 to 1997)

Figure 4. Average monthly temperature (°C) in Araguaína, Carolina (MA) and Conceição do Araguaia (PA)



(c) Evaporation

Around 68% of all evaporation recorded in the meteorological station at Conceição do Araguaia (PA) and around 74% of all evaporation recorded in the meteorological station at Carolina (MA) occurs in the six months between May and October.

Table 6. Total monthly evaporation (mm) in Carolina (MA) and Conceição do Araguaia (PA)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Conceição do Araguaia	53,5	50,6	55,8	63,7	82,8	122,6	160,4	164,9	123,1	84,4	67,9	60,4	1090,1
Carolina	67,3	61,0	79,1	80,5	136,2	201,8	271,9	289,7	220,5	120,6	80,9	69,3	1678,8

Source: INMET – Conceição do Araguaia (1966 to 1990) and Carolina (1976 to 1990)

(d) Humidity

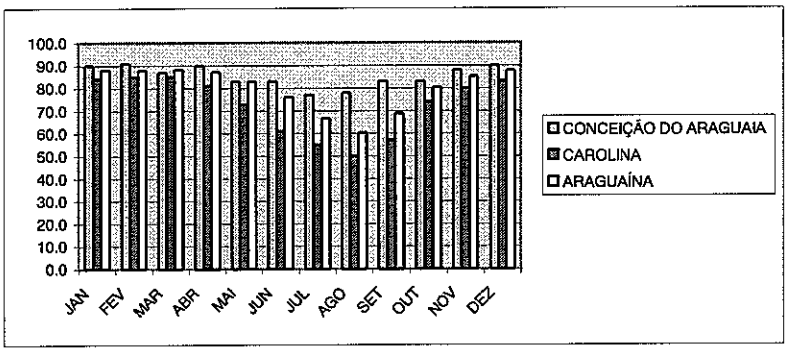
Analysis of the data from the Principal Climatological Station in Araguaína for the period from 1988 to 2000, shows that the relative air humidity in the municipality has an annual average of around 80%.

Table 7. Monthly average relative air humidity (%) in Araguaína (TO), Carolina (MA) and Conceição do Araguaia (PA)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Conceição do Araguaia	90,0	91,0	87,0	90,0	83,0	83,0	77,0	78,0	83,0	83,0	88,0	90,0	85,0
Carolina	84,0	85,0	85,0	81,0	73,0	61,0	55,0	50,0	57,0	74,0	80,0	83,0	72,0
Araguaína	88,1	87,8	88,2	87,1	82,9	76,0	66,6	60,3	68,9	80,3	85,1	87,7	79,9

Source: INMET – Conceição do Araguaia (1966 to 1990) and Carolina (1976 to 1990) and Principal Climatological Station in Araguaína (1995 to 1997)

Figure 5. Monthly average relative air humidity (%) in Araguaína (TO), Carolina (MA) and Conceição do Araguaia (PA)



(e) Hours of Sunshine

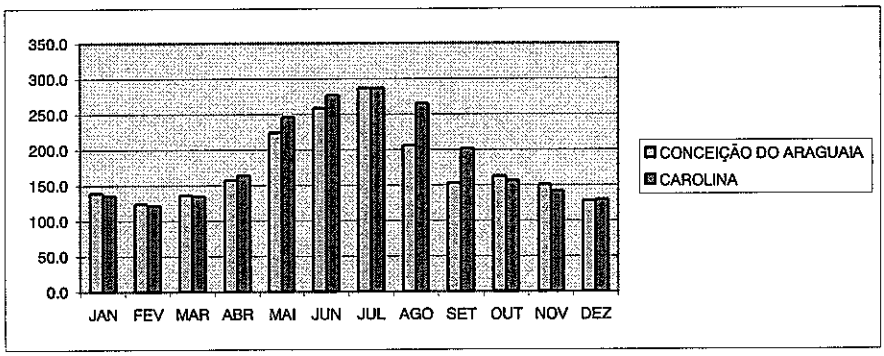
The period of lowest rainfall coincides with the period with the most hours of sunshine. In the months from May to August, when rainfall is low, the meteorological station at Carolina (MA) recorded a total of 244 hours of sunshine per month and the meteorological station in Conceição do Araguaia (PA) recorded 269 hours per month.

Table 8. Total hours of sunshine per month (in hours and tenths of hours) in Carolina (MA) and Conceição do Araguaia (PA)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Conceição do Araguaia	139,2	123,6	136,2	157,5	223,9	258,6	286,9	206,1	152,9	162,8	150,6	128,2	2126,4
Carolina	135,5	121,3	134,5	163,6	246,2	277,4	286,9	265,4	201,9	156,2	142,0	129,5	2239,4

Source: INMET – Conceição do Araguaia (1966 to 1990) and Carolina (1976 to 1990)

Figure 6. Total hours of sunshine per month in Carolina (MA) and Conceição do Araguaia (PA)



2.1.3. Geology

Geological maps of the region show that the municipality of Araguatins is situated in a Paleo-Mesozoic domain represented by the Itapecuru, Sambaíba, Pedra de Fogo, Mutuca, Codó, Corda and Mosquito formations.
In the Araguaína municipality, the geology is dominated by the Proterozoic, the orogenic Tocantins-Araguaia strip which encompasses the Estrondo and Tocantins Groups (Couto Magalhães, Pequizeiro, Xambioá, Morro do Campo formations and basic-ultrabasic rocks), plus basic-ultrabasic outcrops. From the Palaeozoic era, in a synclinal basin type, the Parnaíba Basin (Sambaíba, Pimenteiras, Longá, Mutuca, Pedra de fogo and Cabeças) and Mosquito formations are also important.
Along the rivers (Araguaia, Lontra and Muricizal) in both municipalities Caenozoic alluvial plains are also found.

Itapecuru Formation (Ki)
Dating from the Mesozoic era, this is composed of clayey greyish-white, greenish or reddish-chestnut sandstones interspersed with siltstone and argillic horizons.

Sambaíba Formation (TRs)
Dating from the Mesozoic era, this is characterised by the formation of extensive sandbanks in the upper levels, with brownish-yellow to brownish-red, fine-grained bimodal sandstones with large-scale cross stratifications of increasing grain size.

Pedra de Fogo Formation (Ppf)
Belonging to the Palaeozoic era, this is characterised by the presence of faciological variations caused by cyclical depositions, and whose base presents carbonaceous greyish-red clayey siltstones, interspersed with clayey limestones; siltstones and sandstones with bone fragments; dense light grey dolomitic limestones and poorly stratified cream to pink calcitic limestones. In the medial levels, there are greenish siltstones with interspersions of sandstone and loams, greyed medium and large grained sandstones, and carbonaceous cement; in the upper levels, there are reddish sandstones, silicaceous limestones, loams and purplish siltstones.

Mutuca Formation (PTRm)
Formed between the Palaeozoic and Mesozoic eras, this basically comprises sandstones interspersed with argillite and siltistone with limestone, gypsum and anhydrite also present. Fine and medium grained pinkish and reddish sandstones predominate in the lower levels; in the medial levels siltstones and greenish laminates become more frequent, with fine intercalations of clayey limestone; in the upper levels, fine and medium textured red, pinkish or white sandstones predominate, with intercalations of siltstones and red argillites.

Mosquito Formation (TRJm)
Of Mesozoic origin, this is distinguished by the presence of brown-purple and dark grey basalts, with a fine ophitic texture dense structure and frequent amygdaloid levels with a predominance of plagioclase and clinopiroxene alternating in spheroid structures, with occasional centimetric intercalations of fine red sandstones.

Codó Formation (Kc)
Comprised of limestones, gypsum beds and fine clayey sandstones with a brownish colouration.

Corda Formation (Jc)
Distinguished by the presence of reddish and purplish sandstone that is fine or medium textured, cross stratified and laminated, clays and beds of siltstone. Flintstone horizon, basal conglomerate.

Alluvial Deposits (Qal)
Originating in the Caenozoic era, these cover areas along the Araguaía, Lontra, and Muricizal rivers, as well as others, and are characterised by the presence of pebbles, limonites, laterites, clays and sandstones with flat-parallel and cross stratifications, consolidated to semiconsolidated, and by unconsolidated pebbles, sands, and clays with varied granulation.

Couto Magalhães Formation (PMtc)
Pertaining to the Tocantins Groupo, part of the Tocantins-Araguaia orogenic unit, dating from the Proterozoic era, it constitutes phyllites, slates, metargillites, with subordinate metasandstones, with a whitish, yellowy, reddish or purple colouration. In the area around Araguaína slates predominate with metargillite and metasandstone variations, with a purplish to reddish colouration and well developed cleavage in the slates.

Pequizeiro Formation (Pmep)
Classified as part of the Estrondo Group and pertaining to the Tocantins-Araguaia orogenic unit, dating from the Proterozoic era, it basically consists of calcium-chlorite-muscovite-quartz feldspatic schist with quartz-chlorite schist, and calcium-chlorite-muscovite schist variations with subordinate quartzites. Initially, the colouration is green withgreyish bands alternating with bands rich in mica (muscovite and chlorite) and bands of quartz, carbonate and feldspar.

Xambioá Formation (Pmex)
Also classified as part of the Estrondo Group, this is characterised by the presence of muscovite-biotite-quartz feldspatic schist and calcium-biotite-quartz feldspatic schist. Normally, the schists vary in colour from dark grey to green, and have a granolepidoblastic texture, with fine to medium granulation composed of quartz, biotite, carbonate, plagioclase, muscovite and epidote.
The biotite is green and present in aggregates.
The plagioclase is tabular xeromorphic and idiomorphic.
The carbonate appears alongside the chlorite, epidote and sericite, and associated with the quartz.
The amphibolites follow the direction of the principal foliation, dare dark grey in colour, fine grained and composed of amphibolite and plagioclase.

Morro do Campo Formation (PMem)
Belonging to the Estrondo Group, this is characterised by the strong presence of quartzites, quartz schists and amphibolites.

Pimenteiras Formation (Dp)
Dating from the Palaeozoic era, pertaining to the Parnaíba Basin, this includes a predominantly pelitic package composed of interstratified siltstones and sandstones with microconglomeratic and conglomeratic levels. In the lower levels, siltstones predominate and in the upper zones, sandstones. The siltstones are cream to grey in colour, with greenish and reddish tones.
In the upper layers, there are frequent intercalations of fine sandstones of a flaser structure, ferriferous, brownish in colour, hard and with siltstone and ferrugineous nodules, for the most part peneplain and laterised.

Longá Formation (DI)
Also from the Parnaíba Basin, this is characterised by the presence of cream and whitened sandstones, fine to medium grained, sometimes clayey, with greygreen to dark micaceous siltstones.
The siltstones are usually identified as intercalations in the sandstones, and in the upper layers are predominantly dark grey in colour.

Cabeças Formation (Dc)
Pertaining to the Parnaíba Basin, this has sandstones and paraconglomerates in its basic composition, with the former being creamy pink and whitish in colour, with fine and medium grains and they are generally kaolinic and friable.
Basic-Ultrabasic Rocks
Although considered part of the Tocantins-Araguaia orogenic unit, the classification of these rocks has been somewhat uncertain and they have been identified as being formed from serpentines and silicified serpentines and, on many occasions, as silico-carbonated rocks associated with and commonly overlain by flintstones. Several authors have refrained from taking a position on their classification.
The serpentines are green, very fine and with a dense structure and generally with segregation of quartz and brecciation.
The chlorite tremolites are dark green, with a nematoblastic texture and an oriented structure with the presence of iron oxide.

2.1.4. Geomorphology

➢ **Araguatins**

The majority of the territory of this municipality (1.724,9 km² of a total 2.297 km²) has a topography which was defined by the structure of its geological origins, modified by morphodynamic processes referred to as Smoothing of the Degraded Denuded Pediplan (*Aplainamento de Pediplano Degradado Desnudado*) with the more resistant layers standing out against these.

Next in terms of size (231,7 km²), and concentrated primarily in the southwest and central west of the municipality, are the areas of Homogenous Dissection with Convex Summit

Features (*Dissecação Homogênea com Feições do Topo Convexas*) from which originate topographic reliefs that are configured into different features by the action of erosive agents; in the southeast are areas covering 207,4 km² whose relief is defined by Homogenous Dissection with Tabular Summit Features (*Dissecação Homogênea com Feições do Topo Tabulares*) where the action of erosive agents has caused a reduction in height of the more elevated parts, thereby generating a levelling tendency on the topographic relief. Areas of Fluvial Accumulation Plains (*Acumulação Fluvial de Planície*) covering 39,6 km² can be found on the banks of the Araguaia river in the central part of the municipality and are characterised by a topography resulting from the deposition of sediments and normally subject to flooding; and finally, in the far north there are areas covering 32,1 km² where the relief has its origins in Fluvial Accumulation Plains and Terraces (*Acumulação Fluvial de Planícies e Terraços*) caused by sedimentary deposition and also subject to flood action. There are also other mechanisms of relief conformation in the municipality (61,3 km²), but these are dispersed throughout the territory and are therefore not represented in Figure 08.

➢ **Araguaína**

The municipality of Araguaína (3.920 km²) is characterised by saliences derived from morphodynamic processes referred to as Smoothing of the Degraded Denuded Pediplan (1.901,7 km²) and Homogenous Dissection with Convex Summit Features (1.414 km²), whose topography is conditioned by the structure of its geological origins.

The former can be found in the east of the municipality and extend westwards towards the central north and south, and within this zone there are also places (6 km²) whose topography is derived from Structural or Differential Dissection (*Dissecação Estrutural ou Diferencial*).

The areas of Homogenous Dissection with Convex Summit Features occupy almost all the western part of the municipality being broken only by a further topographical feature referred to as Smoothing of the Reworked Denuded Pediplan (*Aplainamento de Pediplano Retocado Desnudado*), which runs north-south over an area of 509,6 km².

In the central north of the municipality an area of 29,2 km² has its relief formed by a process referred to as Homogenous Dissection with Pointed Summit Features (*Dissecação Homogênea com Feições do Topo Aguçadas*) and, on the banks of the Araguaia river in the far north of the municipality, there is an area of 40,9 km² whose topography results from Fluvial Accumulation Plains.

Topographical reliefs whose forms are consequent on other processes and which are can be found scattered throughout the whole municipality make up an area of roughly 16,6 km².

2.1.5. Hydrography

The municipalities are located in the Araguaia-Tocantins system, a tributary of the Amazon Basin.

➢ **Araguatins**

The hydrographic system of virtually all of the municipality of Araguatins is part of the Araguaia basin, and in the south lies the Piranhas river basin (A16). Part of the boundaries of the municipality run along the watershed between the Araguaia (A1) and Tocantins (T1) river basins with part of the latter also lying within the municipal territory.

The topography of the municipality is gradually sloping and drainage is predominantly into the Araguaia river with lesser tributaries being rather scarce due to the natural narrowing of the main basin as it approaches the confluence with the Tocantins river.

In this context, the main tributaries of the Araguaia, along its right bank, are the São Martinho river, and the Barreiro and Taquari creeks.

The table below shows the various hydrographic basins which occur in the municipality.

Table 9. The Hydrographic Basins of Araguatins, by Absolute and Percentage Area

Araguaia River (A1)		**Piranhas River (A16)**		**Tocantins River (T1)**		**Others**		**Total Área (Km²)**
Area (Km²)	%	Area (Km²)	%	Area (Km²)	%	Area (Km²)	%	
1978,7	86,14	287,5	12,52	29,3	1,27	1,5	0,06	2297,0

Source: Data from PCI (2000)

The minimum flow rates and characteristics of the river Araguaia are shown in the table below.

Table 10. Characteristic flow rates of the Araguaia river as recorded at the Araguatins monitoring station:

SUB-BASIN	LOCATION	PERIOD	FLOW RATES (m^3/s)				
			$Q_{5\%}$	$Q_{25\%}$	$Q_{50\%}$	$Q_{75\%}$	$Q_{95\%}$
28	Araguatins – Araguaia River	1974/95	16.489	10.023	4.745	2.184	1.008

Source: Base data DNAEE – calculations by ONA S.A. Engenharia (1997)

The information given in the table below indicate the maximum flow rates of the Araguaia river and their respective return times. They serve to illustrate the degree of variation between extreme hydrological events.

Table 11. Maximum flow rates (with return times: Tr) of the Araguaia river as recorded at the Araguatins monitoring station:

SUB-BASIN	LOCATION	PERIOD	Max. Flow Rate (m^3/s)		
			Tr=100 years	Tr=1.000 years	Tr=10.000 years
28	Araguatins – Araguaia River	1975/95	38.070	49.885	61.700

Source: Base data DNAEE – calculations by ONA S.A. Engenharia (1997)

The region's water resources have been compromised and conditioned by a number of factors; apart from the irregularity of the rainfall, there are also permeable sedimentary rocks which have become influential because of the intensive deforestation and clearance of vegetation cover that has occurred in the region in recent decades.

➢ **Araguaína**

The municipality of Araguaína is composed of 5 basins, with the most extensive of these being the Lontra river basin (A14), which bathes the municipal capital, and the basins of the Araguaia river (A1) and of the Muricizal river (A13). These three basins account for roughly 92% of the municipal area, with the largest being the Lontra river basin, as is shown in the table below:

Table 12 – The Hydrographic Basins of Araguaína, by Absolute and Percentage Area

A14		A1		A13		T1 and A12		Others		Total Area (km^2)
Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	Area (Km^2)	%	
1.619,3	41,31	1.038,2	26,48	973,8	24,84	285,5	7,28	3,2	0,08	3.920,0

Source: Data from PCI (2000)

It can be seen from the table that the Tocantins river basin – denominated T1 – also is part of the hydrographic system of Araguaína occupying an area of 242,7 km^2, as is the Jenipapo river basin (A12) with an area of 42,8 km^2 within the municipal boundaries.

2.2. Current Land Use

2.2.1. Soils

(a) Methodology

The collection of soil samples was done over the period 7-13 December, 2000, using an auger at 3 depths, namely: 0 – 20 cm (A), 30 – 50 cm (B) and 80 – 100 cm (C), so as to be better able to make technical recommendations for land use for annual and perennial crops.

A total of 60 samples were collected from a total of 20 different locations, so as to ensure the adequate representation of the predominant soil types in the municipalities of Araguaína and Araguatins.

To characterise these soils, bibilographic research, laboratory analyses of the soils and soil data from the Ecological Economic Zoning of Tocantins (Seplan, 1999) along with calculations by PCI (2000) were all used, identifying soil classes and their respective divisions, the descriptions of which, plus commentaries and other results can be found below.

Table 13. Geographic coordinates of the soil sampling locations

ARAGUAÍNA		
SAMPLES	LATITUDE	LONGITUDE
1A, 1B and 1C	7° 13' 25" S	48° 10' 01" W
2A, 2B and 2C	7° 13' 01" S	48° 10' 24" W
3A, 3B and 3C	7° 26' 02" S	48° 44' 01" W
4A, 4B and 4C	7° 27' 49" S	48° 39' 24" W
5A, 5B and 5C	7° 22' 26" S	48° 57' 59" W
6A, 6B and 6C	7° 11' 01" S	48° 22' 28" W
7A, 7B and 7C	7° 24' 34" S	48° 30' 14" W
8A, 8B and 8C	7° 23' 10" S	49° 09' 04" W
9A, 9B and 9C	7° 11' 47" S	48° 16' 48" W
10A, 10B and 10C	7° 21' 42" S	18° 33' 57" W

ARAGUATINS		
SAMPLES	LATITUDE	LONGITUDE
1A, 1B and 1C	5° 28' 40" S	48° 07' 48" W
2A, 2B and 2C	5° 37' 59" S	48° 06' 02" W
3A, 3B and 3C	5° 35' 31" S	48° 03' 59" W
4A, 4B and 4C	5° 33' 26" S	47° 59' 49" W
5A, 5B and 5C	5° 28' 58" S	48° 17' 41" W
6A, 6B and 6C	5° 47' 22" S	48° 01' 19" W
7A, 7B and 7C	5° 32' 45" S	48° 14' 52" W
8A, 8B and 8C	5° 53' 19" S	47° 55' 58" W
9A, 9B and 9C	5° 52' 26" S	47° 58' 20" W
10A, 10B and 10C	5° 47' 22" S	48° 10' 39" W

Source: Fleury (2000).

(b) Characterisation of Pedological Units

Among the soil types that are found in the municipalities of Araguaína and Araguatins, the most predominant are, in decreasing order: quartzose sands, latosols and podzolic soils The occurrence of lithosols, gleys and plinthosols.
The tables below illustrate the predominant soil types by absolute and percentage area, as illustrated in Figure 9 and Figure 10.

Table 14. Distribution of soil types in the Araguatins municipality

PREDOMINANT SOIL TYPES IN ARAGUATINS	AREA OF OCCURRENCE KM²	AREA (%)
Podzolic soils (yellow and red podzolic soils – PV, dark red podzolic soils – PE and yellow podzolic soils – PA)	1.142,3	49,73
Latosols (red and yellow latosols – LV and yellow latosols – LA)	605,8	26,37
Quartzose sands – AQ	361,2	15,72
Petric plinthosols – PP	38,6	1,68
Lithosols – R	36,7	1,6
Gley – G	14,4	0,63
Others *	98,2	4,27
TOTAL	**2.297,20**	**100**

Source: Data from PCI (2000).
* Rivers, lakes, urban areas, indigenous areas and protected areas.

Table 15. Distribution of soil types in the Araguaína municipality

PREDOMINANT SOIL TYPES IN ARAGUAÍNA	AREA OF OCCURRENCE KM²	AREA (%)
Quartzose sands – AQ	1.271,0	32,42
Latosols (red and yellow latosols – LV and yellow latosols – LA and dark red latosols – LE)	1.251,8	31,93
Podzolic soils (yellow and red podzolic soils – PV, dark red podzolic soils – PE)	916,6	23,38
Lithosols – R	456,7	11,65
Others *	24,1	0,62
TOTAL	**3.920,20**	**100**

Source: Data from PCI (2000).
* Rivers, lakes, urban areas, indigenous areas and protected areas.

The characterisations of the soils which occur in the municipalities being studied are presented below, as identified by Goedert (1986) and Sano & Almeida (1998):

- **Podzolic soils**

These are characterised by a textural B horizon. The horizon sequence displays an accentuated differentiation in texture, colour and structure, usually with abrupt transitions between the A and B horizons

They are strongly acid soils, with medium to low levels of organic matter in the A horizon, and very low levels in the B horizon. The sum of bases and base saturation are low, which classifies them as distrophic.

These soils have an eluvial horizon (A2), which is normally discloured and with a lighter texture, and an illuvial horizon (Bt) with more vivid colouring and evidence of clay enrichment.

- **Quartzose sands**
  These are soils with a sandy or very sandy texture without differentiation down the soil profile; the sequence of horizons is A and C, with a depth of over two metres; the percentages of sand are over 80 % and they are therefore extremely permeable, with a very low water retention capabilities.
  The natural fertility of these soils is very low. They are strongly acid with a low percentage of organic matter. The sum of bases, base saturation, and their cation exchange capacity are extremely low.

- **Latosols**
  These are very deep soils, normally deeper than 2m, with an A, B and C horizon sequence which shows little differentiation.

  The principal granulometric components are clay and sand. The clay content varies from 15% - 80%. Silt is present in relatively constant levels between 10% and 20%.

  Latosols have low cation exchange capacities and more than 95% are acid distrophic.

  In the Cerrado (savannah) biome latosols of the type resulting from smoothing (*aplainamento*), and these are known regionally as *chapadas* (plains) exhibiting a level and gently undulating topography, with a predominance of the dark red to yellow colours.

- **Gley soils**
  These are little developed soils found on level ground at the waterlogged margins of rivers or in depressions. They are formed from alluvial sediments in places where the water table is close to the surface for most of the year and this gives rise to a dark A horizon with a high concentration of organic matter which is partially or totally decomposed.

  Most of these soils are distrophic and strongly acid with a high percentage of organic matter which contributes to a high cation exchange capacity. The values of the sum of bases are middling, and the percentage base saturation is low.

  The most common profiles are A and C, with silt being the predominant granulometric fraction. In the upper levels, the clay fraction is larger than the sand fraction, and this fact hampers the drainage of the soil. The predominant colours are black in the upper levels and light grey in the lower levels.

- **Lithosols**
  These are characterised by little developed, shallow profiles with the A horizon resting directly on the bedrock, or on a C horizon of little depth.

  They are soils of quite variable texture but normally the A horizon is dominated by the sand fraction.

  Most lithosols are distrophic with a generalised lack of nutrients. They are strongly acid and have moderate amounts of organic matter. Their cation exchange capacity is moderate in the A horizon. The sum of bases and base saturation both have low values, and their aluminium saturation values are moderate to low while their phosphorous content is very low. They normally occur in rough, undulating or mountainous terrain.

- **Plinthosols**
  This soil type was previously referred to as hydromorphic laterite characterised by hydromorphic mineral soils with severe restrictions to water percolation.

Their granulometric composition shows a predominance of silt in the A horizon and a predominance of clay in the B horizon (clayey).

Their cation exchange capacity is moderate, with low values for the sum of bases and base saturation throughout the soil profile. They are distrophic and strongly acid, with low nutrient availability.

They are found in vegetation types such as open savannah (*campo limpo*), scrubby savannah (*campo sujo*) and lightly wooded savannah (*parque cerrado*).

(c) Comments on the results of the soil analysis

The results of the soil sampling exercise were collated following the interpretation of the data, and are shown in Tables 16 and 17.

In the Araguaína municipality, the soils have very low levels of phosphorous, a pH that is weakly to strongly acid, moderate to very high aluminium saturation, a low organic matter content, a potassium content which is low in sandy textured soils and moderate to high in medium and clayey textured soils, low calcium levels and moderate magnesium levels.

The analyses of soils in the municipality of Araguatins show low levels of phosphorous and a moderately to strongly acid pH. The base saturation in clayey textured soils is moderate to very high and in sandy soils it is low to moderate. The organic matter content is low in most samples, with low potassium levels in clayey textured soils and moderate to high levels in sandy soils. Magnesium levels in all samples are considered moderate to high.

2.2.2. Current Land Use

The current land use in the municipalities of Araguatins and Araguaína is shown in Figures 11 and 12 which were drawn up for the Plan for the Development of Agricultural and Ranching Activities in the Northern Region based on data from the Agroecological Zoning of Tocantins (Seplan, 1999).

The land tenure structure of the municipalities being studied exhibits a concentration of lands in properties where agricultural practices are of a medium to low technological level. Araguaína has higher indices of regularised land tenure than Araguatins.

➢ Forests

The forest formations present in the municipalities have been segmented and in many cases have been affected by the extraction of timber species with economic and commercial value.

➢ Pastures and crops

Large areas of pasture dominate the countryside, evidence of the practice of extensive, low technology cattle ranching for which graminaceous species such as *Brachyaria*, 'quicuio', and bluestem grass (*andropógon*) are used along with native pasture species.

Areas of agricultural crops for subsistence farming can also be found in the municipalities on family small-holdings. Rice, beans, maize, manioc and fruit trees such as banana, coconut, pineapple are the main crops grown. In Araguaína there are green belts where vegetables are grown, as well as cereals and fruit species under regimes which use moderate to high levels of agricultural technology.

➢ Cerrado

Areas of cerrado (Brazilian savannah) exhibit significant evidence of human alteration and are for the most part interspersed with pastures and therefore suffer from the practice of burn-off which is used to clear the land of dead vegetation so as to stimulate the regrowth of pasture grasses.

➢ Others

These areas consist of urban areas in the municipalities, rivers, lakes, resevoirs, water holes, roads and highways..

Current land use in the areas studied is shown in the table below:

Table 18. Current land use in the municipalities of Araguatins and Araguaína

CURRENT LAND USE	ARAGUATINS		ARAGUAÍNA	
	Km²	%	Km²	%
Forests	783,5	34,11	957,3	24,42
Pastures/crops	1.036,5	45,12	2.619,9	66,83
Cerrados	376,6	16,40	284,3	7,25
Others	100,3	4,37	58,5	1,49
Total Área	**2.297,0**	**100**	**3.920,0**	**100**

Source: Data from PCI (2000).

It is important to note that agriculture (as distinct from cattle ranching) is still in its early stages in these two municipalities and therefore it only accounts for a very low proportion of current land use, around 0,02%.

2.2.3. The Suitability of Regional Soils for Agriculture

The rational use of a natural resource involves a wide range of studies which indicate the best economic results from the lowest investments. In addition to this, in the current understanding of the concept of rationality, environmental considerations are also included so as to account for the sustainability, or otherwise, of the productive process.

The suitability of soils is a factor which results from successive interrelated processes arising from physical, chemical, biological and environmental conditions which convey specific qualities in terms of their use: fertility, erodibility, moisture regime and mechanisation, among others.

Thus, an examination of Figures 13 and 14 which illustrate the suitability of land in the municipalities of Araguaína e Araguatins, and which were provided by the PCI consultancy, will indicate a number of points, as briefly described below.

Presupposing the observance of technological practices which are compatible with the specific necessities of each group, such as applications of soil improvers and fertilisers, soil and water conservation, the cultivation of species which are suited to the soil conditions and the use of mechanisation, the lands which are adjudged to be suitable for agriculture are categorised into groups 1, 2 and 3, which together make up the majority of the soils in the municipalities studied.

The soils in groups 1 and 2 are adjudged to be suitable for intensive production (short and long cycle agriculture and/or ranching). Group 1 lands are thought to be better suited to agriculture because they will require a lower level of investment, while group 2 lands are suited to cattle ranching since this is less demanding in terms of its capital requirements.

In group 3 are included soils which are suited to moderately intensive usage for production. They have some limitations for agricultural purposes, but they are deemed appropriate for intensive ranching purposes using artificial pastures.

In group 4 can be found the soils which are adjudged to have low productive potential and which can usually be found suitable for tree planting and/or extensive ranching activities.

Group 5 lands have even lower productive potential, and little or no sustainable economic exploitation of these appears feasible given their severe natural limitations. They contain the lands destined to be Conservation Areas.

Table 19. Schematic table showing land use suitability

LAND USE SUITABILITY						
Group	Nature Conservation	Tree Planting / Natural Pasture	Artificial Pasture	Agriculture		
				Limited	Regular	Good
1	X	X	X	X	X	X
2	X	X	X	X	X	
3	X	X	X	X		
4	X	X				
5	X					

2.2.4. Soil Erodibility

To evaluate the erodibility of soils in the municipalities studied, the risks associated with soil mechanics were considered according to data given by Seplan (1999), and presented in the Development Plan. Among various characteristics, the erodibility was evaluated as a function of the basic soil documentation, geology and altimetry.

Table 20. Potential erodibility classes of soils in Araguatins and Araguaína

ERODIBILITY CLASSES	ARAGUATINS		ARAGUAÍNA	
	Area (km²)	% of total area	Area (km²)	% of total area
Light	864,6	37,63	1.854,8	47,32
Moderate	744,1	32,39	765,7	19,53
Strong	275,8	12,01	512,1	13,06
Very weak to weak	263,5	11,47	483,7	12,34
Very strong	40,5	1,76	280,7	7,16
Special	17,4	0,76	0,0	0,0
Others	91,1	3,97	22,9	0,58
Total	**2.297,0**	**100**	**3.920,0**	**100**

Source: Data from PCI (2000).
Over 70% of soils in the municipality of Araguatins pertain to the light and moderate classes of potential erodibility.

The main potential erodibility classes present in the municipality of Araguaína are: light, moderate, strong and very strong.

According to the mapping of soil erodibility undertaken for the Ecological Economic Zoning (Seplan, 1999), the characteristics of the principal classes present in the municipalities are as follows:

- Light: these have areas featuring deep well drained and very well drained soils, with slopes of between 3% and 8 % predominating.

- Moderate: these are formed by deep or moderately deep soils and are usually located in undulating terrain with slopes of between 8% and 20%.

- Strong: soils of restricted depth with moderate drainage predominate in this class. They generally occur on strongly undulating terrain with slopes of between 20% and 45%.

- Very strong: comprising shallow or very shallow soils. The topography which predominates in this class ranges from mountainous to escarpments with slopes of 45% or more.

2.2.5. Physical and Chemical Characteristics of Water Resources in Araguatins and Araguaína

According to National Environmental Council's Resolution N° 020/86 (Conama 020/86) the classification of water resources should be based not necessarily on their actual state, but on the water quality levels which they ought to obtain so as to meet the requirements of the community. The water resources in the State of Tocantins have yet to be fully classified and for this reason they are all considered as pertaining to Class 2. Conama's Resolution N° 20 (dated 18 June, 1986) establishes 5 class types to classify all fresh water resources in national territory according to their principal uses.

I – Special Class; II – Class 1; III – Class 2; IV – Class 3 and V – Class 4.

According to Article 5 of the Resolution, the limits and conditions established for Class 2 waters are the same as those determined for Class 1, namely:

a) Floating material, including non-natural foam: virtually absent;
b) Oils and grease: virtually absent;
c) Substances that convey tastes or odours: virtually absent;
d) Artificial colours: virtually absent;
e) Substances which form objectionable deposits: virtually absent;
f) Dissolved oxygen (DO), in any sample, not below 6 mg/L O_2;

g) Turbidity: up to 40 nephelometric turbidity units (NTU);
h) pH: 6,0 to 9,0;
Nitrate 10 mg/L N
Nitrite 1,0 mg/L N
Total Dissolved Solids (TDS)500 mg/L

The following exceptions apply:

a) the presence of artificial colours, which cannot be removed by the conventional processes of coagulation, sedimentation and filtration, is prohibited;
b) coliforms: for recreational use, in the first instance, Article 26 of Resolution N° 20 applies. For other uses, the allowable limit is 1.000 faecal coliforms per 100 mm in 80% or more of at least 5 monthly samples taken in any month; where means of examining faecal coliforms exist, the allowable index limit is up to a total of 5.000 coliforms per 100 mm in the same proportion as stated previously;
c) colour: up to 75 mg Pt/l;
d) turbidity: up to 100 NTU;
e) Biological Oxygen Demand (BOD) 5 days at 20°C up to 5 mb/l O_2;
f) Dissolved oxygen, in any sample, not below 5 mg/L O_2;

➢ **Methodology**
The methodology used for the collection of water samples follows that used by Cetesb (1975) and the analysis of the samples was conducted in accordance with Standard Methods (1995).

Table 21. Results of the analyses of water samples from water resources in Araguatins

1. Atoleiro Stream	68,2	43,0	0,07	14,20	0,48	24,4	3,20	39,5	5,9	90,4	05°30´41´´S 48°06´31´´W
2. Bacaba Stream	84,2	20,0	0,00	11,87	0,44	25,2	3,20	36,4	5,9	42,8	05°32´56´´S 48°05´48´´W
3. Barreiro Stream	86,2	18,0	0,00	8,48	0,40	24,0	4,20	27,7	6,4	38,1	05°42´02´´S 48°08´24´´W
4. Araguaia River	174,0	20,0	0,00	9,14	0,36	24,5	4,75	27,6	6,2	43,8	05°38´57´´S 58/07´54´´W
5. Buriti River	119,4	28,0	0,10	9,90	0,60	27,4	3,62	32,0	6,1	59,1	05°19´55´´S 48°11´24´´W
6. Lage River	65,0	31,0	0,00	7,45	0,56	27,7	3,62	31,0	5,9	65,5	05°34´10´´S 48°04´37´´W
7. Macaúba River	48,3	16,0	0,00	7,01	0,40	24,8	4,56	21,5	6,1	33,6	05°33´40´´S 48°56´09´´W
8. São Martinho River	112,5	16,0	0,00	9,74	0,40	26,3	4,46	38,1	6,1	33,9	05°47´21´´S 48°10´38´´W
9. Taquari River	142,0	23,0	0,00	10,41	0,52	25,8	3,62	30,2	6,3	48,2	05°39´´35´´S 48°07´21´´W
10. Taquarizinho River	58,2	4,0	0,12	1,33	0,12	26,2	4,40	5,5	5,7	9,6	05°47´06´´S 48°10´35´´W

Source: Field data, Naval (2.000). Translator's Note: Stream = *Córrego*; Creek = *Ribeirão*; River = *Rio*
Data transcribed from water analyses conducted at the UNITINS laboratory – Palmas(TO).

Table 22. Results of the analyses of water samples from water resources in Araguaína

1. Small stream in the Muricizal Basin	96,2	31,6	0,997	0,00163	0,16	25,9	3,98	14,2	5,6	15,0	07°22´31´´S 49°09´55´´W
2. Inajá Creek	84,0	34,0	1,000	0,00134	0,88	25,6	4,20	9,4	5,3	72,2	07°22´43´´S 49°03´39´´W
3. Água Amarela Stream	78,0	5,0	6,800	0,00126	0,04	25,4	3,60	7,9	4,9	10,9	07°27´47´´S 48°35´28´´W
4. Chá Stream	116,4	36,0	0,532	0,00085	0,80	24,7	3,94	10,6	5,6	74,8	07°23´13´´S 49°07´40´´W
5. Escorrega Stream	78,2	23,0	0,680	0,00075	0,72	25,4	3,69	10,1	5,8	48,5	07°27´38´´S 48°33´44´´W
6. Araguaia River – mid-river	96,3	15,0	0,153	0,00674	0,56	26,3	3,58	35,3	5,2	32,0	*
7. River on the Garimpinho - B. Muricizal road	114,2	21,0	1,060	0,00161	0,24	25,2	4,06	8,8	6,3	43,5	07°27´29´´S 48°32´32´´W
8. Araguaia River – river's edge	76,0	15,0	1,680	0,00134	0,40	26,2	4,20	43,7	5,5	32,2	*

Table 22. (continued)

1. Stream near a dry forest	56,9	5,0	1,080	0,00047	0,28	27,3	4,97	1,8	5,9	11,6	07°27´12´´S 48°42´30´´W
2. Atoleiro Stream	78,4	4,0	1,970	0,75	0,04	26,4	4,12	3,7	5,0	8,7	07°24´56´´S 48°45´33´´W
3. Source of the Jacuba Creek	56,0	4,0	7,730	0,43	0,24	24,3	3,90	9,2	4,6	8,5	07°13´38´´S 48°10´28´´W
4. Lontra River - 2 Km from the source	56,0	5,0	0,000	7,50	0,32	25,6	3,60	9,2	5,2	10,1	07°25´06´´S 48°10´43´´W
5. Jacuba Creek	63,0	5,0	0,530	10,50	0,32	26,2	3,60	2,6	5,6	11,8	07°13´08´´S 48°10´01´´W
6. Riachinho Creek	69,5	4,0	0,740	0,54	0,20	25,2	4,69	1,2	5,7	9,6	07°27´50´´S 48°38´08´´W
7. Preto River	145,2	57,4	6,300	0,47	0,04	23,8	3,80	16,3	5,8	2,7	07°23´04´´S 48°47´44´´W
8. Jacuba Creek at the Club	54,0	5,0	0,000	0,19	0,24	25,2	4,70	8,0	5,3	10,3	07°13´38´´S 48°10´28´´W
9. Lontra River bridge	54,0	9,0	0,180	1,56	0,28	26,7	4,50	13,5	4,9	18,3	07°12´29´´S 48°14´32´´W
10. Muricizal Creek	98,5	11,0	1,510	5,83	0,24	24,8	3,12	24,5	6,1	23,8	07°27´29´´S 48°32´32´´W
11. Stream 40	71,5	8,0	0,690	0,86	0,24	25,4	4,32	5,3	6,0	15,1	07°27´12´´S 48°42´30´´W

Source: Field data, Nunes (2000). Translator's Note: Stream = *Córrego*; Creek = *Ribeirão*; River = *Rio*
*Samples presenting difficulties for coordinate identification
Data transcribed from water analyses conducted at the UNITINS laboratory – Palmas(TO).

➢ **Discussion of the Results**

When considering the results of the analyses, it can be noted that, with regard to the Dissolved Oxygen parameter, all samples presented values below that stipulated by the Conama Resolution, as occurred in the Chá stream, Araguaia river, Muricizal creek, the small stream in the Muricizal basin, the river near the Garimpinho road, the Pardo river, the Atoleiro stream, the Escorrega stream, the Riachinho creek, the Água Amarela stream and the Lontra river and its headwaters. However, it should be noted that the high temperatures in the region reduce amount of gas that can be dissolved and thereby impoverish its water resources in terms of dissolved oxygen concentrations.

An analysis of the results shows that all samples from the Araguatins municipality are below the dissolved oxygen criteria established by Conama's Resolution N° 020/86. In all samples, the oxygen content is below the specified levels.

With reference to turbidity, only the Garimpinho stream has values above those recommended by the Conama Resolution. The values of all other parameters studied were within recommended limits.

Some of the water courses sampled, for example the Buriti, Taquari, São Martinho and Araguaia rivers, have elevated COD (chemical oxygen demand) values. This may be because the samples were taken in the rainy season during which time a lot of material, including organic material, is washed into water courses. With regard to turbidity, only the Atoleiro stream is close to the concentration determined by the Resolution.

2.3. Description of the Biotic Environment

2.3.1. Methodology

The basic Methodology utilised was the collection of secondary data by means of a bibliographic review and by gathering information from unpublished studies with which team members were familiar. The data on the region's fauna is scarce, and little specific information could be gathered relative to the area studied.

Using the data collected through this process as a basis, the strategy for subsequent work was drawn up, involving field trips for the collection of primary data *in loco*. The avifauna was used as a bioindicator from which inferences were drawn about the wider fauna in the area under study. This strategy was adopted because the detection of species in this group is facilitated by their habits (which are for the most part diurnal), because they occur in diverse habitats, and because they allow an evaluation of the degree of alteration to which the environment has been subjected. Detection of species in the group relied on direct observations, whether visual or auditory.

With regard to the mastofauna, the species register was obtained by means of direct observation, observation of tracks and spoors and, most of all, information provided by the local population. For the reptiles, amphibians and fish, the recording process followed the same procedures as used for the mammals. The underlying basis of the surveys and observations conducted was the characterisation of existing habitats and their capacity to support fauna species.

The survey was conducted over a period of four days and its results were used to build up a diagnosis of the biotic environment in the two municipalities being studied.

2.3.2. Characterisation of the Regional Flora and Fauna

The study area is situated in an ecotone region between the cerrados (Brazilian savannah) which extend to the south, and the Amazon forest (ombrophile forest), which extends to the north and west.

For the sake of clarity, the main vegetation types occurring in the region are described below.

(a) Cerrado

In terms of extension, this is surpassed only by the Amazon forest. In all, the Brazilian savannah or cerrado covers 2 million km² spread over 10 States. Cerrado is a tropical savannah in which the herbaceous vegetation coexists with over 420 tree species and scattered bushes. The soil, which is old and deep, is acid and has low fertility with high levels of iron and aluminium. Despite this, the cerrado benefits from the fact that it is crossed by three of the largest hydrographic basins in South America (belonging to the Tocantins, São Francisco and Prata rivers) which favours the maintenance of a surprising degree of biodiversity. It is estimated that the flora of the region contains some 10,000 different plant species (many of them used in the production of cork, fibre, oil and handicrafts as well as for medicinal

and nutritional purposes). Alongside these, some 400 bird species, 67 mammal genera, and 30 types of bat have been documented in the area. The number of insects is surprising: in the Distrito Federal (in which Brazil's capital, Brasília, is located) alone, 90 species of termite, 1,000 species of butterfly and 500 different species of bees and wasps have been recorded (WWF, 2000).

The term *mata ciliar* (ciliary forest) refers to the forest vegetation which accompanies medium and large size rivers in the cerrado region and in which the tree vegetation does not form galleries. In general this forest type is relatively narrow on both banks, having a width which rarely exceeds 100 metres. Its width on either bank is commonly proportional to that of the river itself, although on level ground, it may be greater. However, *mata ciliar* generally occurs on broken or irregularly undulating terrain and there may be a transition, which is not always clear, into other types of forest formation such as dry forest or wooded savannah.

The *mata ciliar* can be distinguished from gallery forest (*mata de galeria*) by its deciduosity and floral composition since in *mata ciliar* there are different degrees of leaf loss in the dry season whereas in gallery forest, the leaves are perennial. In terms of floral composition the *mata ciliar* is similar to dry forest (*mata seca*), although it can be distinguished from it by its close association with the watercourse, and by its structure which tends to be denser and taller than dry forest.

Characteristic tree species include: *Anadenanthera* spp. (mimosas, known locally as 'angicos'), *Apeiba tibourbou* (lindens, known locally as 'pau-de-jangada' and 'pente-de-macao'), *Aspidosperma* spp. ('perobas'), *Celtis iguanaea* ('grão-de-galo'), *Enterolobium contortisiliquu*m ('tamboril'), *Ingá spp.* ('ingás'), *Myracrodruon urundeuva* (pepper trees, known locally as 'aroeira'), *Sterculia striata* ('chichá'), *Tabebuia spp.* ('ipês'), *Trema micrantha* (elms, known locally as 'crindiúva') and *Triplaris gardneriana* ('pajeú'). Other common species in open areas or clearings include *Cecropia pachystachya* ('embaúba') and *Attalea speciosa* (the 'babaçu' palm). The number of species of epiphyte Orchidaceae is low, although the species *Encyclia linearifolioides*, *Oncidium cebolleta*, *O. fuscopetalum*, *O. macropetalum* and *Lockhatia goyanesis* are frequent in the community, as they are in semi-deciduous and deciduous dry forests. Different sections of a continuous stretch of *mata ciliar* may present quite varied floral compositions, with some parts which may be dominated by just a few species.

Alongside rivers, in places subject to severe flooding, there may be a predominance of tree species such as *Celtis iguanaea*, *Ficcus spp.* (fig species, locally known as 'gameleiras'), *Ingá spp.* and *Trema micrantha*, or even large graminaceous species such as *Gynerium sagittatum* (known as 'canarana') or *Guadua paniculata* (a bamboo species also known locally as 'taquara') as is the case near the large rivers in the northeast of Goiás State. In this region, the formation of sand banks and beaches in and along the margins of rivers is common and on these a bushy-herbaceous vegetation is characteristic, with the presence of species from the Boraginaceae, Myrtaceae and Rubiaceae families.

In places where small tributaries (streams and creeks) join the main river, the flora that typifies the *mata ciliar* may blend with gallery forest flora in a way that makes it hard to determine where one vegetation type ends and the other begins.

The term gallery forest (*mata de galeria*) refers to the forest vegetation that accompanies the small rivers and streams of the plateaus of Central Brazil forming closed corridors ('galleries') around the watercourse. They are generally located along the bottom of valleys or at the headwaters where the watercourses have not yet worn out a definite channel. Gallery forests are perennially in leaf, with no leaf loss during the dry season. They are almost always surrounded by strips of non-forest vegetation along both banks and in general there is an abrupt transition to savannah or open field formations. The transition is almost imperceptible when, in rare cases, gallery forests meet ciliary forests, dry forests and even wooded savannah, although it is possible to distinguish these types on the grounds of their floral composition.

The cerrado biome features a number of different types of palm groves (*palmeiras*). These vary in structure according to the dominant species, and may in fact be identified by means of the common name of this species. In general, the palm groves of the cerrado are found on well drained soils, although they do also occur on poorly drained soils where they may form galleries accompanying the drainage channels (Eiten 1983, 1994).

Palm groves on well drained soils are generally found in interfluvial areas and the predominant species tends to be a member of genera such as the *Acrocomia, Attalea* or *Syagrus.* Where the canopy tends to be discontinuous or absent, the palm groves commonly consist of the *Acrocomia aculeata* species (the macaw palm or *macaúba,* known collectively as a *macaubal*) or the *Syagrus oleracea* species (forming a grove known locally as a *guerobal*). When the

dominant species is *Attalea speciosa* (the 'babaçu' palm), the grove is known as a *babaçual*, and usually has a more continuous canopy than the other forms.

The presence of the babaçu palm appears to be closely linked to areas of human impact since it aggressively colonises areas where old growth forest has been cut down. The species is moderately resistant to fire, to which other tree species tend to succumb (Eiten, 1994). There are much greater numbers of babaçu palms *(Attalea spaciosa)* in the Araguatins region than in the Araguaína region, possibly because of the greater influence of the coconut palm forests of Maranhão on the former.

Palm groves on poorly drained, marshy soils, which can be found along the valley bottoms in Central Brazil, are almost always dominated by the 'buriti' palm (*Mauritia flexuosa*) which forms a grove known locally as a *buritizal*. In certain cases, other palm species may also be present in small numbers, for example the mauritia palm (*Mauritiella armata*) known locally as the *buritirana* (Eiten, 1994).

(b) Amazon forest

The Amazon forest is located in the north of the continent of South America. Approximately 67% of its area belongs to Brazil, with the remainder distributed among Venezuela, Suriname, Guyana, French Guiana, Bolivia, Colombia, Peru and Equador. The vegetation can be categorised into three main types of forest: flooded forest (*mata de igapó*), flood plain forest (*mata de várzea*) and high-ground forest (*mata de terra-firme*). Flooded forest is permanently inundated, flood plain forest is only inundated in periods of high water, and high-ground forest, being located on elevated terrain, is not normally subject to inundation. Although the soils of the Amazon are poorly structured, the flood plains, which receive organic matter and mineral deposits during times of high water, are more fertile than the rest of the forest. During the dry season, the soils of the flood plains are used for subsistence agriculture by the people living along the river.

One of the distinguishing features of the Amazon region is the equilibrium between the forest with its dense and varied formations, the rich hydrography of what is the most well-watered river basin in the world, the hot humid climate and the soils which are generally poor but which receive great quantities of organic matter from the forest itself. Together this suite of conditions forms an intrinsic nutrient cycle which contributes to the forest's continued existence and to its natural bounty

Since the colonisation of Brazil, the Amazon region (Amazonia) has been despoiled in various ways depending on the availability of its natural resources and the economic necessities prevailing at the time. The 1970s saw an intensification of this process with increased rates of human occupation and of the extraction of its mineral and plant resources. At present, the main processes of despoliation are: deforestation for agriculture and cattle ranching; timber extraction and human occupation; mining, principally for iron, cassiterite, bauxite and gold; the agro-pastoral practice of burn-off (*queimadas*) used to clear pastures and also to open up roads etc. As a result, there is a noticeable alteration in the forest's nutrient cycles, undermining the very factors that support its continued existence.

According to the classification of phyto-regions established by the Radambrasil Project, the forest formation that predominates in the region of Araguaína and Araguatins is that of open mixed ombrophile forest (*floresta ombrófila aberta mista*) interspersed with palm groves. The open ombrophile forest region is characterised by trees of large size with the canopy being 20 to 30 metres high. The tallest species are: mahogany (*Swietenia macrophylla,* known locally as 'mogno'), cedrela (*Cedrella fissilis* known as 'cedro'), *Hymenaea stilbocarpa* ('jatobá'), *Miracrodruon urundeuva* ('aroeira'), *Tabebuia impetiginosa* ('ipê') and *Hymatanthus bracteosus* ('pau-de-leite'). The dominant stratum tends in practice to be mixed with strata of subordinate species. These comprise many kinds of rubiaceous and myrtaceous species as well as young trees belonging to the upper strata. Musaceous species, such as the Heliconia genus, and gramineous and sedge species, are found in the under-storey. Lianas and climbing plants are also present, and their emergence may be prompted by the opening up of small clearings following selective felling of the trees. The leaf litter layer has a depth of 3 to 8 cm. The soils tend to be sandy clays.

The floral composition of mixed open ombrophile forest is highly diverse with its most representative ecotopes being woody plants. Variations in vegetation type in the region are largely determined by edaphic factors, with sandy soils in low-lying areas being covered by forest in which babaçu palms occur with great frequency.

(c) Secondary growth formations

Secondary growth formations (known as *'capoeiras'*) in the region are characterised by vegetation cover with a high density of tree species, demonstrating various stages of succession. The strata are generally undefined and liana species are very frequent. The Bignoniaceae, Leguminosae and Malpighiacae families are the most predominant. Groves of

babaçu and inajá palms are also prominent in these environments and in some areas that have been subject to human disturbance they may achieve total dominance. Other tree species of various ecological groups are also common, notable examples being *Cecropia sp* ('embaúba'), *Cedrella fissilis* ('cedro') , *Bauhinia spp* ('unha-de-boi'), *Ingá sp* ('ingá'), and *Vitex sp* ('tarumã'), although the occurrence of adult populations of such species is rare.

2.3.3. Flora: Current Status and Endangered Species

➢ **Araguatins**

The town of Araguatins is located in the far north of the State of Tocantins, in the region known as the Parrot's Beak (*'Bico do Papagaio'*) which is marked by the contact between the two largest vegetation provinces in Brazil: the cerrado and the Amazon forest. The areas of contact between these two provinces occur in the form of interpenetrating peninsulas with the change in vegetation being determined by the type of substrate that prevails.

Variations can be noted in the two compositions: in the cerrado there is a predominance of cerrado type vegetation in the strict sense, and wooded savannah (*cerradão*); and in the Amazon forest, there is open ombrophile forest with babaçu palms. In environments where plant cover is cerrado *sensu stricto*, the substrate has sandy and well drained characteristics, the tree species have upright forms, but are of small size with cork-rich bark.

Wooded savannah areas (*cerradão*) arise in isolated enclaves and in more extensive areas where they represent the transition between cerrado and forest. The substrate is still sandy, but in lower proportions. The tree species present are larger, ranging between 8 and 12 metres high, and form a continuous canopy in areas which have been well preserved.

The region is dominated by ombrophile firest, which covers areas where the soil quality is good, rich in organic matter, and this allows the emergence and development of individuals of large stature reaching up to 25 m high with tecoma trees (*Tabebuia serratifolia*, known locally as 'ipê-amarelo') being particularly common, along with a great variety of palm trees, most notably the babaçu palm (*Attalea speciosa*). The region also possesses moist environments which are found in the valley bottoms associated with minor watercourses. In these, dense forest cover, denominated ciliary forests (*matas ciliares*), develops with gallery forests also being present.

Vegetation cover in areas occupied by ranches and settlements has been suppressed, especially in areas covered by babaçu palm groves where clearings for cultivation (*roças de toco*) and pasture have been estabished. In some areas, the annual practice of burn-off or *queimada* to stimulate regrowth in cattle pastures is common, as is the introduction of gramineous species such as brachyaria (*braquiária*) and bluestem (*andropogom*), and also Aristida, Panicum and some sedges of the Cyperus genus.

There are remnants of primary vegetation isolated in the midst of pastures, or in small agglomerations and narrow strips along the smaller watercourses form. Notable species in these forest remnants include the yellow mombin or 'cajazeiro' (*Spondias lutea*), the tecoma or 'ipê amarelo' (*Tabebuia serratifolia*), the 'chichá' (*Sterculia strita*) and *Simarouba sp.*

The region's most representative species are: babaçu palms (*Attalea speciosa*), 'mato-cachorrro' (*Simarouba sp.*), 'sucupira-preta' (*Bowdichia virgiloides*), 'faveira' (*Dimorphandra mollis*), 'angelim-do-campo' (*Andira sp.*), 'vinhático' (*Plathymenia reticulata*), 'caraiba' (*Tabebuia caraiba*), 'tucum-rasteiro' (*Astrocaryum campestre*) and 'botão-de-ouro' (*Xyris sp*).

High quality timber species found in the region include the 'vinhático' (*Plathymenia reticulata*) and the 'sucupira-branca' (*Pterodon pubescens*), as well as palms such as the 'bacaba' (*Oneocarpus distichus*), 'macaúba' (*Acrocomia aculeata*), and 'bacuri' (*Attalea phalerata*), as well as the 'tucum' (*Astrocaryum sp*).

With regard to the species that are representative of the ciliary forests (*matas ciliares*), those which occur most frequently are the 'bingueiro' (*Cariniana rubra*), the 'colhereiro' (*Hyeronima alchorneoides*), the 'marinheiro' (*Guarea guidonia*), the 'palmito' (*Euterpes sp.*), the buriti palm (*Mauritia vinifera*), the 'urucum' (*Bixa orelana*), the 'lírio-de-são-josé' (*Hedychium coronarium*), the 'bananeira-de-pendão' (*Musa sp.*) and the 'bananeira-do-mato' (*Heliconia sp.*).

➢ **Araguaína**

The municipality of Araguaína is situated in the Northern Region of the State of Tocantins around 400 km north of the capital Palmas. The vegetation here, as in all of the Northern Region of the State, is characterised by the transition between cerrado and the ombrophile Amazon forest. Cerrado vegetation predominates, and is characteristic of soils where available water and nutrients are low. Associated with the cerrado are gallery forests which grow on the banks of

watercourses and form forest corridors in a landscape that is dominated by open formations while, in the east of the municipality, open ombrophile forest characteristic of the Amazon domain is more prevalent.

The physiognomy of the cerrado in the municipality displays variations ranging from sparse savannah (*cerrado ralo*), through true savannah to wooded savannah (*cerradão*). Many of these vegetation types have been significantly altered by human action as the cerrado generally is highly sensitive to environmental change.

Despite the great quantity of available land, most areas have already been subject to some form of human exploitation in the past so examples of primary vegetation are rare.

Most of the land in the municipality of Araguaína is used for pasture under extensive cattle ranching systems which are characterised by low utilisation efficiency. The practice of burn-off (*queimada*) is utilised in the maintenance of these pastures. Due to these *queimadas*, the original cover of the cerrado and of the ombrophile forest region has suffered extensive damage, and this has also caused problems by damaging the local fauna and even the health of the region's human inhabitants.

In the west of the municipality of Araguaína, ombrophile forest predominates occurring on deeper, more fertile soils, and here individual species of large stature such as mahogany *(Swietenia macrophylla)*, 'ipê' (*Tabebuia serratifolia*), 'aroeira' *(Myracroduon urundeuva)*, 'sucupira-preta' *(Bowdichia virgiloides)* can be found. Selective logging is practised in this region, and this has noticeably reduced the number of individuals of species with high commercial value. The presence of palm species can also be noted, with species such as the 'macaúba' (*Acromia aculeata*) and the 'inajá' (*Attalea maripa*) predominating, the latter species being a successful coloniser which occupies the spaces left by logging activities.

In general terms, the species which are most representative of the region are: 'inajá' (*Attalea maripa*), 'macaúba' *(Acromia aculeata)*, 'ipê' (*Tabebuia serratifolia*), 'fava-de-bolota' (*Parkia platycephala*), 'faveira' (*Dimorphandra mollis*), 'jatobá' *(Hymenaea courbaril)*, 'angelim do campo' *(Andira sp)*, 'bacaba' (*Oneocarpus distichus)*, the 'buriti' palm (*Mauritia flexuosa)*. In the ciliary forests (*matas ciliares*) representative families and species include: Burseraceae *(Protium* spp.), Clusiaceae *(Calophyllum brasiliense, Clusia* spp.), Euphorbiaceae *(Richeria grandis)* and Magnoliaceae *(Talauma ovata),* and there are also significant numbers of species from the following families: Melastomataceae *(Miconia* spp., *Tibouchina* spp.), Piperaceae *(Piper spp.)* and Rubiaceae (e.g. *Coccocypselum guianense, Ferdinandusa speciosa, Palicourea* spp. and *Posoqueria latifolia).*

2.3.4. Fauna: Current Status and Endangered Species

➢ **Araguatins**

The fauna in the Araguatins region is abundant when compares to other regions of the State, although many species have been the victims of indiscriminate hunting and fishing and/or have been forced to seek new refuges following the deterioration of their natural habitats, which are now occupied by extensive cattle ranches or agricultural systems cultivating non-native species. This process, alongside that of timber extraction, has given rise to the deforestation of large areas. For this reason, some populations of the region's autochtonic fauna, especially those of the larger mammalian species, are now endangered, due to the large-scale transformation of their natural habitats.

Nonetheless, there is great diversity of fauna present and, for the most part, the fauna species have a wide geographic distribution and includes some species which can be found throughout South America. This high biodiversity results from the fact that the region is located in a zone of ecological transition between the Cerrado (Brazilian savannah) and the Amazon forest.

With regard to the avifauna of the region, the habitat alteration resulting from the substitution of wooded areas for pasture has benefited bird species which are characteristic of open environments at the cost of those that favour closed environments. The region boasts the occurrence of a number of species which IBAMA, the Brazilian environment agency, has classified as endangered (an example being the blue macaw). Such species are most in evidence in the region's conservation areas. The capture of birds is common in the region, with members of the parrot (*Psitaccidae*), oriole (*Icteriadae)* and *Fringilidae* families being most frequently targeted. A number of species are also raised in captivity, examples being *Oryzoborus angolensis* (the 'curió'), *Sporophila lineola* (known locally as 'bigodinho'), *Icterus icterus* (the 'sofrê'), *Aratinga solstitialis* (the yellow-headed parakeet or 'jandaia') and the green parrot (*Amazona aestiva*).

Several species of carnivore are presently very rare in the region where once they were common. Among these are the painted jaguar (*Panthera onca*), the puma (*Felis concolor*) and the otter species *Pterobura brasiliensis* and *Lutra longicaudis*. Species such as the 'paca' or spotted cavy (*Agouti paca*), the agouti (*Dasyprocta azarae*), the armadillo (*Euphractus sexcinctus*) and the capybara (*Hydrochaeris hydrochaeris*), which are hunted and serve as food for the local inhabitants, can still be found although in small numbers.

In terms of icthyofauna, the region does not has the same quantity that it had decades ago, but in the large rivers wich as the Araguaia and the São Martinho, quite a good number of species are represented, including some which are threatened in other regions, for example the *Brachyplatystoma* species (the 'surubim'), and two *Cichla* species *(Cichla ocellaris* – the 'tucunaré-açu' and *Cichla temensis* - the 'tucunaré').

The region also boasts a large number of lacertilian (lizard) species which have a widespread distribution and include *Tropidurus torquartos* (the 'papa-vento'), *Ameiva ameiva* (the 'calango-verde'), *Hemidactylus mabouya* (the 'lagartixa'), *Tupinambis spp.* (known locally as 'teiú') and the iguana (*Iguana iguana*).

With regard to the region's ophidian (snake) species, the presence of the anaconda (*Eunectes murinus* - known locally as the 'sucuri') and the boa constrictor (*Boa constrictor amarali* - known locally as the 'jibóia') can be highlighted, in addition to others such as *Liophis sp.* ('cobra-de-capim'), *Helicops sp* ('cobra-d'água'), *Chironius carinatus* ('cobra-cipó'), *Mastigodryas bifossatus* ('jaracuçu-do-brejo') and *Spilotes pullatus* ('caninana'). The region's inhabitants also report the presence of the rattlesnake or 'cascavel' (*Crotalus d. collilineatus*), as well as the 'jararaca' and 'jaracussu' pit vipers (*Bothrops niwiedii* and *B. moojeni*). Among the region's most frequently occurring amphibians, the presence of several species of tree frogs or 'pererecas' (*Hyla ssp.*) and frogs of the *Leptodactylus* genus as well as the 'cururu' toad (*Bufo paracnemis*) can be highlighted.

➢ **Araguaína**

Due to habitat destruction as a result of deforestation and burning (*queimadas*) and to hunting pressures, the numbers of some species of fauna in the Araguaína municipality, in particular mammalian species which require large territories, have been reduced to just a few individuals and sightings of these are rare. Despite this, the calls of a group of howling monkeys *(Alouatta caraya)* and faeces of the agouti *(Dasypprocta fuliginosa)* were observed by the survey team and, according to reports of local inhabitations, the *Mazama americana* deer ('veado mateiro"), the whie-lipped peccary or 'queixada' *(Tayassu pecari)*, the 'paca' or spotted cavy *(Agouti paca)*, the cougar or 'suçuarana' *(Felis concolor)*, the capybara *(Hydrochaeris hydrochaeris)*, the spotted leopard cat or 'jaguatirica' *(Leopardus pardalis),* and the *Euphractus sexcintus* armadillo are also present although they are sighted but rarely.

With regard to the avifauna, species which have very specific requirements in terms of habitat or diet have tended to migrate to the better preserved areas while those which are characteristic of open habitats have been favoured. Some rare species, such as the king vulture or 'urubu rei' *(Sarcorhamphus papa)* can still be found.

Some of the region's commoner species include the rhea *(Rhea americana)*, the tinamou or 'jaó' *(Tinamus gutattus)*, the Brazilian lapwing or 'quero-quero' *(Vanellus chilensis)*, the 'rolinha' dove *(Columbina minuta)*, the black-beaked toucan *(Ramphastos vitellinus)*, the common ani *(Crotophaga ani)* and the crested seriema *(Cariama cristata)*.

With regard to the resion's icthyofauna, reports by local inhabitants suggest that there has been a reduction in the numbers of the more sought after species such as the 'surubim' *(Pseudoplatystoma)* and the 'pirarucu' *(Araipama gigas)* which is said to be the largest freshwater fish in the world and which is in danger of extinction. Fishing for these two species is governed by the Directives Nº 002/98 dated 16/02/1998, and N° 003/90 dated 29/03/90, respectively.

Given the size of the territory and the complexity of Amazonian and cerrado communities, knowledge of the herpetofauna (reptiles) is still limited but it is known to be influenced by the Amazon biome.

The clearing of vegetation has a strong effect on lizard population dynamics with heliophytic and opportunist species such as *Ameiva ameiva*, *Kentropyx calcaratus* and *Tropidurus plica* (Vitt & Colli, 1992; Vitt 1991a; 1991b; Vitt & Torre, 1995), showing a significant increase in numbers. Invasive species (e.g. *Hemidactylus mabouia*) which are always associated with human presence are also found.

The cayman *(Caiman crocodilus)* and the freshwater turtle *(Podocnemis expansa)* are both considered desirable food sources. According to reports from local inhabitants, they have become rare and, despite being easily recognisable, they are seldom sighted. Animals of medical interest, such as poisonous snakes, are widely known and feared and their

presence is the subject of legends and exaggerations. Some of the better known snakes such as the boa constrictor *(Boa constrictor)* and the anaconda *(Eunetes murinus)* are part of the cultural mythology of the region.

Species that have specialised in particular habitats and which have specific requirements in terms of the supply and quality of natural resources have been the ones most affected by the environmental alteration which has occurred in the municipality.

The habitat types listed below in association with each species indicate its preferred habitat. However, it should be noted that some of the animals may also frequent habitats other than those listed.

The habitat key is as follows:
C- Cerrado (*sensu strictu*)
AA- Environments altered by human impact
CE- Cerradão (wooded cerrado)
AQ- Aquatic environments
Ca – Open savannah
LO- Lotic environments (streams, rivers, etc.)
LE- Lentic environments (ponds, lakes, etc.)
F- Forest
M- Marshes, springs and damp or waterlogged areas ('veredas')
COS- Cosmopolitan

Table 23. List of plant species found in the Araguatins and Araguaína municipalities

SCIENTIFIC NAME	COMMON NAME	HABITAT
Alibertia edulis	Marmelada	F
Chomelia martiana	Eludo	F
Astronium fraxinifolium	Gonçaleiro	C
Tapiria guianensis	Pombeiro	CE
Myracrodruon urundeuva	Aroeira	F
Spondias lutea	Cajazinha	F
Andira anthelmia	Angelim	F
Bowdichia virgiloides	Sucupira -preta	C/CE
Dalbergia sp.	Tropeiro	C
Erythrina mulungu	Mulungu	M/CE
Machaerium acutifolium	Jacarandá	M/CE
Pterodon pubescens	Sucupira-branca	C/CE
Dioclea sp.	Mucunã	F
Andira sp.	Angelim-do-campo	C
Apeib tiborbou	Jangada	F
Luehea sp.	Açoita-cavalo	CE/F
Apuleia mollaris	Garapa	F/M
Bauhinia spp	Unha-de-boi	F
Hymenaea courbaril	Jatobá	C/CE/A
Hymenaea stigonocarpa	Jatobá-do-campo	F
Hymenaea sp.	Jatobá-de folha-média	C/CE
Aristida sp	Capim-barba-de-bode	C/Ca
Brachiaria spp.	Capins-braquiaria	AA
Imperata brasiliensis	Sapé	F/M
Melinis minutiflora	Capim-gordura	C/M/A
Panicum sp.	Capim-do-campo	AA
Hyparrhenia rufa	capim-jaraguá	C/AA
Panicum maximum	Capim-colonião	AA
Andropogon sp.	Capim andropogon	AA
Astrocaryum sp.	Tucum	M/F
Attalea speciosa	Babaçu	F/M/A
Attalea maripa	Inajá	F
Mauritia vinifera	Buriti	M/F
Mauritiella armata	Buritirana	F/M

Oneocarpus distichus	Bacaba	F/CE
Sacheelea phalerata	Bacuri	F/A
Sygrus comosa	Gapiova	C/Ca
Astrocaryum campestre	Tucum-rasteiro	C
Attalea Maripa	Ingá	F
Acrocomia aculeata	Macaúba	CE/F
Acrocomia intumescens	Macaúba barriguda	CE/F
Brosimum gaudichadii	Mama cadela	C/Ca
Ficus spp	Gameleiras	F
Byrsonima subterranea	Murici-anão	C
Byrsonima sp.	Murici-peludo	C
Peixotoa sp.	Peixotoa	C/Ca
Calophyllum brasiliensis	Landi	F/M
Cariniana rubra	Bingueiro	F/M
Caryocar sp.	Pequizeiro	CE
Connarus suberosus	Bico-de-papagaio	C
Costus spiralis	Cana-de-macaco	M
Hedychium coronarium	Lírio-de-são-josé	M/F
Crcropia spp	Imbaúbas	F/M/A
Cupania vernalis	Assa-leitão	F/A
Serjania sp.	Timbó	F
Magonia pubescens	Tingui	F/CE
Cuphea sp.	Sete-sangrias	C/Ca
Physocalymma sacaberrimun	Nó-de-porco	CE
Davila ellitica	Lixinha	C/Ca
Curatella americana	Lixeira	C/Ca
Didymopanax macrocarpum	Mandiocão-do-campo	C
Dioscorea sp	Cará-do-cerrado	C
Diospyros hispida v. camporum	Fruta-de-cotia	C
Erythroxylum sp.	Pau-de-rolinha	C/Ca
Guarea guidonia	Marinheiro	F
Hymathanthus obovatus	Pau-de-leite	C
Aspidosperma macrocarpon	Guatambu-do-campo	C
Hyronima alchorneoides	Colheiro	F
Sloanea monosperma	Ouriceiro	F
Sapium grandulatum	Leiteiro	F
Miconia sp.	Chumbinho	F/M
Tibouchina sp.	Quaresmeira	F/M/A
Tibouchina sp.	Quaresmeira-do-cerrado	C
Musa sp	Bananeira-do-mato	F/M
Heliconia sp.	Bananeirinha	F/M
Nectrandra sp.	Canela Branca	F
Ocotea	Canela	F
Ouratea hexasperma	Amescla-do-campo	C/Ca
Philodendron bipinnatifidum	Cipó-imbé	F
Piper sp	Jaborandi	F/M
Plathymenia reticulata	Vinhático	C
Stryphnodendron sp.	Barbatimão	C
Dimorphandra mollis	Faveiro	C
Parkia platycephala	Fava-de-bolota	CE/AA
Acacia polyphilla	Monjolo	F
Calliandra sp.	Mimosa	C
Enterolobium contortisiliquum	Tamboril	F/A
Sclerolobium paniulatum	Carvoeiro	CE
Protium heptaphillum	Almesca	F
Pseudobombax sp.	Imbiruçu	CE
Erytheca gracilipes	Algodoeiro	CE

Pachia aquatica	Manguba	F/A
Rapanea guianensis	Pororoca	F/M
Rhamnidium elaeocarpum	Cafezinho	F/M
Rhynchospora sp.	Capim-navalha	F
Cyperus sp	Capim-do-campo	C
Salacia crassifolia	Bacupari	C/Ca
Salacia sp.	Bacupari	C
Simarouba sp.	Mata-cachorro	C/Ce
Smilax sp.	Japecanga	C/CE/A
Styrax ferrugineus	Laranjinha-do-cerrado	C/CA
Tabebuia impetiginosa	Ipê-roxo	F
Tabebuia ochracea	Ipê-do-cerrado	C
Tabebuia serratifolia	Ipê-amarelo	F
Tabebuia caraiba	Caraíba	C
Terminalia argentea	Capitão	C/CE
Trema micrantha	Candiúba	F/A
Vitex polygama	Tarumã	F/CE
Virola sebifera	Pindaíba-ferrugem	
Xylopia aromatica	Pimenta-de-macaco	CE
Annona spp	Araticuns	C/CE/A
Xyris sp.	Botão-de-ouro	M

Table 24. List of mastofauna species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
Agouti paca	Paca	F/CE/C
Dasyprocta azarae	Cutia	F/CE/C
Allouata caraya	Guariba	F/CE
Cebus apella	Macaco-prego	F/CE/C/A
Callithrix sp.	Mico	F/CE/C/A
Cavia sp.	Preá	F/CE/C/Ca
Cerdocyon thous	Cachorro-do-mato	F/C/CE/A
Chrysocyon brachyurys	Guará	C/Ca/A
Dusicyons vetulus	Raposinha	C/CE/A
Coendou prehensilis	Ouriço-cacheiro	F/CE
Dasypus novemcinctus	Tatu-galinha	Cosm.
Euphractus sexcinctus	Tatu-peba	Cosm.
Cabassous unicinctus	Tatu-de-rabo-mole	CE/C/Ca
Didelphis albiventris	Gambá	Cosm.
Didelphis marsupialis	Gambá	Cosm.
Chirocectes sp.	Cuíca-d'água	AQ/M
Eira barbara	Irara	CE/C
Galictis sp.	Furão	M/CE/C
Lutra sp.	Lontra	F/AA
Felis widii	Gato-maracajá	F/CE/C/M
Felis tigrina	Gato-do-mato	F/CE/C/A
Felis parfalis	Jaguatirica	F/CE/C/M
Felis concolor	Suçuarama	F/CE/C/M
Felis yaguaroundi	Gato-mourisco	F/CE/C/M
Panthera onca	Onça-pintada	F/CE/C/M
Hydrochaeris hydrochaeris	Capivara	F/AQ
Mazana americana	Veado-mateiro	F/C/CE
Mazana gouazoubira	Veado-catingueiro	
Mus musculus	Camundongo	A
Rattus norvegicus	Ratazana	A
Rattus rattus	Rato-de-casa	A
Myrmecophaga tridactyla	Tamanduá-bandeira	C/Ca
Tamandua tetradactyla	Tamanduá-mirim	C/Ca

Nasua nasua	Quati	F/CE/C/A
Procyon cancrivorus	Mão-pelada	F/CE/AA
Oryzomys sp.	Rato-de-mato	F/CE/C/Ca
Proechimys longicaudatus	Soiá	F/CE
Sylvilagus brasiliensis	Tapiti	CE/C/Ca
Tapirus terrestris	Anta	F/CE/C/AQ

able 25. List of avifauna species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
Alanus lecucurus	Gavião-peneira	C/Ca/A
Buteo magnirostris	Gavião-carijó	C/Ca/CE/F/A
Gampsonix swainsonii	Gaviãozinho	F/C/CE
Amazilia fimbriata	Beija-flor-gargante-verde	F/CE/M/A
Antharacothorax nigricollis	Beija-flor-preto	F/CE/M
Phaethornis pretei	Limpa-casa	Cosm.
Eupetomena macroura	Beija-flor-tesourão	COSM
Colibri serrirostris	Beija-flor-orelha-violeta	C/Ca/A
Chorestes notatus	Beja-flor-garganta-azul	F/CE/M
Anhima cornuta	Inhuma	F/AQ
Anhinga anhinga	Biguatinga	F/AQ
Anthilopia galeata	Soldadinho	F/CE
Ara ararauna	Canindé	F/CE/C/M
Ara nobilis	Maracanã	F/CE/C/Ca/M
Aratinga aurea	Periquito-rei	F/CE/C/Ca/M
Aratinga solstitialis	Jandaia	F/M
Aramides cajanea	Três-potes	F/AQ/M
Gallinula chloropus	Frango-d'água	F/AQ/M
Laterallus sp.	Pinto-d'água	F/AQ/A/M
Porphyryla martinica	Frango-d'água-azul	F/AQ/M
Ardea cococi	Socó-grande	Ca/F/A/AQ
Casmerodius albus	Garça-branca-grande	Ca/AQ Ca/F/A/AQ
Egrtta thula	Garça-branca-pequena	Ca/F/A/AQ
Pinherodius pileatus	Graça-real	Ca/A
Bubulcus íbis	Garça-vaqueira	
Athene cunicularia	Coruja-buraqueira	Cosm.
Glaucidium brasilianum	Caboré	F/CE/C/
Rhinoptynx clamator	Coruja-orelhuda	F/CE/C/CA/M
Brotogeris chiriri	Periquito	F/CE/C/M/A
Forpus sp.	Tuim	F/CE/C/M/A
Amazona xanthops	Papagaio-galego	F/CE/C/Ca/M
Amazona aestiva	Papgaio-verdadeiro	F/CE/C/Ca/M
Cacius cela	Xexéu	F/CE/C/A
Molothrus bonariensis	Chopim	C/Ca/A
Psarocolius decumanus	Rei-congo	F/CE
Cacius haemorrhous	Guaxe	F/CE/M/A
Pseudoleistes guirahuro	Chopim-do-brejo	F/M/AQ
Icterus cayanensis	Encontro	F/CE/C/A
Icterus icterus	Sofrê	F/CE/C/M
Gnorimopsar chopi	Pássaro-preto	C/Ca/M/A
Caprimulgus sp.	Curiango	F/CE/C
Podager nacunda	Corujão	C/CA/A
Cariama cristata	Seriema	C/Ca/A
Ceryle torquata	Matraca	F/M/AQ
Chloroceryle americana	Martim-pes.-pequeno	F/M/AQ
Chloroceryle amazona	Martim-pescador-verde	F/M/AQ
Colaptes campestris	Pica-pau-do-campo	C/Ca/A
Celeus flavescens	Pica-pau-cabeça-amarela	F/CE/C/Ca/A

Droyocopus lineatus	Pica-pau-bonda-branca	F/CE/C/A
Melanerpes candidus	Birro	C/CA/M/A
Picumnus sp.	Pica-pau-anão	F/CE/C/A
Columba picazuro	Asa-branca	COSM
Colimba speciosa	Pomba-galega	F/CE/C/Ca
Senaida auriculata	Pomba-de-bando	C/Ca/A
Columbina talpacoti	Rolinha	C/Ca/F/CE/A
Scardafella squammata	Fogo-pagou	COSM
Leptotila sp.	Juriti	F/CE
Crotophaga ani	Anu-preto	COSM.
Guira guira	Anu-branco	COSM.
Piaya cayana	Alma-de-gato	F/CE
Cyclarhis gujanensis	Gente-de-fora-vem	F/CE
Cynocorax cyanopogon	Cancã	F/CE/C
Cyanocorax cristatellus	Gralha-do-campo	C/Ca
Dendrocygna viduta	Paturi	F/AQ
Dendrocygna viduta	Marreco-cabocla	F/AQ
Cairana moschata	Pato-do-mato	F/AQ
Donacobius atricapilus	Sabiá-do-brejo	M/AQ
Minus saturninus	Sabiá-do-campo	C/Ca/A
Euphonia chlorotica	Vivi	F/CE/M
Tangara cayana	Saíra-amarela	CE/C/Ca/A
Thraupis palmarum	Sanhaço-do-coqueiro	M/A
Thraupis sayaca	Sanhaço-cinzento	CE/C/M/A
Piringa flava	Sanhaço-de-fogo	F/CE
Cissopis leveriana	Tietinha	F/CE/C
Folco femoralis	Falcão-de-coleira	CE/C/Ca/A
Falco sparverius	Quiri-quiri	CE/C/Ca/A
Milvago chimachima	Pinhé	C/Ca/A
Polyborus plancus	Carcará	F/CE/C
Furnarius rufus	João-de-barro	F/CE/C/Ca/A
Synallaxis spixi	João-teneném	C/Ca
Galbula ruficauda	Bico-de-agulha	F/M/AQ
Jacana jacana	Jacanã	F/AQ/M
Lepdocolaptes sp.	Arapaçu	F/CE
Xiphorhynchus guttatus	Arapaçu-verde	F/CE/M
Momutus momota	Juruva	F/CE
Mossa nigrifrons	Bico-de-brasa	F/CE/M/A
Nystalus chacuru	João-bobo	C/Ca/A
Mycteria americana	Cabeça-seca	F/AQ
Jabiru mycteria	Tuiuiú	AQ/M
Nyctibius sp.	Urutau	F/C/CE/M
Penelope superciliasris	Jacupemba	F/CE/M
Crax fasciolaata	Mutum-de-penhacho	F
Phaethusa simples	Trinta-réis	AQ
Phalacrocorax olivaceus	Binguá	F/AQ
Pteroglossus aracari	Araçari-de-bico-branco	F/C/M
Ramphastos toco	Tucanoçu	F/CE/C/M
Ramphastos dicolorus	Tucano-de-bico-verde	F/CE/M
Reinarda squamata	Tesourinha	C/Ca/M
Rhynchotus rufescens	Perdiz	C/Ca/A
Crypturellus sp.	Inhambu	C/C/A
Crypturellus undulatus	Jaó	F/CE
Nothura sp.	Codorna	C/CE/A
Sarcorhamphus papa	Urubu-rei	F/CE/A/Ca
Coragyps atratus	Urubu-comum	COSM
Cathartes burrovianus	Urubu-cabeça-amarela	F/CE/C/Ca

Cathartes aura	Urubu-cabeça-vermelha	C/CE/F/Ca
Tachycineta albiventer	Andorinha-do-rio	F/AQ
Phaeoprogne tapera	Andorinha-do-campo	C/Ca/A
Stelgidopterix ruficollis	Andorinha-serrado	C/Ca/A
Thamnophilus doliatus	Choca-barrada	F/CE/C
Theristicus caudatus	Curicaca	C/Ca/A
Mesembrinibis cayennensis	Corococó	F/AQ
Trogodytes aedon	Cambaxirra	F/CE/C/Ca/A
Trongo sp.	Surucuá	F/CE
Turdus amaurochalinus	Sabia poca	F/CE
Turdus rufiventris	Sabiá-çaranjeira	F/CE/M/A
Vanellus chilensis	Quero-quero	C/Ca/A/AQ
Charadrius collaris	Baturí-de-coleira	Ca/A/AQ
Volatinia jacarina	Tiziu	C/Ca/A
Sporophila spp.	Papas-capim	Ca/A
Oryzoborus angolensis	Curió	F/M
Sporophila lineola	Bigodinho	C/Ca/A
Saltator atricollis	Bico-de-pimenta	C/CA/A
Xolmis cinerea	Maria-branca	C/Ca/A
Colonia Colonus	Viuvinha	F/CE/M/AQ
Arundinicola leucocephala	Freirinha	F/M/AQ
Tyrannus savana	Tesourinha	C/Ca/A
Tyrannus melancholicus	Suiriri	C/Ca/M/A
Pitangus sulphuratus	Bem-te-vi	F/CE/C/A

Table 26. List of amphibian species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
Bufo paracnemis	Sapo-cururu	COSM
Bufo sp.	Sapo	F/CE/M/AQ
Hyla raniceps	Perereca	F/M/AQ
Hyla fuscovaria	Perereca	F/M/AQ
Phrynohias venulosa	Perereca	F/M/AQ
Leptodactyllus labirintesticus	Rã-pimenta	M/AQ
Leptodactylus ocellatus	Rã-manteiga	M/AQ
Physalaemus cuvieri	Ranzinha	F/M/AQ

Table 27. List of ophidian species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
Boas constrictor	Jibóia	F/AQ
Eunectes murinus	Sucuri	F/M/AQ
Bothrops moojeni	Jaracussu	F/CE/C/M
Bothrops niwiedii	Jararaca	F/CE/C/M/A
Crotalus d. Collineatus	Cascavel	C/CA/A
Chironius carinatus	Cobra-cipó	F/CE
Helicops sp.	Cobra-d'água	AQ
Liophis sp.	Cobra-de-capim	C/CE/Ca/A
Mastigodryas bifossatus	Jaracussu-do-brejo	F/M/AQ
Spilotes pullatus	Caninana	F/CE/C/M/A
Wagleropohis merremii	Boipeva	F/CE/C/M/A
Leptotyphlops sp.	Cobra-cega	COMS

Table 28. List of turtle species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
	Jabutí	F/CE
Hydromedusa maximilliani	Cágado	AQ
Phrynops sp.	Cágado	AQ
Platemis radiolata	Cágado-amarelo	AQ
Podocmenis expansa	Tartaruga	AQ

Podocmenis unifilis	Tracajá	AQ

Table 29. List of reptile species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
Ameiva ameiva	Calango-verde	COSM
Tupinambis sp.	Teiú	C/CE/F/Ca
Cnemidophorus ocelifer	Calango	CE/F/Ca
Colobossaura modesta	Calanguinho	CE/F/Ca
Amphisbaena sp.	Cobra-de-duas-cabeças	F/CE/C/M/A
Anolis chrysolepis	Papa-vento	F/CE/C
Iguana iguana	Iguana	F/AQ/M/A/ COSM
Tropidurus torquatus	Largatixa-preta	
Gymnodactylus geckoides	Lagartixa	F/CE/C
Hemidactylus mabouya	Lagartixa	A
Mabuya bistrita	Calango	C/Ca/A

Table 30. List of crocodilian species found in the Araguatins and Araguaína municipalities.

SCIENTIFIC NAME	COMMON NAME	HABITAT
Caimam crododilus	Jacaretinga	AQ
Melanosuchus niger	Jacaré-açu	AQ

Table 31. List of icthyofauna species found in the Araguatins and Araguaína municipalities

SCIENTIFIC NAME	COMMON NAME	HABITAT
Acestrorhynchus falcatus	Peixe-cachorro	LO
Hydrolycus scomberoides	Cachorra	LO
Rhaphiodon vulpinis	Peixe-ripa	LO
Triportheus spp.	Sardinhas	LO/LE
Brycon Brebicauda	Matrichã	LO
Achirus achirus	Peixe-folha	LO
Arapaima gigas	Pirarucu	LO
Bourengerella sp	Bicuda	LO
Cichlasoma spp.	Acarás	LO/LE
Cichla ocellaris	Tucunaré-açu	LO/LE
Cichla temensis	Tucunaré-pintado	LO/LE
Crenicichla spp.	Joana-mole	LO/LE
Geophagus surinamensis	Acará-tinga	LO/LE
Geophagus spp.	Acarás	LO/LE
Astronotus ocellatus	Apaiari	LO/LE
Eletrophorus eletricus	Peixe-elétrico	LE/LO
Hoplias malabaricus	Traíra	LE/LO
Pachypops furcraeus	Corvina	LO
Pachyurus schomburgkii	Corvina-pintada	LO
Semaprochilodus brama	Jaraqui	LE/LO
Prochilodus nigricans	Curimatã	LE/LO
Curimata spp.	Branquinhas	LO/LE
Serrasalmus nattereri	Piranha-caju	LE/LO
Serrasalmus rhombeus	Piranha	LE/LO
Serrasalmus sp.	Piranha	LE/LO
Myleus spp.	Pacus	LO
Mylossoma duriventre	Pacu-manteiga	LO
Colossoma brachypomum	Caranha	LO
Shizodon vittatum	Piau-pororoca	LO
Leporinuns friderici	Piau-verdadeiro	LO
Leporinus affinis	Piau-listrado	LO
Leporinuns trifasciatus	Piau-cabeça-gorda	LO
Ageneiosus brevifilis	Fidalgo	LO
Auchenipterus nuchalis	Mandi-peruano	LO
Hemisorubim platyrhynchus	Bico-de-pato	LO
Phractocephalus hemiliopeterus	Pirarara	LO

Paulicea lutkeni	Jaú	LO
Brachyplatystoma filamentosum	Filhote	LO
Pseudoplatystoma fasciatum	Surubim	LO/LE
Pimelodella cristata	Mandi	LO
Pimelodus blochii	Mandi	LO
Pirinampus pirinampu	Barbado	LO
Pumelodina flavipinnis	Mandi-moela	LO
Pseudocanthicus sp.	Acari	LO
Panaque nigrolineatus	Cascudo-de listras	LO
Hypostomus sp.	Cascudo	LO
Hemiancistrus sp.	Cascudo	LO
Pseudoloricaria punctata	Cascudo-viola	LO
Pseudoras niger	Cuiu-cuiu	LO
Pterodoras granulosus	Cuiu-cuiu	LO
Hassar sp.	Botinho	LO

2.4. Description of the Human Environment

2.4.1. Methodology

The methodology adopted to analyse social and economic impacts on the human environment resulting from interventions in the rural area is that of "sustainable livelihoods". "Sustainable livelihoods is a way of thinking about the objectives, scope and priorities for development, in order to enhance progress in poverty elimination" (Ashley & Carney, 1999, pg.1). This methodology is directly connected with the words "development" and "poverty". It may be used in understanding the complex reality of small and medium-scale rural producers because it is a holistic conceptual system which aims to provide a structure to help any external support to be congruent with the priorities of the target group.

2.4.1.1. Methods

The first phase of the research was conducted in Palmas with the collection of statistical data from the State Secretariats, the Small Business Support Service (SEBRAE), the Brazilian Institute for Geography and Statistics (IBGE) and other public institutions.

In the second phase, participative methods were used to gather information from the inhabitants of rural communities. These included: tendency analysis, individual interviews and drawings expressing respondents' perceptions of the possible future. The field work was conducted over the period 7-12 December, 2000 in the Araguaína and Araguatins municipalities, with two rural settlements being selected in the former, and a rural community and a settlement being surveyed in the latter municipality.

Table 32. Profile of the 201 respondents in the field research

GENDER / AGE	0 to 14	15 to 25	26 to 40	41 to 60	Total
Male	26	5	29	69	129
Female	15	6	22	29	72
Total	41	11	51	98	201

Source: Santos (2000).

a) Group work

Tendency Analysis: 160 adults were led to discuss changes in aspects of their lives from the time of their arrival in the community to the present day. They were also asked to discuss their perceptions of the future (within a 10-year horizon) with regard to these same aspects.

Drawing if the possible future: 41 children aged up to 14 years old were asked to draw pictures expressing how they envisaged the possible situation of the community in 10 years' time.

b) Interviews

Semi-structured interviews were conducted with certain key informants in order to indirectly obtain information on the five capital types established by the sustainable livelihoods methodology (discussed below).

2.4.1.2. Sustainable Livelihoods

This research makes use of the definition of sustainable livelihoods originally developed by Robert Chambers and Gordon Conway (Chambers & Conway, 1992) and slightly modified by Scoones:
"A livelihood comprises the capabilities (a term created by Amartya Sen)*, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base" (Carney, 1998: 4).*

Chambers and Conway define sustainable livelihoods as an integrating concept that links equity, capability and sustainability. Equity can be defined as incorporating relative income distribution, more equal distribution of assets and less discrimination, especially against women and the less educated. Capability, as defined by Amartya Sen (Sen, 1984, cited in Chambers & Conway, 1992), refers to being able to perform certain basic functions, this includes what a person is capable of doing, how able they are to cope with stress and shocks, and how they make use of livelihood opportunities. The authors define shocks as sudden, unpredictable and traumatic events, for example, fires, floods and epidemics. Stresses materialise as pressure which is typically continuous and cumulative, predictable and distressing such as seasonal shortages. Capability can include access to food, income and assets, which are divided into tangible and intangible. The former can be financial resources and stocks, and the latter may be the skill required to make assert one's rights and/or ease of access to different areas. Sustainability is a versatile synonym for something positive or good, but it is difficult to find a single definition of the word.

Scoones subsequently developed a framework for investigating whether livelihoods are sustainable or not. According to his paper, this framework can be applied at a range of scales, for example, at the level of an individual, or a family, or community, or town or region or even a country (Scoones, 1998: 5). The author argues that the ability to pursue different livelihood strategies is dependent on the basic material and social assets that people have in their possession. Scoones identifies five different assets which he calls "capitals", making use of an economic metaphor. These five "capitals" are: natural, economic or financial, human, social and other. In the same year (1998), DFID adapted the Scoones framework, renaming the fifth capital "physical" capital.

These capitals can be better understood by using the definitions proposed by Scoones and DFID:
Natural capital: the natural resource stocks (soil, water, air, generic resources etc.) and environmental services (hydrological cycle, pollution sinks etc) from which resource flows and services useful for livelihoods are derived.
Financial capital: the capital base (cash, credit/debt, savings and other economic assets) which are available to people and which provide them with different livelihood options.
Human capital: the skills, knowledge, ability to labour and good health and physical capability important for the successful pursuit of different livelihood strategies.
Social capital: the social resources (networks, social claims, social relations, relationships of trust, affiliations, associations) upon which people draw when pursuing different livelihood strategies.
Physical capital: the basic infrastructure (transport, shelter, water, energy and communications) and the production equipment and means which enable people to pursue their livelihoods (Scoones, 1998: 7-8, Carney, 1998: 7).

In order to assess the effectiveness of a given project or policy using the sustainable livelihoods framework, DFID created a visual representation of information about people's assets, is the shape of a pentagon (Figure 19). The sustainability of a livelihood can be verified by measuring, for example, increases quality of life or in income, or a reduction in risks and vulnerability, improved food security and more sustainable use of the natural resource base. However, these results can be subject to divers influences. For instance, people may aspire to having a large amount of financial resources, but this ends up interfering with others' access to a minimum of resources, and also because this aspiration leads to an unsustainable use of natural resources (www.livelihoods.org/ Julho 2000).

Figure 21. DFID's sustainable livelihoods pentagon

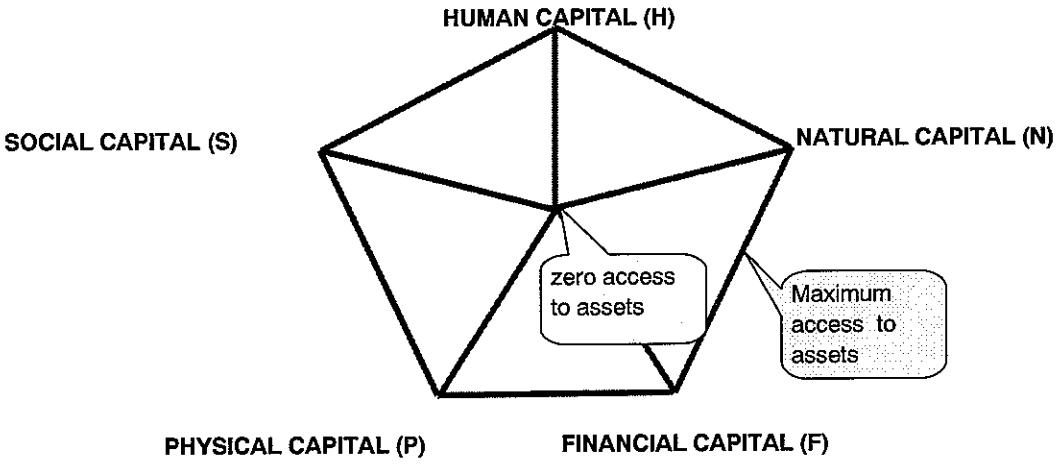
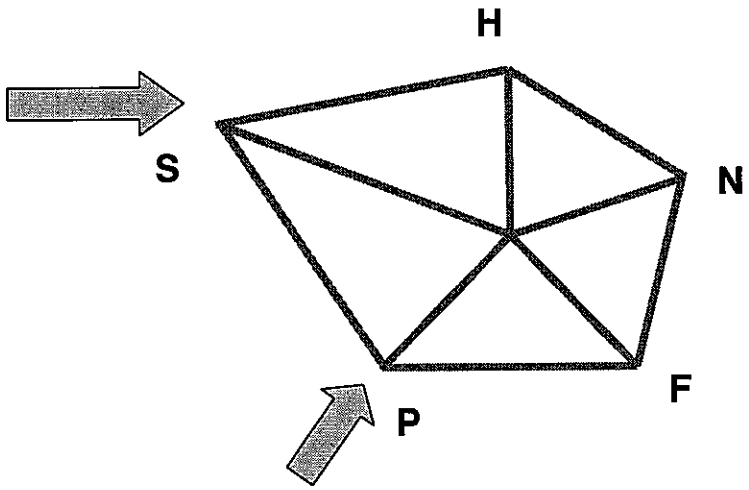


Figure 22: Changes in access to capitals (www.livelihoods.org/ 2000)



As can be seen from Figure 19, the centre of the pentagon represents zero access to assets while the outer border represents maximum access to assets . However, there is no common scale for measuring the level of access. For example, it is important to take account of the level of access which each member of a group has in relation to the different capitals. This is because the sustainable livelihoods approach may overlook gender problems and social issues due to the difficulty of measuring intangible assets. Figure 20 illustrates how access to a certain capital is continuously changing, and consequently the shape of the pentagon will be constantly shifting. In the case shown in Figure 20, the two arrows suggest that access to social and physical capitals is declining.

No single capital is enough to achieve a sustainable livelihood. For this reason it is important to remember during any intervention in a given community, that goal of this intervention may be to help people to develop the skill and flexibility to be able to alter their livelihood strategies over time. Livelihood strategies can be defined as the range and combination of activities and choices that people make and undertake in order to achieve their livelihood objectives.

2.4.1.3. Indicators of a sustainable livelihood

The indicators which are most suited to measure whether a given livelihood is sustainable or not are described below:
Natural capital: reduction of deforestation, maintenance of fish stocks, increase and maintenance of wild game stocks, reduced incidence of burning (*queimadas*) and enhanced soil quality.
Financial capital: increased ability to obtain credit and higher levels of household savings.

Human capital: increased adult literacy, an increase or improvement in the professional skills of a household, especially an increase in knowledge of agricultural and ranching technologies and also improved family health, especially because good health is essential for the survival of those engaged in agriculture.
Social capital: increased participation in social organisations, an increase in the number of people capable of taking collective decisions for the benefit of the community, reduced dependency on local government on the part of those institutions which represent the local community.
Physical capital: the existence or maintenance of roads or access routes to the community, the maintenance of school buildings, hospitals and health centres, the maintenance of community infrastructure, such as flour mills, artesian wells or equipment such as tractors.

2.4.2. Demography

Demographic data for the State of Tocantins have been slightly modified by the Demographic Census of the year 2000, preliminary results of which were released by the IBGE in December (see Table 33 below). However, due to the preliminary nature of these initial results, data from the Population Count of 1996 will be used for the purposes of this study. According to this Count, the State has a population of 1.048.642 inhabitants. Thus, the municipality of Araguaína, with 105.819 inhabitants, contains approximately 10% of the State's population, while the municipality of Araguatins, with 22.558 inhabitants, is home to approximately 2% of the State's population.

In the municipality of Araguaína, 94% of the population live in urban areas and only 6% in rural areas. By contrast, in the Araguatins municipality, 64% of the population live in urban areas and 36% in rural areas.
With regard to the age range of their inhabitants, the populations of both municipalities are young, with over 50% of their inhabitants being under 30 years of age. In the municipality of Araguaína, there are 61.447 inhabitants in the 0 to 24 age range, equivalent to 58,5% of the whole population while in the municipality of Araguatins there are 13.939 inhabitants in the 0 to 24 age range, equivalent to 61,8% of the municipal population.

Table 33. Resident population by sex and location of domicile in Tocantins State and in the municipalities of Araguaína and Araguatins - 1996/2000

PLACE	RESIDENT POPULATION					
	08.1996	On 01.08.2000 (1)				
		Total	Male	Female	Urban	Rural
Tocantins	1.048.642	1.155.251	590.511	564.740	858.388	296.863
Araguaína	105.019	112.762	55.036	57.726	105.701	7.061
Araguatins	22.558	26.008	13.269	12.739	15.791	10.217

Source: IBGE, Population Count 1996 and Demographic Census 2000.
(1) Preliminary results

Table 34. Domicile location and sex distribution of the population resident in Tocantins State and in the muncipalities of Araguaína and Araguatins,

PLACE	TOTAL	%	MALE	%	FEMALE	%
Tocantins	1.048.642	100	537.118	51.22	511.524	48.78
Urban	741.009	70.66	368.723	28.65	372.286	72.78
Rural	307.633	29.34	168.395	31.35	139.238	27.22
Araguaína	105.019	10.01	51.508	49.05	53.510	50.95
Urban	98.546	93.84	47.998	93.18	50.548	94.46
Rural	6.473	6.16	3.511	6.82	2.962	5.54
Araguatins	22.558	2.15	11.523	51.08	11.035	48.92
Urban	14.454	24.07	7.143	61.99	7.311	66.25
Rural	8.104	35.93	4.380	38.01	3.724	33.75

Source: IBGE (1996).

Figure 23. Sex distribution of resident population in Araguaína and Araguatins

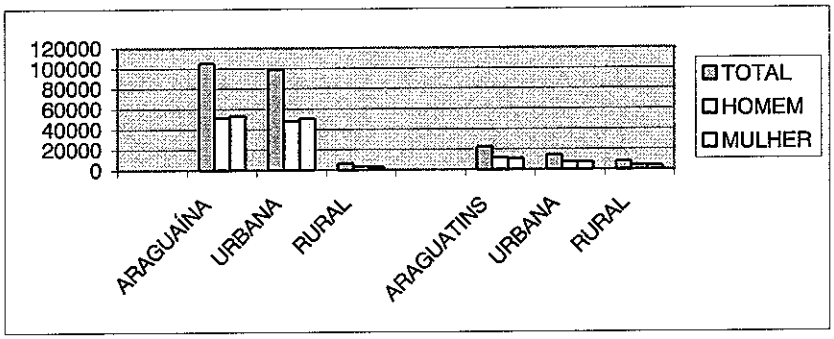
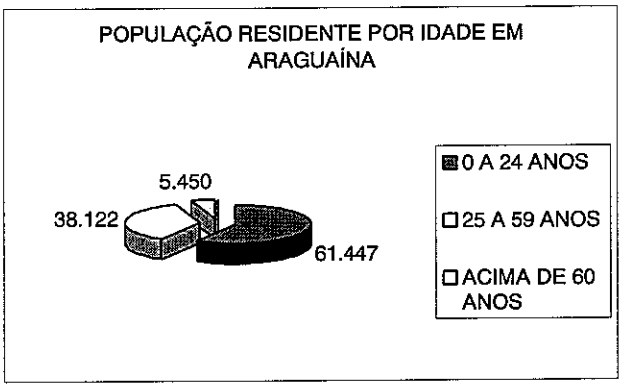


Table 35. Age distribution of the resident population in Araguaína and Araguatins

AGE	ARAGUAÍNA		ARAGUATINS	
	N° Inhabitants	%	N° Inhabitants	%
0 to 24	61.447	58.5	13.939	61.8
25 to 59	38.122	36.3	7.018	31.2
Over 60	5.450	5.2	1.601	7

Source: IBGE-1996.

Figure 24. Age distribution of resident population in Araguaína and Araguatins



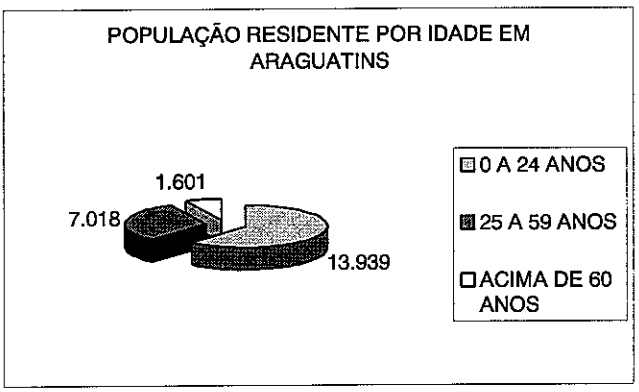


Table 36. Profile of the population resident in Araguaína and Araguatins

VARIABLES	ARAGUAÍNA	ARAGUATINS
	Number of residents	Number of residents
Resident population	105.019	22.558
Male residents	51.509	11.523
Female residents	53.510	11.035
Resident population – urban area	98.546	14.454
Resident population – rural area	6.473	8.104
Population residing in rural settlements	999	1.693
Population residing in the rural areas outside rural settlements	5.474	6.411
Population residing in private dwellings	104.585	22.515
Population residing in permanent private dwellings	104.337	22.155
Population residing in improvised private dwellings	248	360
Population residing in collective dwellings	434	43
Heads of family resident	24.319	4.728
Spouses resident	17.661	3.524
Children resident	49.740	11.334
Other relatives resident	11.209	2.661
Residents who are not relatives	916	196

Pensioners resident	91	7
Domestic employees resident	709	85
Relatives resident as domestic help	52	8
Single residents in collective dwellings	296	12
Resident population - 0 years – months	2.646	583
Resident population - 0 – 4 years old	12.157	2.854
Resident population - 5 – 9 years old	11.955	3.086
Resident population - 10 - 14 years old	13.037	3.261
Resident population - 15 - 19 years old	13.173	2.853
Resident population - 20 - 24 years old	11.125	1.885
Resident population - 25 - 29 years old	9.221	1.474
Resident population - 30 - 34 years old	7.742	1.319
Resident population - 35 - 39 years old	6.322	1.094
Resident population - 40 - 44 years old	5.246	1.016
Resident population - 45 - 49 years old	4.122	787
Resident population - 50 - 54 years old	3.062	692
Resident population - 55 - 59 years old	2.407	636
Resident population - 60 - 64 years old	1.866	546
Resident population - 65 or more years old	3.584	1.055

Source: IBGE, Population Count 1996

2.4.3. Municipal Infrastructure

➢ Energy

The municipalities of Araguaína and Araguatins are served by CELTINS – The Electric Utility Company of Tocantins State.

➢ Water supply and sewage

Only Araguaína is served by SANEATINS – The Sanitation Company of Tocantins State, which supplies mains water and a public sewage service to part of the poplulation of the municipality.

➢ Communications

Viewers in Araguaína can choose between 5 television channels. The municipality also has 2 FM radio stations and one AM radio station, as well as 11 newspapers both local and regional. Araguatins is dependent on services from Araguaína in this sector.

The telephone service is delivered in both municipalities by Telegoiás – Tele-Centro Sul.

➢ Road network

Araguaína

a) Federal: Highway BR 153 which runs between Brasília and Belém passes close by the municipal capital

b) State: Araguaína to Filadélfia - 120 Km
Araguaína to Babaçulândia 61 Km
Araguaína to Aragominas 46 Km

c) Municipal: Araguaína to the Rio Preto settlement 120 Km
Araguaína to the Pilões community 08 Km
Araguaína to the NPA 18 Km
Araguaína to the Araguaminas settlement 28 Km
Araguaína to the P.A. Sudam 120 Km
Araguaína to the Água Amarela community 08 Km

Araguatins

a) Federal: BR 230 – Transamazônica

b) State: TO 404
TO 010

c) Municipal: Araguatins to the Natal township 46 Km
Araguatins to the Barreiro community 32 Km
Araguatins to the Macaúba township 65 Km
Araguatins to the Santa Cruz settlement 90 Km

Araguatins to the Santa Luzia township	58 Km
Araguatins to the Mangabeira community	62 Km

2.4.4. Health

For the Northern Region of Tocantins, Araguaína is a strong regional centre for health care and it even caters to demand from other states such as Pará and Maranhão. In contrast, the health infrastructure in Araguatins serves only the demand from the municipality and the small townships in surrounding areas.

The tables below show relevant statistics on the health sector in the municipalities of Araguaína and Araguatins.

Table 37. Health infrastructure in Araguaína and Araguatins.

VARIABLES	ARAGUAÍNA		ARAGUATINS	
	N°.	UNIT	N°.	UNIT
Hospitals	5	hospitals	2	hospitals
Hospital beds	558	beds	52	beds
Walk-in clinics	51	units	6	units
First Aid posts	1	posts	3	posts
Health centres	19	centres	1	centres
Walk-in clinics of general hospitals	2	units	1	units
Medical assistance posts	1	posts	0	posts
Hospital internments	19.002	internments	1.485	internments

Source: IBGE (1996)

2.4.5. Education

According to the data collected by the Education Census 2000 undertaken by the Tocantins State Secretariat for Education, there are 125 education establishments at primary and secondary level in Araguaína, with at total of 37.147 pupils enrolled. These are distributed as follows: 29.607 pupils in primary school and 7.540 pupils in secondary school. In the municipality of Araguatins, there are 57 educational establishments with a total of 9.447 pupils of whom 7.978 are in primary school and 1.469 in secondary school.

In both municipalities, educational services are provided by state, municipal and private networks. In Araguatins there is also a school belonging to the federal network – the Agrotechnical School of Araguatins (Escola Agrotécnica de Araguatins), which draws students from Tocantins and other states such as Pará, Maranhão, Piauí and Mato Grosso.

According to the IBGE's data (1996), the number of people with no education or with less than one year's schooling is high in Araguaína - 22,38% - and in Araguatins - 34,87%.

Table 38. Numbers in Primary and Secondary Education in Araguaína and Araguatins by municipality, network and zone.

MUNICIPALITY	NETWORK	ZONE	Nº Educational Establishments	N° Teachers	Nº Primary Pupils	Nº Secondary Pupils
Araguaína	State	Urban	35	811	21.302	6.821
		Rural	-	-	-	-
Araguaína	Municipal	Urban	35	229	5.319	-
		Rural	27	36	802	-
Araguaína	Private	Urban	28	323	2.184	689
		Rural	-	-	-	-
Araguaína	Federal	Urban	-	-	-	-
		Rural	-	-	-	-
Araguatins	Federal	Urban	-	-	-	-
		Rural	1	31	-	403
Araguatins	State	Urban	5	27	889	58
		Rural	4	101	3.272	1.008
Araguatins	Municipal	Urban	3	63	1.802	-
		Rural	42	79	1.959	-

Araguatins	Private	Urban	2	14	56	-
		Rural	-	-	-	-

Source: Education Census 2000 – Tocantins State Secretariat for Education

Table 39. General data on education in the municipalities of Araguaína and Araguatins

VARIABLES	ARAGUAÍNA		ARAGUATINS	
	N°.	UNIT	N°.	UNIT
Residents - 4 years or more who attend school / residents – 4 years	38,28	people	34,77	people
Resident males - 4 years or more who attend school / residents – 4 years	47,04	people	49,83	people
Female residents - 4 years or more who attend school / residents – 4 years	52,96	people	50,17	people
Residents - 4 - 6 years or more who attend school / residents – 4 – 6 years	49,46	people	27,73	people
Residents - 7 - 9 years or more who attend school / residents - 7 - 9 years	91,19	people	79,74	people
Residents - 10 - 14 years or more who attend school / residents 10-14 years	93,1	people	85,86	people
Residents - 15 - 19 years or more who attend school / residents - 15 - 19 years	66,91	people	56,75	people
Residents - 20 - 24 years or more who attend school / residents - 20 - 24 years	27,34	people	20,32	people
Years of study – residents - 4 years or more – average	4,39	years of study	2,91	years of study
Years of study – male residents - 4 years or more – average	4,11	years of study	2,71	years of study
Years of study – female residents - 4 years or more – average	4,66	years of study	3,11	years of study
Residents - 4 years or more without education or less than 1 year's education/ person	22,38	people	34,87	people
Male residents - 4 years or more without education or less than 1 year's education/ male	24,32	people	36,61	people
Female residents - 4 years or more without education or less than 1 year's education/ female	20,53	people	33,05	people
Enrolments – pre-school education	2.655	enrolments	379	enrolments
Enrolments – primary education	32.913	enrolments	7.208	enrolments
Enrolments – secondary education	7.730	enrolments	1.189	enrolments
Teachers - pre-school education	136	teachers	20	teachers
Teachers – primary education	1.165	teachers	198	teachers
Teachers – secondary education	386	teachers	68	teachers
Pre-school education establishments	69	estabs.	13	estabs.
Primary school establishments	105	estabs.	56	estabs.
Secondary school establishments	25	estabs.	4	estabs.

Source: IBGE, 1996.

2.4.6. Economic Activities

2.4.6.1. Primary Sector

The economy of the State of Tocantins is basically primary, with the principal crops being rice, beans, manioc, maize and soya beans. Of these rice is the most widely grown. Broadly speaking, two main production zones can be distinguished: the Central Southern Region of Tocantins which is characterised by cereal production, predominantly soya bean and irrigated rice, and the Northern Region where cattle ranching predominates.

In recent years, there has been a growing trend towards fruit production in the Northern Region focused on the production of coconuts, bananas, passion fruit, pineapple and other species. In the municipalities of Araguaína and Araguatins, there is very little irrigated agricultural production. These municipalities have traditionally been engaged in livestock production, with cereal and fruit production being fairly recent introductions.

Manioc production is particularly important in the Araguaína municipality which is the region's leading producer with an area of 600 ha producing 6.600 tonnes, and also maize which is cultivated on an area of 3.900 ha to produce 5.400 tonnes; pineapple plantations are also being established. In Araguatins, the main crop is maize with 2.572 tonnes being produced from 1.800 ha. Here also, pineapple plantations are being established.

In terms of cattle, Araguaína has 236.525 head and Araguatins has 105.420 head raised for beef production.

Table 40. Agricultural Production in Araguaína and Araguatins

ARAGUAÍNA			
PRODUCT	**AREA (ha)**	**PROD. (t)**	**MAX. YIELD (Kg/ha)**
Manioc	600	6.600	11.000
Tomato	30	1.170	3.900
pineapple	174	4.002	23.000*
soya beans	46	83	1.804
dry maize	3.500	5.400	1.385
dry rice	400	440	1.100
beans (1st harvest)	80	29	363
beans (2nd harvest)	40	16	400

ARAGUATINS			
PRODUCT	**AREA (ha)**	**PROD. (t)**	**MAX. YIELD (Kg/ha)**
manioc	240	3.600	15.000
dry maize	1.750	2.415	1.380
dry rice	2.450	3.528	1.440
beans (1st harvest)	150	50	600
beans (2nd harvest)	200	120	600

Source: IBGE – LSPA - September, 2.000.
* fruit/ha

Table 41. Cattle ranching in the municipalities of Araguaína and Araguatins

VARIABLES	ARAGUAÍNA		ARAGUATINS	
	N°	UNIT	N°	UNIT
Residents	105.019	people	22.558	people
Male residents	51.503	people	11.523	people
Female residents	53.510	people	11.035	people
Urban residents / total residents %	93,84	people	64,07	people
Cattle ranching establishments 31.12.1995	656	estabs.	-	estabs.
Area – cattle ranching establishments - 31.12.1995	419.337	hectares	146.115	hectares
People employed – cattle ranching establishments - 31.12.1995	3.214	people	4.548	people
People employed – cattle ranching establishments – under 14 years of age - 31.12.1995	478	people	1.254	people
Cultivation machinery - cattle ranching establishments - 31.12.1995	20	units	17	units
Harvesting machinery - cattle ranching establishments - 31.12.1995	0	units	2	units

Tractors – cattle ranching establishments - 31.12.1995	155	units	58	units
Trucks - cattle ranching establishments - 31.12.1995	28	units	8	units
Utility vehicles - cattle ranching establishments - 31.12.1995	68	units	57	units
Value of animal and plant production - cattle ranching establishments - 01.08.1995 to 31.07.1996	13.315	'000 Reais	5.804	'000 Reais
Land area in the municipality	3.903	km²	2.287	Km²

Source: IBGE, 1996.

2.4.6.2. Land-holding Structure

According to the Integrated Environmental Management Project for the Bico do Papagaio Region (PGAI – Bico do Papagaio) "the region was prioritised in the State Environmental Plan because it is the one most subject to socio-environmental impacts" It should be noted here that the two municipalities covered in this study are included within the scope of the PGAI – Bico do Papagaio. This project highlights the fact that, from a structural and socio-economic point of view, the region has problems that increase the vulnerability of its resource base.

According to data from the National Institute for Colonisation and Agrarian Reform (Incra, 1997), "in the 23 municipalities that comprise the Bico do Papagaio region, properties with areas of up to 320 ha account for 85% of all registered land holdings, and 34 % of the total, legally registered cadastral area. In contrast, 66% of the total cadastral area is held in estates with more than 320 ha and these account for just 14% of all land holdings in the area. At the extreme ends of the land-holding spectrum, small-holders account for 55% of all land holdings and 10% of the cadastral area while the largest estates account for 4% and 36% respectively."

With regard to the status of its producers, the Cattle Ranching Census 1995-96, found that "70% are land owners, responsible for 98,5% of the area of existing properties; 26% are squatters, with 1% of the total area; 3% are tenants, with 0,1% of the total area and 1% are members of Incra associations (*parceiros*), with 0,4% of the total area."

In terms of land holdings, the IBGE states that the number of properties held by small-scale producers is 10% less than that recorded among the medium and large-scale producers, while the number of properties occupied by squatters is 10% greater among small-scale producers. It should be noted that all land in the area has been duly registered by Incra but, in its attempts to move forward with the disappropriation measures it is charged with effecting, the Institute is being hampered by the legal resources being brought to bear against it by the current owners of the lands earmarked for disappropriation."

In this respect, the two municipalities have a high number of law suits relating to land-holding issues underway or completed, as can be seen in the table below.

It is important to point out that the table does not show the presence of a large number of landless producers which was demonstrated in the document "Grito da Terra Brasil 2000" produced by the Federation of Agricultural Workers in Tocantins State (Fetaet), and which sets out claims for the disappropriation of 32 areas encompassing more than 33,500 ha for the settlement of over 526 families. The same document calls for the survey of 22 other areas covering more than 33.000 ha for subsequent disappropriation in order to provide land for over 896 families.

Table 42. Distribution of Settlements by Municipality

MUNICIPALITY	N° SETTLEMENTS	AREA (HA)	N° FAMILIES SETTLED
Araguaína	4	17.154,87	343
Araguatins	18	47.447,42	1.371

Source: Incra-DP/DPM-2000

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Table 43. Land tenure in the settlements of Araguaína and Araguatins.

PROJECT NAME	MUNICIPALITY	Area (ha) appropriated	Area (ha) established	Method of Acquisition*	CREATION Directive Nº	CREATION Year	Nº of Families
Água limpa	Araguatins	801,9	801,9	federal	-	-	23
Atanásio	Araguatins	2.962,80	2.930,80	contract	20	1996	94
D. Eunice	Araguatins	2.492,60	2.480,70	contract	21	1996	81
Marcos freire	Araguatins	2.758,15	2.720,70	expropriated	-	-	87
Maringá	Araguatins	3.279,11	unrecorded	expropriated	41	1998	102
Mutirão	Araguatins	1.626,42	unrecorded	expropriated	47	1996	65
Nova vida	Araguatins	454,12	469,12	expropriated	-	-	17
Ouro verde	Araguatins	3.751,20	5.750,80	expropriated	-	-	107
Petrônio	Araguatins	615,7	unrecorded	expropriated	49	1998	20
Prof. Djanira	Araguatins	1.352,40	-	expropriated	48	1996	53
Rancho alegre	Araguatins	1.630,40	1.629,80	expropriated	8	1997	54
Ronca	Araguatins	5.707,80	3.495,10	expropriated	7	1995	120
Santa cruz ii	Araguatins	10.728,80	10.548,80	expropriated	-	-	300
Santa helena	Araguatins	552,24	555,67	federal	38	1996	22
São josé	Araguatins	2.992,80	3.110,10	expropriated	-	-	88
Transaraguaia	Araguatins	1.793,15	1.821,13	expropriated	-	-	60
Trecho novo	Araguatins	801,9	801,9	federal	-	-	26
Pe. Josimo	Araguatins	1.613,15	1.610,27	contract	18	1996	52
Andorinha	Araguaína/sta fé / muric.	3.794,15	3.733,16	expropriated	196	1992	70
Aragominas	Araguaína	1.816,60	2.383,00	expropriated	64	1995	36
Alegre	Araguaína	1.680,98	1.655,20	expropriated	710	1987	49
Rio preto	Araguaína / muric.	9.500,00	9.956,10	expropriated	107	1991	204

Source: Incra, 2000.
*Translator's Note re Form of Acquisition: federal = the land was acquired by the federal authorities and transferred via INCRA; expropriated = removal of land rights following judicial decision; contract = acquired via a purchase and sale agreement involving the full consent of the landowner concerned.

2.4.6.3. Secondary and Tertiary Sectors

Although productive economic activity in Tocantins is essentially dominated by the primary sector, there are three industrial centres under development in the State in the municipalities of Gurupi, Palmas and Araguaína.

In Araguaína, in addition to the Agro-industrial District that has already been set up with tens of businesses in operation, the State government in partnership with private enterprise has been taking steps to make the establishment of an Export Processing Zone viable.

Given the geographic location of Araguaína, the municipality has become an important economic centre for the southern part of Pará and Maranhão, providing the impetus for commerce and services in particular, but also for industrial activity.

While Araguaína has around 3.041 businesses in the commerce, industry and service sectors, according to data from the Business Census carried out by Sebrae-TO (the Small Business Support Service of Tocantins) in 1998, the municipality of Araguatins has 443 businesses, equivalent to around 15% of the total found in Araguaína.
The tables below show relevant aspects of the industry, commerce and service sectors in the two municipalities.

Table 44. Statistical information on businesses in Araguatins, according to Sebrae (1998).

Total N° Businesses: 443

N° BUSINESSES BY SECTOR			N° BUSINESSES BY SIZE		
SECTOR	N°	%	SIZE	N°	%
Commerce	195	44,02	Micro	443	97,97

Industry	53	11,96	Small	9	2,03
Services	195	44,02	Medium	0	0,00
			Large	0	0,00

N° JOBS BY SECTOR			N° JOBS BY BUSINESS SIZE		
SECTOR	**N°**	**%**	**SIZE**	**N°**	**%**
Commerce	388	42,13	Micro	840	91,21
Industry	155	16,83	Small	81	8,79
Services	378	41,04	Medium	0	0,00
Total	921		Large	0	0,00

EMPLOYEE EARNINGS (IN MINIMUM SALARIES*) BY SECTOR							
Sector	**Less than 1**	**1 - 3**	**3 - 5**	**7 – 10**	**10 - 15**	**15 -20**	**more than 20**
Commerce	59 (35,54)%	279 (41,95)%	32 (53,33)%	4 (100,00)%	2 (33,33)%	0 (0,00)%	0 (0,00)%
Industry	29 (17,47)%	117 (17,59)%	8 (13,33)%	0 (0,00)%	1 (16,67)%	0 (0,00)%	0 (0,00)%
Services	78 (46,99)%	269 (40,45)%	20 (33,33)%	0 (0,00)%	3 (50,00)%	0 (0,00)%	0 (0,00)%
Total	166	665	60	4	6	0	0

*Translator's Note: 1 Minimum Salary (*salário minimo*) in Feb 2001 = approx. US$80 per month

BUSINESS STATUS			BUSINESS STATUS BY SECTOR		
STATUS	**N°**	**%**	**Commerce**	**Industry**	**Services**
Informal	340	76,75	129 (66,15)%	42 (79,25)%	169 (86,67)%
Formal	103	23,25	66 (33,85)%	11 (20,75)%	26 (13,33)%
Total	443	100	195	53	195

PRINCIPAL ACTIVITIES BY SECTOR		
Commerce		
GROCERY STORES AND RETAIL WAREHOUSES	74	37,95%
RETAIL CLOTHING AND ACCESSORIES	19	9,74%
RETAIL MEAT PRODUCTS – BUTCHERS	13	6,67%
RETAIL VEGETABLE FRUIT AND POULTRY PRODUCTS	9	4,62%
RETAIL BICYCLES, TRICYCLES AND OTHER VEHICLES RECREATIONAL GOODS	6	3,08%
Others	74	37,95%
Industry		
RICE PROCESSING	12	22,64%
FURNITURE PRODUCTION (PREDOMINANTLY WOODEN)	9	16,98%
ICED LOLLIPOP PRODUCTION	5	9,43%
TIMBER PROCESSING	4	7,55%
ICECREAM PRODUCTION	4	7,55%
Others	19	35,85%
Services		
BEER HALLS, WHISKY BARS AND OTHER OUTLETS SPECIALISING IN THE SERVICE OF BEVERAGES	37	18,97%
AUTOMOBILE REPAIR AND MAINTENANCE ESTABLISHMENTS	16	8,21%
RESTAURANT S	14	7,18%

BEAUTY PARLOURS, MANICURE SALONS ETC.	14	7,18%
HAIRDRESSERS	13	6,67%
Others	101	51,79%

Table 45. Statistical Information on Businesses in Araguaína, according to Sebrae (1998)

Total N° Businesses: 3,041

N° BUSINESSES BY SECTOR			N° BUSINESSES BY SIZE		
SECTOR	**N°**	**%**	**SIZE**	**N°**	**%**
Commerce	1319	43,37	Micro	2885	94,87
Industry	343	11,28	Small	140	4,60
Services	1379	45,35	Medium	11	0,36
			Large	5	0,16

N° JOBS BY SECTOR			N° JOBS BY BUSINESS SIZE		
SECTOR	**N°**	**%**	**SIZE**	**N°**	**%**
Commerce	4199	37,63	Micro	6789	60,84
Industry	2070	18,55	Small	2370	21,24
Services	4890	43,82	Medium	1342	12,03
Total	11159		Large	658	5,90

EMPLOYEE EARNINGS (IN MINIMUM SALARIES*) BY SECTOR							
Sector	**Less than 1**	**1 - 3**	**3 - 5**	**7 – 10**	**10 - 15**	**15 -20**	**more than 20**
Commerce	231 (24,89)%	3060 (38,09)%	621 (45,07)%	93 (41,70)%	32 (30,48)%	16 (26,23)%	12 (22,64)%
Industry	342 (36,85)%	1429 (17,79)%	165 (11,97)%	37 (16,59)%	9 (8,57)%	6 (9,84)%	9 (16,98)%
Services	355 (38,25)%	3545 (44,12)%	592 (42,96)%	93 (41,70)%	64 (60,95)%	39 (63,93)%	32 (60,38)%
Total	928	8034	1378	223	105	61	53

*Translator's Note: 1 Minimum Salary (*salário minimo*) in Feb. 2000 = approx. US$ 80 per month

BUSINESS STATUS			BUSINESS STATUS BY SECTOR		
STATUS	**N°**	**%**	**Commerce**	**Industry**	**Services**
Informal	1899	62,45	588 (44,58)%	212 (61,81)%	1099 (79,70)%
Formal	1142	37,55	731 (55,42)%	131 (38,19)%	280 (20,30)%
Total	3041	100	1319	343	1379

PRINCIPAL ACTIVITIES BY SECTOR		
Commerce		
GROCERY STORES AND RETAIL WAREHOUSES	304	23,05%
RETAIL CLOTHING AND ACCESSORIES	131	9,93%
RETAIL MEAT PRODUCTS – BUTCHERS	85	6,44%
RETAIL SPARE PARTS AND ACCESSORIES FOR VEHICLES	62	4,70%
RETAIL VEGETABLE FRUIT AND POULTRY PRODUCTS	59	4,47%
Others	678	51,40%
Industry		
PRODUCTION OF BAKERY, CONFECTIONERY AND PASTRY PRODUCTS	53	15,45%
FURNITURE PRODUCTION (PREDOMINANTLY WOODEN)	43	12,54%
PRODUCTION OF MADE-TO-MEASURE ITEMS OF	29	8,45%

CLOTHING		
TIMBER PRODUCTS	27	7,87%
ICECREAM PRODUCTION	18	5,25%
Others	173	50,44%
Services		
BEER HALLS, WHISKY BARS AND OTHER OUTLETS SPECIALISING IN THE SERVICE OF BEVERAGES	273	19,80%
HAIRDRESSERS	110	7,98%
AUTOMOBILE REPAIR AND MAINTENANCE ESTABLISHMENTS	106	7,69%
SNACK BARS, JUICE BARS, TEA HOUSES ETC	103	7,47%
RESTAURANTS	56	4,06%
Others	731	53,01%

2.4.6.4. Sources of Financial Resources for Production

In Tocantins State, a number of different financial institutions have invested resources in production, processing, industrialisation and commercialisation activities. Principal among these is the Banco da Amazônia (Bank of Amazonia) which is particularly active in the rural sector generating significant returns through its various credit programmes, led by the Pronaf – A and Prorural (the Rural Development Support Programme) which involve Incra associations (*parceiros*) and associations of family farming operations respectively.

Information released by the Banco da Amazônia (Basa) in May 2000 showed that in the period from November 1989 to December 1999, the bank invested a sum of around R$ 455 million to promote production activities, which corresponds to roughly 73% of all capital allocated for these purposes in Tocantins State.

The activities of the Banco do Brasil (Bank of Brazil) in the primary production sector are also worthy of note in providing finance for ranching and agricultural activities, in particular through the Pronaf C and D programmes, which numbered more than 1.000 operations in the 1999/2000 harvest. The table below shows the main credit lines available from financial institutions in the Stae of Tocantins.

Table 46. Financial insitutions and credit lines

AGENCY	NAME	TARGET PUBLIC
Basa	Pronaf – A / Prorural / Prodex	Family agriculture
	FNO "Normal"	Primary/Secondary
	Promicro	Micro-businesses
Banco do Brasil	Pronaf C and D, Agregar	Family agriculture
	Custeio	Producers
	Proger – Rural	Producers
Basa / BB	Bndes / Finame	Primary/Secondary

Source: Ruraltins (2000).

Table 47. Financial resources applied in the period 1999 / 2000

MUNICIPALITY	BANCO DO BRASIL S/A *		BANCO DA AMAZÔNIA S/A		TOTAL	
	Nº OPER.	VALUE (R$)	Nº OPER.	VALUE (R$)	Nº OPER.	VALUE (R$)
Araguaína	135	2.103.856,00	160	2.233.458,91	295	4.337.314,91
Araguatins	15	163.823,00	31	261.697,61	46	425.520,61

Sources: Banco do Brasil S/A – GETER/ADPRO – Crédito rural harvest year 99/2000 – investing agencies (as of 30/04/2000) and Banco da Amazônia S/A – DERUR/DICOP/Sistema CONTROPER – financial operations 01/07/1999 to 31/05/2000.

(*)- Operations and values transacted by agencies; in the municipalities 14 (R$51.479,26) and 3 (R$3.227,26), respectively.

2.4.7. Field Research

2.4.7.1. Evaluation of livelihood strategies in the rural communities of Araguaína and Araguatins

Through consideration of the statistical data collected and the field research undertaken in the two municipalities, it is possible to evaluate the livelihood strategies of small- and medium-scale rural producers in the region. This is principally because a large part of the reality that is described below can be extrapolated to cover the municipality as a whole. This analysis will enable an understanding of the circumstances of the rural producer and in doing so it can establish the parameters for future interventions in the area by means of cattle ranching and agricultural projects.

➢ **Araguaína**

(a) Brief description of the NPA1 settlement

The settlement was established in 1995 by the government of Tocantins State. Each one of the original 51 families received a piece of land by the Prata river is a cerrado area with sandy soils. The settlement is located 18 km from the centre of Araguaína. There are now 31 families living there and they are finding it impossible to support themselves on the land resources they have available. The setllement's inhabitants discussed the changes which have occurred in the 5 capitals (discussed above) over the 5 years that they have lived in the area, and also gave their views on how they saw the future.

Schematic analysis of livelihoods in the NPA1 Settlement

As can be seen in the pentagon below (Figure 24), the natural capital of the NPA1 settlement has deteriorated considerably, to the detriment of the community's rural activities. The deforestation of the ciliary forests (*mata ciliar*) along the water courses and inappropriate soil management, water resources have been subject to high rates of sedimentation and reduced water flow, particularly in the Prata river. Some parts dry up in the summer. Some plots of land have been eroded and there has been an increase in the use of pesticides due to an increase incidence of pests. Preventative measures need to be taken urgently.

The community's financial capital was reasonably high at the outset, with families receiving an initial credit of R$ 5.000,00, more than is provided on the Incra settlements. However, lack of knowledge as to how to produce certain crops drove the families to use these resources to cover their daily expenses. There are still financial resources available, but most are in default and have no real perspective of being able to repay the loan.

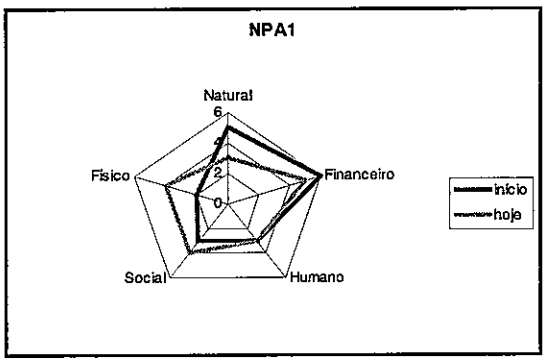
Human capital is low, with significant percentages of illiterate and semi-illiterate inhabitants. Agricultural knowledge is limited to traditional cultivation practices for crops such as rice, maize and beans, with no training in other areas. Human capital started off low and has continued thus without any significant alteration.

The settlement's social capital is improving, with people starting to get involved in the settlement's association in an effort to understand why the financial resources available have proved insufficient to improve living standards. There is a strong internal crisis underway, with many inhabitants mistrustful of the association's leadership and others complaining about the privileges that are afforded to a few members.

The settlement's physical capital is is being worn down, with the central pivot, flour mill and tractor being under-used due to the lack of production or inadequate planning of the irrigation resource. Physical capital is good but is deteriorating due to the lack of maintenance of community infrastructure. Even the school is under-utilised, with only 8 children attending classes.

In general, the self-esteem of the community is low, and there is complete dependence on the government for its rural activities, with fertilisers and seed having to be donated every year.

Figure 26. Schematic representation of livelihoods in the NPA1 settlement
Source: Santos (2000).



(b) Brief description of the Alegre Settlement Project (PA Alegre)

The PA Alegre was created in 1985 for 36 families, with each family being allocated around 36 ha. Currently there are only 12 families present who were part of the initial group of settlers. The other current inhabitants bought their plots from members of the original group who have since departed. According to Incra's regional office in Araguaína, this will be the first Settlement Project (PA) in Tocantins to achieve full land-holding status. Families have been given 20 years complete payments to Incra in return for legal entitlement to their land. The settlement is situated by the Jaboti river near the BR-153 highway, some 35 km from the centre of Araguaína.

Schematic analysis of livelihoods in PA Alegre

As can be seen from the pentagon below, the natural capital of PA Alegre has been degraded by deforestation, a reduction in the extent of the ciliary forest (*mata ciliar*) near the watercourses and the consequent flight of the local fauna. The soils are being intensively utilised for pasture which causes erosion in certain places. The creeks and stream valleys in the region are affected by sedimentation with some creeks drying up in certain areas.

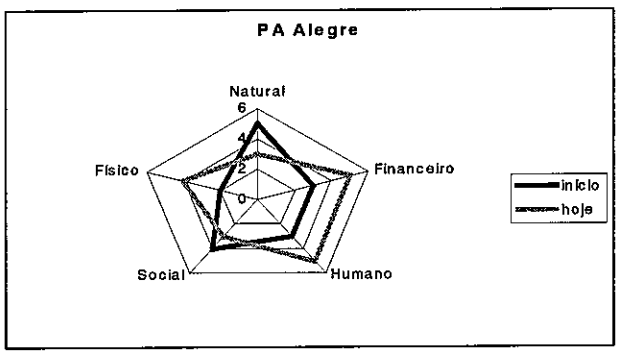
The PA's financial capital is considerably reduced, with some inhabitants being dependent on relatives for their survival. The inhabitants have access to bank credits for agricultural production and are able to draw financial resources for the commercialisation of their production with earnings being used to repay these loans and the payments due for their land.

Human capital has been gradually increasing. The inhabitants have been trained in dairy production techniques and there have been increases in adult literacy. The health services available are still precarious but a minimum level of health care is still provided.

Social capital is low, and there has been a slight decline in the strength of the settlement association due to the fact that the majority of inhabitants are no longer dependent on it as they have greater financial resources.

Physical capital has witnessed a noticeable improvement with roads and basic electricity, telephone and education services now operational. The PA boasts a dairy in working order which only requires water supply to become operational. The PA is served by public transport. However, there is a need for private investment by the inhabitants to secure water supplies.

Figure 27: Schematic representation of livelihoods in the Alegre Settlement Project



Source: Santos (2000)

➢ **Araguatins**

(a) Brief description of Vila Falcão

Vila Falcão is a rural village which is home to people from 3 of Incra's rural settlements: Lot 1 known as Atanásio de Moura Seixas which has 94 families, Lot 2 or Dona Eunice with 78 families and Lot 4 or Padre Josimo with 52 families. Some 14 km from the village lies Vila Planalto which is home to people from the Lot 3 settlement (Marcos Freire) comprising 81 families. These four settlements were established in 1996 on what was then the Santa Gertrudes ranch and at the time they comprised 310 families. There are currently 305 families resident in the area which is situated 42 km from Araguatins to which it is linked by a dirt road. Each family has a plot of land ranging from 25 to 40 ha in size. Vila Falcão is located 2 km from the Araguaia river and the settlements are watered by the Ronca, Piranha, Gorgulho and Cândido tributaries of this river.

Analysis of livelihood strategies of families in Vila Falcão

The natural capital of the four settlements which make up Vila Falcão has diminished noticeably. The native forests have been cut down to make way for pastures and slash-and-burn agriculture and this has driven out the native fauna. Wild animals have also been used as food sources by the community. The number of fish in the watercourses has also decreased. The soil has lost its original thin layer of organic matter, and the community has been forced to expand the area under cultivation. Even so, yields have declined in comparison to those achieved at the outset of the settlements. The number of uncontrolled *queimadas* (fires) has decreased but they still occur in large numbers. Any kind of investment in this region must bear in mind the need to regenerate its natural capital, in particular through increased vegetation cover and soil improvement.

The community's financial capital has increased mainly on account of access to credits from the Pronaf programme and the commercialisation of agricultural and livestock products. The families have not yet begun to repay their loans so it is not possible to determine the rate of default on payments. Even with an increase in financial capital, however, it is not possible to guarantee the sustainability of these families' livelihoods, primarily because of the degradation in the Vila's natural capital which provides the main source of income for the local community.

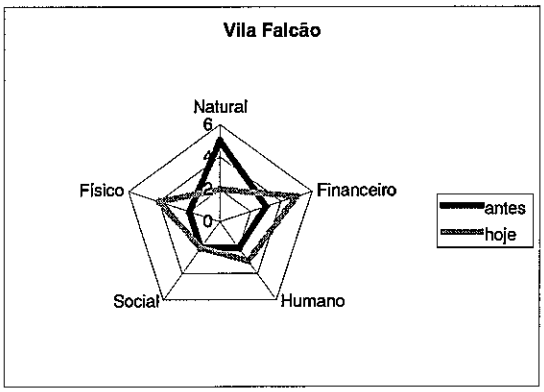
Human capital has improved as a result of the reduced incidence of serious health problems such as malaria. Some adults have professional skills, but many of them are illiterate. Despite the improvement in human capital, the community's situation remains precarious since it has no local health service or technical assitance in the form of extension services. A further aggravating factor is the lack of any secondary education in the region which means that young people either have to emigrate to the urban centre of Araguatins or stop their studies. Emigration from the community has reduced the size of the young rural labour force and the premature cessation of education is impacting on the region's human capital.

Social capital in the Vila is low, and has shown little change since the start of the project. Although settlement associations are not strong, there appears to be a satisfactory level of participation, and they are still the route through which the settlers secure access to rural credit schemes. There is also a high degree of dependence on neighbours when it comes to agricultural production and bartering and exchange arrangements are common.

The Vila's physical capital has shown a good improvement but not enough to guarantee an improvement in living standards or adequate access to local consumer markets. The lack of water supply is a serious problem for the community and it obliges families to spend several working hours to get water for their dwellings. In addition to this deficiency, there is no telephone service or electricty supply, and the community's access routes are inadequate. Despite all these problems, the local infrastructure has improved with the construction of the brick dwellings, the drilling of an artesian well (which is not working due to the lack of electricity) and the building of a gravel-topped road through the neighbourhood.

Investment in this region should prioritise the regeneration of natural capital and investment in human capital with skills building courses and extension services. The social capital needs to be strengthened with courses to promote associative and cooperative initiatives, and investments in infrastructure need to be finalised. The financial capital is adequately developed and requires only the continuation of the existing system of credit. The value achieved in the rural sector needs to be increased since families are hoping to transform the village settlements into a township with the residents being fully entitled to ownership of their land. This hope is also manifest in drawings done by the local children which expressed their desire for an urban existence.

Figure 28. Schematic representation of livelihoods in the Vila Falcão community.



Source: Santos (2000)

(b) Brief description of the Boca da Mata community

The community of Boca da Mata arose spontaneously at the beginning of the 20th century with the arrival of families who chose to settle there. Six years ago, the inhabitants formed the Small- and Micro-scale Farmers Association (Associação dos Pequenos e Micros Agricultores da Boca da Mata - Aspemabam) whose membership includes 60 families. Boca da Mata is situated roughly 12 km from Araguatins near the Federal Agrotechnical School of Araguatins. The locality is watered by the Riachinho, Fazenda Velha and Boca da Mata streams which all flow into the Taquari river.

Analysis of livelihood strategies of families in Boca da Mata.

The natural capital of the Boca da Mata community has been noticeably degraded with the clearing of the native forest and of the ciliary forest (*mata ciliar*) along the creeks which run through the locality. Hardwood timber species have been commercialised narrowing the options open to the current inhabitants. The watercourses dry up in the summer and the rainfall regime has been somewhat altered which is a concern to the farmers. The soil needs fertiliser additions to be productive. Wild animals, such as the jaguar and the tapir are disappearing. Populations of some animals have been reduced in number, but have not become extinct despite the deforestation and hunting pressures to which they are subject.

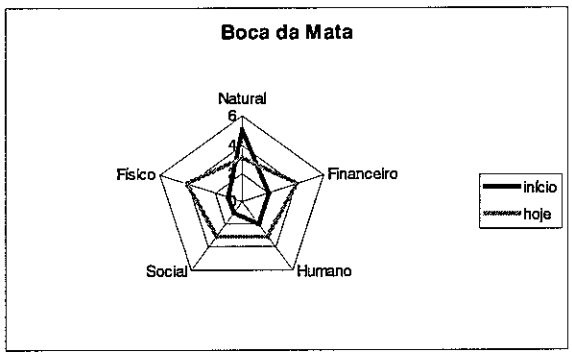
The community's financial capital has improved since previously they lived off income from the sale of agricultural and livestock products without being able to make any investment in their property. Nowadays, the inhabitants have access to bank credit schemes on an individual and collective basis through the community Association.

Human capital has been upgraded by training courses focused on agricultural and livestock production. Even so, the community's human capital deserves more attention since many adults there do not know how to read or write.

The residents' Association has changed living conditions for the better. It has managed to secure community infrastructure and services such as electricity supply, a school, a flour mill and agricultural equipment and has also been able to bring residents together around an ideal. Even with this improvement in social capital as a result of the Association, its members want to see more participation on the part of the youths of the community who are drawn to the town or who are simply uninterested in the Association's discussions.

The community's physical capital has improved significantly with the building of access roads, a school, a flour mill and a well for water supplies. Equipment has also been acquired including a rice processing machine and a fruit pulper. The physical capital of individuals in the community (e.g private dwellings) has seen less improvement than the community's physical capital.

Figure 29. Schematic representation of livelihoods in the Boca da Mata community.



Source: Santos (2000)

2.4.8. Photographic Record – Human Environment

The community was grouped into men, women and children for the discussions. To round off the process, each of these three groups summarised their perceptions and presented them to the other groups.