ANNEX III

ENVIRONMENTAL CONDITIONS

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1. Aspects of the Environment in Tocantins

1.1 Tocantins State: a Historical Perspective

The initial colonisation of Brazil tended to favour the coastal zones, as a result both of the limited means of transport available at that time, and of the geographical obstacles presented by the terrain. In the early days of the Brazilian colony, the roads and track-ways that were opened up inland, resulted more from the drive to occupy and take possession of the territory, than from the desire to exploit its resources. Such exploitation arose later, following on from the 'occupation' phase, and emerging through a process of informal economic activity, within which mercantilist influences soon became apparent. It can be suggested that the role of the Portuguese Crown in its Brazilian colony was very similar to that which it played in Asia through the Portuguese East India Company.

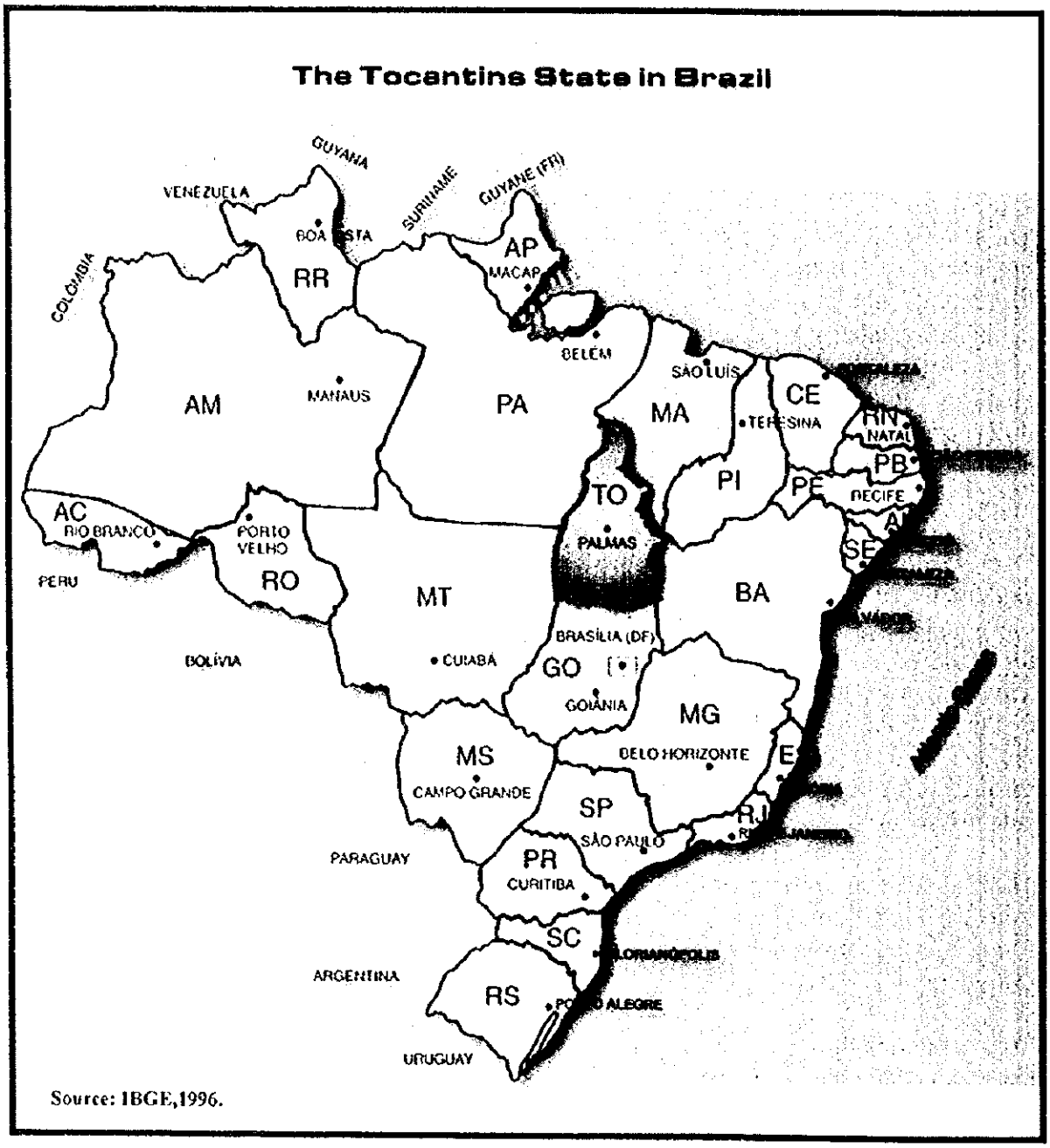
Because of the wealth of natural resources in the colony, efforts soon focussed on the extractive exploitation of Brazilian territory, a concern which displaced the earlier preoccupation with the opening up of previously uncharted areas, and inhibited the establishment of new roads. With the advent of the 'exploitative' phase, the trading and export of precious stones, especially gold, and of hardwood timber, allowed the development of urban centres, and communication networks that linked the interior with the centres of trade and consumption located along the coast. Then, during the Imperial phase of Brazilian history, the first railways, which were seen to fit well with the purposes of the Portuguese Crown, were established under concessions granted to private enterprises.

The settlement of the State of Goiás (including what is now Tocantins State) stemmed initially from two separate sources: the pioneers were mainly responsible for its penetration and occupation from the south, and missionaries operating in the Tocantins River area founded a religious mission in 1625 in the north of the State.

In the centuries since then, the southern part of the state of Goiás, which is readily accessible, has received enormous numbers of people, whereas the northern part was only really settled once the predominance of mining activities was reduced in consequence of the heavy tributes exacted by the Portuguese Crown. The development of agriculture, ranching, and trade drew people to the region from various parts of Brazil.

The northern part of the state gradually became isolated from the south, establishing stronger economic and cultural links with neighbouring states in the Northern Region of Brazil. Owing to changing values, and the barriers to greater integration with the south posed by the presence of two great rivers, a separatist movement emerged among the northern population. This movement features strongly in the history of the north of Goiás, and in 1988 it finally managed to secure the formation of the State of Tocantins.

The State of Tocantins is part of the Legal Amazon region. It occupies 278,421km^2, and has the following geographic co-ordinates at its extremities: to the north, latitude 5°10'6" S and longitude 48°21'00" W; to the south, latitude 13°27'59" S and longitude 47°40'52" W; to the east,



latitude 10°15'18" S and longitude 45°41'46" W; and to the west, latitude 11°27'31" S and longitude 50°44'33" W.

It is bounded in the north by the State of Maranhão; in the east by the States of Maranhão, Piauí and Bahia; in the south , by the State of Goiás; and in the west by the States of Mato Grosso and Pará. In terms of territorial size, it ranks ninth among Brazilian states.

The State of Tocantins was created by Article 13 of the Transitional Dispositions of the Constitution of the Federal Republic of Brazil, promulgated on October 5th, 1988. Its first Governor, José Wilson Siqueira Campos, took office on January 1st, 1989, in the town of Miracema do Tocantins which served as the provisional capital of the new State. On January 1st, 1990, the seat of the State Government was transferred to the new city of Palmas, official capital of Tocantins

State. Following its creation, Tocantins became part of the Northern Region of Brazil.

The new State inherited a tradition of devastation consequent upon the flow of migrants into the mid-West of the country, which had begun in the 1960s, and which was channelled along existing road networks. This migratory movement intensified in the 1970s, when small-holders from Maranhao settled in the "Bico do Papagaio" ("parrot's Beak") area, and in other parts of the north of the State bordering on the Belem-Brasilia highway, where they came into conflict with the large landowners in the region.

Federal Government policy, in the form of fiscal incentives for the establishment of ranching enterprises given by the Superintendency for the Development of the Amazon (SUDAM), stimulated the dynamics of settlement and spatial reorganisation, accentuating the pre-eminence of extensive beef production in the regional economy.

In general, demographic densities in the State are low, and the distribution of the population in uneven. Some areas, such as the Jalapao Region between Goiatins and Lizarda in the eastern part of the State, are virtually uninhabited. In the valley of the River Tocantins, and along the Belem-Brasilia Interstate - the state's major axis - demographic densities are higher, owing to the presence of urban centres which have experienced rapid growth over the last decade. The route of the Belem-Brasilia Interstate, following the northward course of the River Tocantins enables three geographical units to be distinguished within the State's territory.

The North: The northern part of the State, from its border with Maranhao and Para to the municipalities of Arapoema, Colinas de Goias and Filadelfia, corresponds with a transition between tropical rain forest and cerrado (savannah), it is part of the Amazonian ecological system, with its humid climate and the presence of dense tropical vegetation, The northern region has experienced significant demographic increase, and the agricultural area has been considerably enlarged, especially in the municipality of Araguaína. Ranching is the region's main activity, and the expansion of seeded pastures for fattening cattle has prompted the growth of towns, particularly Araguaína itself.

In this northern region, there are contrasting patterns of land use. The area bordering on Maranhão is characterised by small-holder agriculture, the majority of whom have no title to the land. They grow traditional crops (beans, maize and cassava) in a rotational system known as "stump cropping" ("lavoura de toco"). The presence of the babaçu palm allows activities centred on the collection and processing of its fruit to develop. These activities are particularly prevalent among immigrants from the State of Maranhão. Indeed, the connections between this area and the town of Imperatriz in Maranhão are as strong, if not stronger than those linking it to Araguaína.

Within Araguaína's zone of influence, the western part is dominated by modern ranching systems which are based on the fattening of cattle reared in other municipalities. The land-holding structure is complex, and there are social tensions arising from conflicts over ownership.

The Centre: The central zone, which extends as far as Porto Nacional, differs from the north both in terms of the natural landscape and land use. In this zone, one can distinguish two main areas: one running along the eastern borders with Maranhão, Piauí and Bahia, and the other corresponding to the region between the Araguaia and Tocantins Rivers. In the eastern part, which corresponds with the valley of the River Sono, the soils are poor, demographic density is low, and agriculture is rudimentary. There are indian reservations, such as that of the Craô near

Goiatins and Itacajá, and that of the Xerentes near Tocantínia. In the western part, where the soils are fertile and were once covered by forest, agricultural activity is of great economic importance. It is in this area that the town of Miracema do Tocantins is located.
Within this same territorial zone, but further west, in the Estrondo Range which forms the watershed between the Araguaia and Tocantins Rivers, and in the valley of the Araguaia River itself, the soils are less fertile, and land use is geared towards extensive livestock production, with most cattle being sent north for fattening in the Araguaína region.

The South: The southern part of the State is characterised by the relatively advanced technologies determining land use therein. This is a result of policies, adopted by both Goiás State and Federal governments, to stimulate the integration of this region with the economy in south-eastern Brazil.

Cattle-ranching has spread onto Bananal Island (in the south west of Tocantins), and there are plans for the construction of highways across it. These developments have caused concern in the National Indian Foundation (FUNAI) and the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), since Bananal Island is the site of the Araguaia National Park and the Araguaia Indian Reservation.

In the municipality of Formoso do Araguaia which borders the Island, the River Formoso Project was established by the Goiás State Government in 1981. With an irrigated area of some 30,000 ha, this is one of the most important rice-growing areas in the Northern Region of Brazil. In the cerrado areas of Gurupi municipality, another major urban centre, soya cultivation has been encouraged by means of government incentives for mechanisation and investment dating from the 1970s.

The economic structure of this zone of Tocantins State provides indications of the transition from the extreme north, which is part of the Amazonian agricultural frontier, and the territory of Goiás in the south, which is integrated into the economic context of the central and southern regions of the country.

1.2 Geomorphology and Soils

Almeida et al (1977) divided Brazilian territory into ten structural provinces, which can be thought of as broad regions having stratigraphic, tectonic, metamorphic and magmatic features whose limits could be defined both geologically and in conventional terms. In proposing this division, the authors described the Province of Tocantins, located in the Northern Region, as being represented by the northern segment of the Araguaia-Tocantins uplift. The Tocantins Province is bounded on the west by the Rio Branco Province and on the north by the Parnaíba Province, and features rocks belonging to the Tocantins Group.

The rocks in this group were compressed towards the Amazonian Craton (a region of the earth's crust that once served as platforms for uplifting zones or active synclines within its borders), with the result that the geological structures have a characteristic dip towards the east, and a marked tectonic and metamorphic polarity towards the west. In this context, the degree of metamorphism among the rocks of the Tocantins Group decreases closer to the Amazonian Craton, and is absent where they meet the Xingu Complex. The rocks are thought to date from the Lower Proterozoic period, having been folded and metamorphised during the Orogenic,

Uruaçuan and Brazilian Cycles. Among the lithological forms present in the Tocantins Group can be found phyllites, quartzites, micaschists, schists, feldspatic quartzites, anphibolites, anphibolic schists, and ferruginous quartzites.

The plateaux and prairies which feature prominently in the geography of the region are dominated by cerrados (savannah lands). For the most part, the cerrado region of Tocantins lies over extensive sandstone plateaux, where the leached soils are relatively deficient in exchangeable bases, and occasionally exhibit concretions of iron hydroxide. With regard to the texture of the soils, the most frequently occurring are clayey sands, and sandy clays, with a reasonable degree of permeability, porosity and aeration.

High acidity, low cation exchange capacity (the capacity of humus and of clays to exchange positive ions with the soil solution), low base content, and high aluminium saturation are some of the chemical characteristics which determine the nutritional poverty of the soils of this region. The high proportion of aluminium ions in the soil is a serious problem, since it is fairly toxic for most of the species grown as crops. Liming, and the application of fertiliser containing macro- and micro-nutrients is recommended, and in this manner the above characteristics can be remedied by raising the pH and reducing the aluminium levels in the soils.

Coutinho (1982) argues that the problems with the use of cerrado soils are due more to their chemical than to their physical properties which are, for the most part, favourable. The topography, is either flat or gently undulating, and the soils are deep and not excessively stony, which facilitates the use of agricultural machinery.

1.3 Climate

The climate which predominates in the State is tropical, hot and sub-humid, or seasonally dry. According to the Koeppen classification system, the state's climate is of the AW type (Monteiro, 1951) with the highest mean temperatures being recorded in the region between the towns of Tocantinópolis in the extreme north of the state, and Porto Nacional. Mean annual temperatures range between 18° and 26°. Highest temperatures occur during the dry season, in late September or early October, at which time the dry air and the smoke generated by the burning of pastures and cerrado lands tend to raise temperatures still further. Average annual rainfall varies between 1,500 and 1,600 mm, with the lowest annual averages (~1,000 mm) usually recorded in the southern part of the State. The driest zone in the State is in the region east of the town of Paranã, near the Goiás border.

Rainfall distribution patterns divide the year into dry and rainy seasons, the latter being more prolonged in the north of the State. Here, the rainy season occurs between the months of June and March, with a dry season in the months of April and May. In the south, the rainy season runs from October to April, and the dry season from May to September. There is commonly a hot spell in January, during which there is a noticeable diminution in rainfall. The dry and rainy seasons cause alterations in the flora. In the dry months, plant species in both forest and cerrado tend to shed their leaves. Plant cover suffers noticeably from the lack of rainfall, appearing dry and being of little nutritional value for livestock (Rizzo, 1981). Rainfall tends to be heavy and of short duration. Electrical discharges are very common in the region.

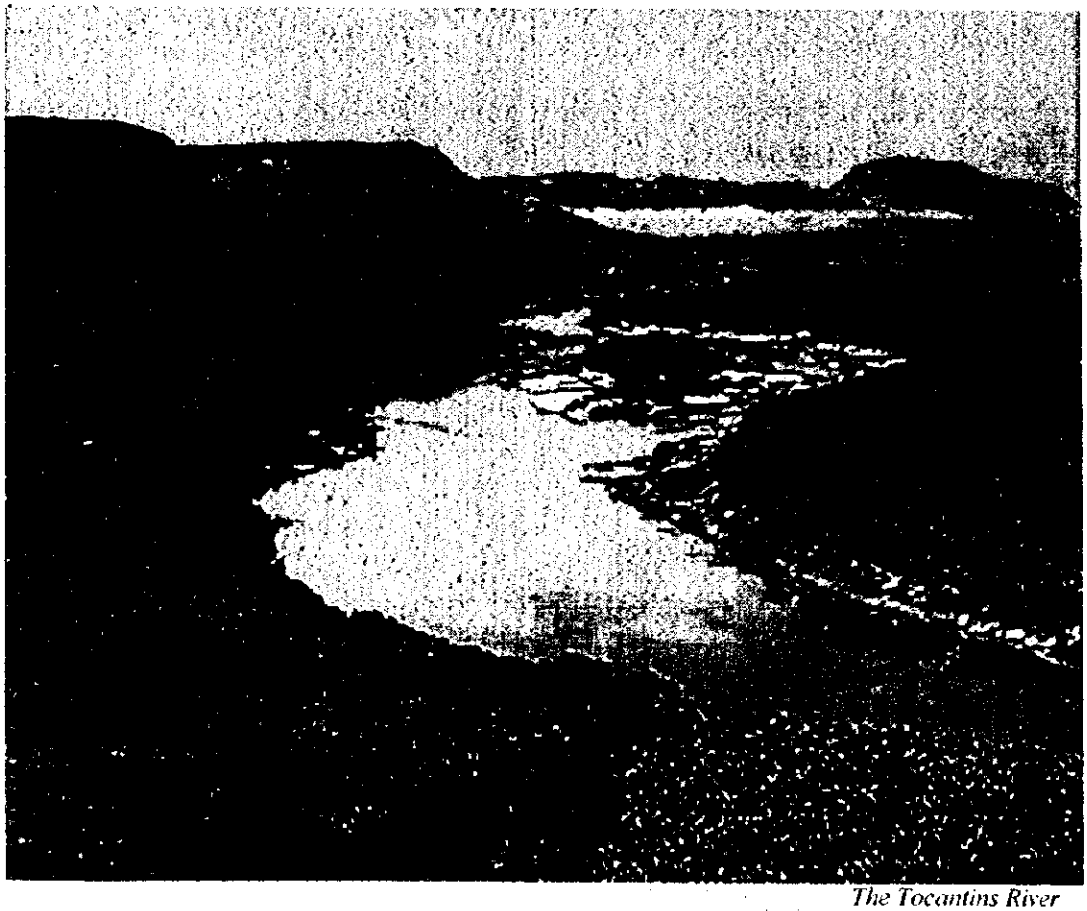
1.4 Hydrography

The entire area of the State is bathed by the Tocantins and Araguaia Rivers, which form the Tocantins sub-basin and the Araguaia sub-basin. The former has two thirds of its area in the state, the latter one third. The Araguaia is the main tributary of the Tocantins. The Tocantins-Araguaia basin, bounded to the south by the Paraná-Paraguai basin, to the west by the Xingu basin, to the east by the São Francisco basin and to the northeast by the Parnaíba basin, is integrated into the Amazon basin.

The Tocantins-Araguaia basin lies between longitude 46° - 55°W, and latitude 2° - 18°S, draining an area of 767,000 km², of which 343,000 km² pertain to the River Tocantins, and 382,000 km² to the River Araguaia. A further 42,000 km² pertain to the River Itacaiunas which joins the Tocantins in its lower reaches, beyond the confines of the State. The Araguaia and the Tocantins are two of the most voluminous rivers in the country, on account of their large number of tributaries and the size of their basins. These characteristics make Tocantins one of the best-endowed States in the Federation, in terms of its water resources. The hydrological regime of the Tocantins-Araguaia basin is well-defined, with a low-flow period in September/October and a high-flow period in the months of February to April.

1.4.1 The River Tocantins

The River Tocantins is formed from the Rivers Almas and Maranhão, whose headwaters are located in the Goiás plateau at an altitude of more than 1,000 m. It is a relatively fast-flowing



Marcio Di Pietro/ GAIA

The Tocantins River

river, characterised by numerous rapids and waterfalls, particularly in its upper reaches. Its waters are rich in nutrients, but they do not provide particularly suitable conditions for fish to spawn on account of the strong current, and the rarity of floodplains. Such areas, besides being ideal spawning grounds, would also reduce the surges in volume observed when the rivers floods (Programa Internacional dos Ecótonos Brasileiros [PIEB], 1996).

On its course through Tocantins State, the main tributaries along its right bank are the rivers: Paranã, Manoel Alves, Sono, Manoel Alves Grande, and Farinha; and along its left bank, the rivers: Almas and Santa Tereza. The average flow rate of the Tocantins River is 4,400 m^3 per second. This rate, however (according to "Pefil Ambiental e Estratégico – Tocantins, 1992") is highly variable, with flow rates of 7,860 m^3 per second when in flood, and 784 m^3 per second in the low water period. These measurements were taken at its confluence with the Araguaia River in the north of the state. Various factors account for the large discrepancy between these two extremes, that can be noted throughout the river basin. The main factors are:

a) in the period between peak flow and minimum flow, evaporation rates are up to four times greater than precipitation rates, in both northern and southern regions of the basin;

b) the narrowness of the Tocantins basin, means that its tributaries are short and of accentuated declivity. Consequently, drainage after rain occurs rapidly, and in low water periods the tributaries can contribute little to the flow of the main river;

c) most of the tributaries of the Tocantins River along its right bank emerge from regions to the south and the east, where the dry season is more pronounced than in the Tocantins region. They are similar to rivers in semi-arid regions where the smaller watercourses dry up during the dry season. The liquid contribution of these rivers therefore shows a marked reduction during this period.

The course of the River Tocantins displays certain characteristics which enable it to be commonly described as having three main stretches: the upper, middle and lower Tocantins.

1.4.1.1 The Upper Tocantins

This stretch lies between latitude 12° and 17°S (THEMAG, 1996), that is, from its headwaters to the Lajeado falls. It is characterised by a series of sections, consisting of long, navigable stretches which are separated by stretches where falls limit navigation both upstream and downstream. This first section is navigable for a distance of 55 km.

After joining the Paranã, the river's characteristics continue the same until it reaches the town of Peixe. The section from Peixe to the Carreira Comprida falls is the fastest-flowing section of the Upper Tocantins, and its bed has clearly not yet become stable. Almost the whole section lies over crystalline rock formations. The most significant features of this section are (in order, moving downstream) the falls of Jacaré, Croá, Capivara and Comandante. The Carreira Comprida falls which end this section constitute an impassable obstacle during the dry season.

The section running from Carreira Comprida to the Lajeado falls where the Upper Tocantins terminates, consists of a 92 km stretch wherein the declivity is less that 20 cm per km. The Lajeado falls are the biggest in the Tocantins River.

1.4.1.2 The Middle Tocantins

This extends from the Lajeado falls to the falls of Itaboca in São João do Araguaia, where the River Tocantins meets the Araguaia in the extreme north of the State (THEMAG, 1996). In this stretch of the river, the section from Miracema do Tocantins to Porto Franco is the best for navigation purposes, extending from the Funil falls just upstream of Miracema to the Island of São João, 90 km downstream from Carolina – a distance of some 400 km. In this section, the minimum depth is 0.60 m near Carolina, with the remainder having minimum depths of between 1.10 – 1.50 m. The declivity, with a few exceptions, is less than 20 cm per km.

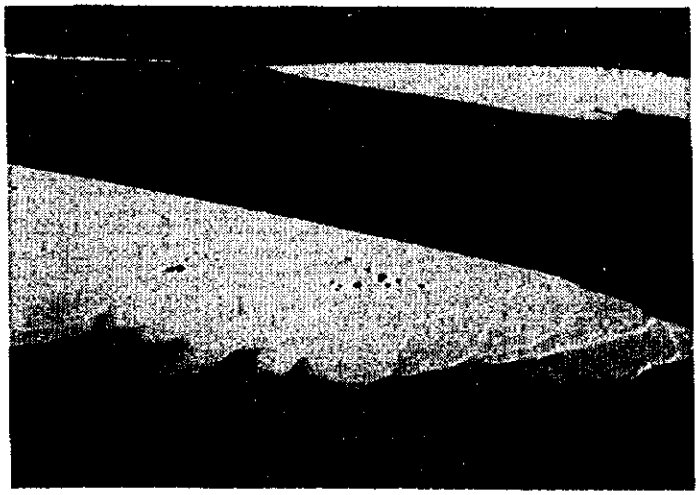
Outcrops of granite occasionally occur in the river bed along this stretch, and are responsible for the existence of rapids and waterfalls. From the Island of São João downstream to Porto Franco, there occurs another section of rapids which make navigation difficult. In periods of low water, crossings are effected with the use of cables. From Porto Franco to Itaguatins, lies a 70 km section of river which is very difficult to navigate. From Itaguatins to São João do Araguaia, the final section of the middle Tocantins, the river is again navigable. It extends for some 200 km, most of this with minimum depths of 1.00 – 2.20 m.

1.4.1.3 The Lower Tocantins

This lies outside the confines of Tocantins State, extending from the Itaboca falls to the mouth of the river near the city of Belém. It is always navigable. Rapids and waterfalls were once important habitats in the Lower Tocantins, but most have now been flooded by the Tucurui reservoir.

1.4.2 The River Araguaia

The River Araguaia is the main tributary of the Tocantins, and is considered by many to be of equal importance in terms of the Araguaia-Tocantins basin generally. This opinion is justified by reference both to its hydrological characteristics, and to the role it has played in the settlement of the state.



Frederic Meriens / GAIA (1826)

The Araguaia River

The Araguaia's headwaters are located in the Caiapó Range, on the borders of the States of Goiás and Mato Grosso, at an altitude of approximately 850 m. It is 2,115 km long, and runs, for the most part, parallel to the River Tocantins, into which it flows near the town of São João do Araguaia, situated in the extreme north of Tocantins State, some 70-80 m above sea-level.

The Araguaia River boasts the largest fluvial island in the world – Bananal Island – which is 80 km wide and 350 km long, and is situated in the south west of Tocantins. The Araguaia's main

tributary is the River Manso or the River Das Mortes. The average flow of the Araguaia River is approximately 4,250 m³ per second (Perfil Econômico e Social, 1989).

Unlike the River Tocantins, the Araguaia possesses ample floodplains with numerous lagoons along its banks, and is slow draining, with frequent sandbanks and islands. These characteristics allow high water periods to last longer than those of the Tocantins River (THEMAG, 1996). Although it is a lowland river, its longitudinal profile is broken into a number of stages, defined by geological features consisting of outcrops of harder rocks (Perfil Ambiental e Estratégias – Tocantins, 1992). Since there was no traditional division of the course of the Araguaia, the National Department for Ports and Navigable Waters (DNPVN) established the following division, taking into account those aspects relating to navigation on the river.

1.4.2.1 The Upper Araguaia

The upper Araguaia stretch is 450 km long, starting at the headwaters and ending at the town of Registro do Araguaia, over which distance the river falls some 185 metres. The designation of this stretch is based on the underlying rock formations, and it takes in the river's emergence in the Caipó Range, whence it descends down a deep geological cutting. Its bed overlies predominantly sedimentary rocks, with occasional outcrops of basalt.

The upper Araguaia has the steepest gradient of the whole river, (approximately 1.20 m per km). The minimum depth is 0.30 m – the lowest observed in the whole river – which renders this stretch the least suitable for navigation, particularly in the dry season.

1.4.2.2 The Middle Araguaia

This extends 1,505 km from Registro do Araguaia to Santa Isabel do Araguaia. It is the longest stretch of the river, and can be subdivided into 3 sections according to the characteristics of the river bed.

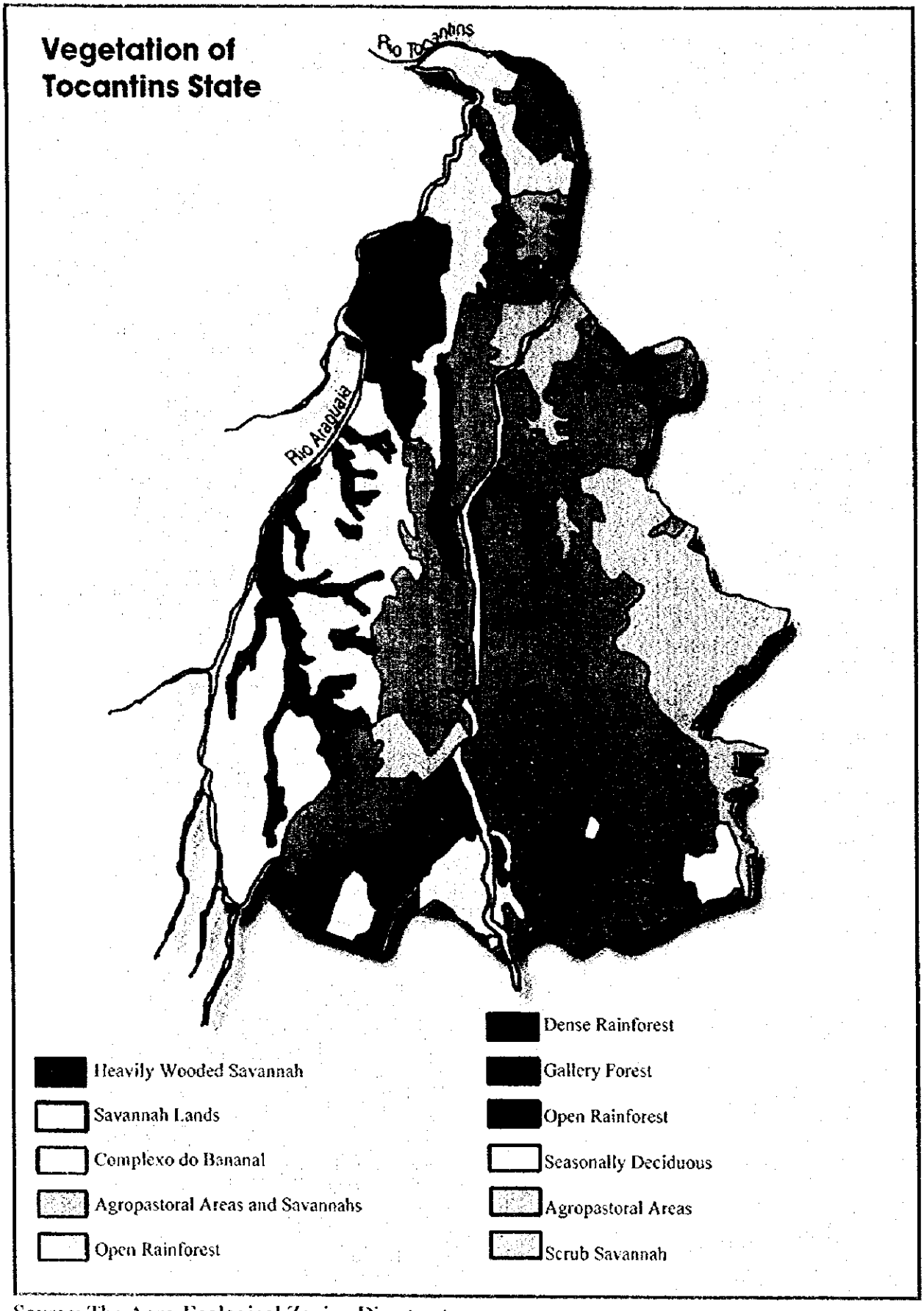
In the first section, which is the longest and calmest of the three, the river's course unfolds across a vast sedimentary plain, large areas of which can be flooded in the rainy season, due to its gentle slope. The várzeas (floodplains) of the River Araguaia can be as wide as 10 to 15 km, and the river itself can divide into several separate strands where its bed overlies recent alluvial deposits. In this section, the declivity is generally around 5 cm per km, and the minimum depth 0.70 m, being freely navigable throughout the year. It is here that navigation is easiest, relative to the other stretches of the river.

1.4.2.3 The Lower Araguaia

This stretch runs from Santa Isabel do Araguaia to where the river meets the Tocantins. It is 160 km long, over which distance it falls 11 metres.

1.5 Vegetation

The cerrado in its broadest sense occupies most of Tocantins State. It covers all the central southern, and eastern regions of the State, being interspersed with cerradão (heavily wooded savannah) in the south, with agropastoral areas in the centre along the Tocantins River, and in



Source: The Agro-Ecological Zoning Directorate.

the north with dense rainforests in the region known as the Parrot's Beak (Bico do Papagaio). The semi-deciduous forests of Araguaia and the Xingu are areas of transition between the cerrado and the Amazon forest, and form a rough line running from Imperatriz (MA), through Arapoema (TO) and thence following the axis of the Araguaia River to Santa Terezinha (MT), following the watershed between the Xingu and the Araguaia basins.

Bananal Island, in south-west Tocantins, is characterised by its well-defined gallery forests. To the north of the Island, in the valley of the River Araguaia, lies the Araguaia National Park which is situated in the transition zone between the Amazon forest and the cerrado. Its fauna contains species from both vegetation types, however species endemic to one or other vegetation type are not found there, due to the lack of suitable habitats. Another significant limiting factor for the fauna of the Park, is the annual flooding of low-lying land.

Frederic Meriens / GAIA, (132)

The cerrados (savannah lands) are distinctive, in relation to the other vegetation types present in the region, because of their particular appearance and great extent. They predominate on the plateaux and the prairies which feature prominently in the geography of the region.

In addition to cerrado, the regional vegetation features Amazonian rain forest formations, semi-arid scrubland (caatinga), and swampland (pantanal). The transition from one vegetation type to another, when observed closely, can be seen to occur in several stages, each of which is manifested by a series of subtle and detailed modifications in the appearance, composition, form and structure of the vegetation. These modifications parallel those occurring in the wider environment, with climatic, topographical and edaphic factors playing the major formative role (IBGE, 1981). Species typical of the Amazon basin appear to have spread deep into Tocantins via the State's extensive fluvial network. They are particularly common in the gallery forests which line the riverbanks.

On the border with the States of Bahia and Goiás, there are areas of seasonally deciduous forest, and along the Piauí and Maranhão borders, areas of scrub savannah (campo limpo) that characterise the area known as Jalapão.

1.6 Fauna

The vegetative mosaic of the cerrado, consisting as it does of xeromorphic, mesophilic and hydrophilic species, provides a highly varied range of habitats for its fauna. According to Branco (In: Negret, 1983), the dry and rainy seasons, which are well-defined in the cerrado regions, have a strong influence on fluctuations in the local fauna (especially birds) and on migratory species. Another factor is that the River Tocantins is part of the migratory route for birds which travel from one hemisphere to the other, or from one region to another, as is the case with those coming from the swamps (pantanal) of Mato Grosso.

Highly significant too, are the human pressures on the cerrado, simplifying vegetation types and reducing the available niches. Hunting activities that make use of burning – a practice adopted by the region's indians – and more recently the hunting pressure generated by local inhabitants has certainly contributed to the rarity of several animal species. The recent establishment of the capital, Palmas, has exacerbated the human impacts on the regional environment, especially on the right bank of the River Tocantins. The expansion of open environments and the establishment of fields of crops, especially cereals, favours heliophilic and perianthropic fauna, which is more tolerant of environmental change (THEMAG, 1996). Against this background, the importance of the forested areas that remain is heightened.

Frederic Mertens / GAIA (ib49).

Tartaruga, Podocnemis expansa

Studies carried out in the Lajeado region, near Palmas, show the presence of large species such as tapirs (Tapirus terrestris), jaguars (Panthera onca), cougars (Puma concolor), deer (e.g. Ozotoceros bezoarticus), guara wolves (Chrysocyon Brachyurus) and primate species (e.g. Alouatta caraya), some of which are of great conservation interest since they are in danger of extinction in other regions of the country. The presence of migratory fauna, such as turnstones and teal (Dendrocygna viduata) is also noted.

Just as elements of the Amazonian flora have dispersed along the gallery forests of the Rivers Tocantins and Araguaia and their tributaries, some Amazonian animal species have likewise extended their geographical range. This is evidenced by the presence of aquatic and semi-aquatic species of mammals and reptiles. Among them: the Amazon porpoise (Inia geoffrensis), and freshwater turtles (Podocnemis unifilis; P. expansa). Certain crocodile species can also be cited (THEMAG, 1996).

a) Birds: The field work done by the THEMAG team in the Lajeado region, identified 196 bird species, in 57 families (for examples, cf. Appendix I). The best represented families are the Tyrannidae (19), Thraupidae (14) and Fringilidae (12), which was as the team had expected, since these are the most common in the Brazilian ornithological fauna. Most of the species were Non-Passeriform (58%), with the remaining 42% being Passeriforms. Of the species recorded in the study, 39 had been previously observed and recorded by Professor Dr. J. Hidasi in the period 1994-1996.

Maçarico, Tyinga sp.

Frederic Mertens / GAIA (ib3)

Biguatinga, Anhinga anhinga

Frederic Mertens / GAIA (ff1)

Arara Canindé, Anodorhynchus hyacinthinus

The blue macaw (Anodorhynchus hyacinthus), the world's largest parrot, whose range is restricted to the Brazilian states of Mato Grosso, Mato Grosso do Sul, Goiás, Bahia, Piauí, Maranhão and Pará, and parts of Bolivia, is also found in Tocantins. At present, it is rare, because of predatory hunting for commercial ends. It is a species which nests mainly in hollow trees, and is thus threatened by deforestation.The blue macaw is only found in areas of difficult access with thick forest cover.

b) Reptiles and Amphibians: THEMAG researchers recorded 17 families, including serpents, lizards, amphibians, crocodiles and turtles (cf. Appendix II). The families Crocodilidae, Chelydae and Platamistidae are characteristically Amazonian. Five families of serpents were present, containing 18 genera and 22 species. Of these the Colubridae is the most numerous, with 7 representatives. The second family, in terms of species numbers, is the Viperidae, which is the group of venomous serpents. It is represented by Amazonian and cerrado species.

Moacir Tinoco (lib15).

Iguana - Iguana iguana

Frederic Mertens / GAIA (lib22)

Lagarto Verde

The species recorded are characteristic of the Central Western and Southern regions of Brazil, and neighbouring countries. Examples of non-venomous species are: Sibynomorphus mikanii, Clelia occipitolcuca and Liophis almadensis, and among the venomous species are the pit vipers (Bothrops jararaca and B. moojeni). Only one species (Leptotyphlops koppesi), collected in Porto Nacional, has a distribution

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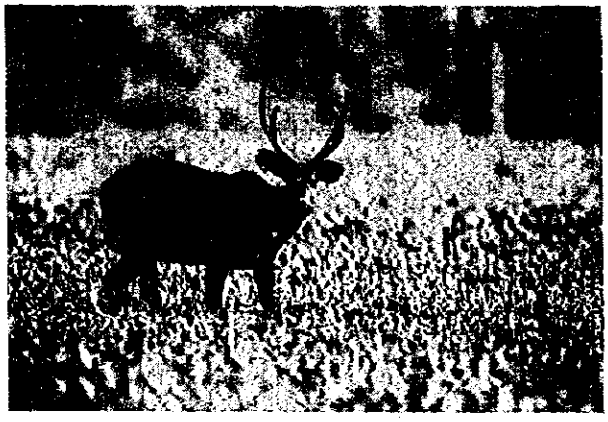
Jacaré-Açu, Melanosuchus niger

restricted to Mato Grosso, acording to the literature (Peters & Orejas-Miranda, 1986; In: THEMAG, 1996).

20 species of lizard were identified, grouped into 16 genera and 8 families. Of these the Gekkonidae and Aphisbaenidae families are most numerous, both having four representatives.

A total of 22 amphibians were recorded in the Lajeado region, grouped in 9 genera and 4 families, including the Hylidae and Leptodactilidae families, (frogs and tree toads). The toad Bufo ocellatus, and the leptodactylid Barycholos savagei have a relatively restricted geographical range, being confined to the South Eastern and Central Western regions of Brazil. The other species are widespread: Bufo granulosus, Hyla raniceps, Phrynohyas venulosa, Leptodactylus ocellatus, and L. fuscus, Scinax fuscovaria, Hyla albopuctata, H. rubicundula, Physalaemus nattereri and Peptodactylus labyrinthicus.

<u>c) Mammals:</u> In the biogeographical system of the cerrado, species whose range includes large parts of Brazil and parts of neighbouring countries predominate, as is the case with the ant-eaters (Myrmecophaga tridactyla; Tamandua tetradactyla), the ground squirrel (Sciurus aestuans), and the tatouay armadillo (Cabassous unicinctus), and with species whose range includes Central and South America such as the capybara (Hydrochoerus capybara) and the brocket deer (Mazama americana).



Frederic Mertens / GAIA (ib20)

Cervo do pantanal, Blastocerus dichotomus

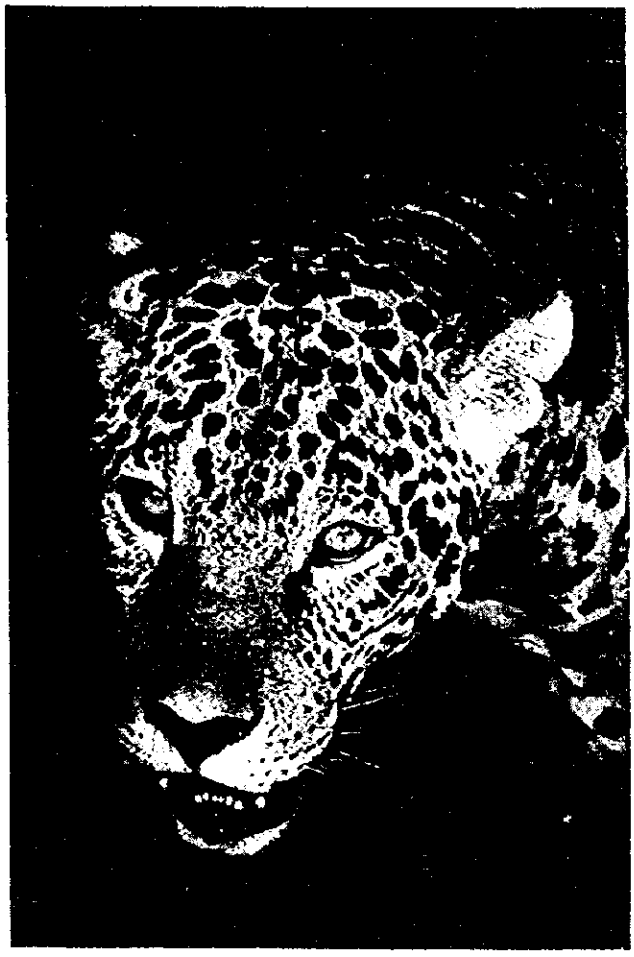
11% of the species occur in the central and southern regions of Brazil and neighbouring countries, that is in regions characterised by open landscapes. Among this group are included the howling monkey (Alouatta caraya), a primate species characteristic of the savannah region, and present in the gallery forests, the grison (Dusicyon vetulus), and the guara wolf (Chrysocyon brachyurus). Only one species, the soim (Callithrix jacchus penicillata) has a restricted range, being found in dry scrub, and gallery forests from Bahia, Goiás and Tocantins to São Paulo. The sloth (Bradypus variegatus) and the giant river otter (Pteronura brasiliensis) also occur. The Amazon porpoise (Inia geoffrensis) is more common in the Araguaia River than in the fast-flowing Tocantins. Its occurrence in the latter river

Mouzir Tinoco.(2)

Sagui - Callitrix jacchus

Moacir Tinoco (6)

Capivara - Hydrochaeris hydrochaeris



Moacir Tinoco, (1)

Onça - Panthera onca

was noted by the THEMAG team in the locality of Santa Maria (TO) upstream of the Crixás River. The THEMAG report (1996) states that the porpoises move up and down the river, following the fish on which they feed.

Some mammal species have a very wide natural range, occurring in North, Central and South America, including among this group the cougar (Puma concolor), the jaguar (Panthera onca) and the spotted leopard-cat (Leopardus pardalis) (THEMAG, 1996). According to Emmons and Feer (1990) the tatouay armadillo (Cabassous unicinctus), the ground squirrel (Sciurus aestuans) and, apparently, the ferret (Galictis vittata), are thought to be naturally rare in their distribution, whereas other species, such as the ant-eaters (Myrmecophagidae), the felines (Felidae) and the tapir (Tapirus terrestris) among others, have become rare due to the destruction of their habitats and predatory hunting.

d) Fish: The icthyological fauna of the Tocantins-Araguaia basin, consisting of 300 species, 126 genera, and 34 families with characids, silurids and ciclids predominating (Paiva, 1982; Santos et al, 1984; Leite, 1993 ; All In: THEMAG, 1996), is not very rich by Amazonian standards (2,000 species classified, according to Lowe-McConnell, 1969, and Roberts, 1972; In: THEMAG, 1996).

According to the diagnostic report given in the "Viability Study for the Lajeado Dam, River Tocantins" (THEMAG, 1996), the synergistic effect of the drying out of the river valley and the consequent depression in its base level, and the limited occurrence of flood plains, resulted in the upper reaches being colonised by species distinct from those found in the middle and lower reaches which are characteristic of the middle Amazon. On the other hand, links with other river basins – that of the Paraná and São Francisco Rivers – made possible by the River Maranhão, allowed non-Amazonian species to colonise the upper reaches, an example being the Salminus hilarii.

The complex morphogenesis of the basin is another factor to be considered in the colonisation of

the locality, since it made possible the evolution of many endemic taxa, such as Laemonita petiti, Leporinus affinis, Sartor tucuruiense (Santos & Jegu, 1989; In: THEMAG, 1996), and Rhinopetitia myersi (Gry, 1964; In: THEMAG, 1996).

It should be stressed that few surveys of the icthyological fauna of the Tocantins-Araguaia basin have been done, especially in the middle and upper reaches. Those that have been undertaken arose primarily because of proposals for hydro-electric schemes in the region. The lack of consensus on the taxonomic status of many species (Pereira et al, 1995; In: THEMAG, 1996), and the small number of experts in this field confer a certain degree of imprecision to these surveys, and show the need for an intensification of the studies, if only because the certainty of differentiation between species constitutes a basic pre-requisite for knowledge regarding their biology.

The THEMAG report states that, in general, the abundance and richness of species decreases as one moves from the mouth of the Tocantins River to its headwaters, attributing this to the smaller floodplain area in the middle and upper reaches, and the absence of species which are typical of the lower reaches of rivers that drain into the Amazon. The report cites Santos et al (1984) and Leite (1993) who registered more than 220 species in studies of the lower Tocantins, whereas studies undertaken in the middle Tocantins by THEMAG/ELETRONORTE (1989) found only 123 species (THEMAG, 1996).

The building of dams is one of the principal causes of impact on the icthyological fauna, and has caused alterations in the community even before its original structure was known, a fact which hinders the prediction of impacts and the adoption of mitigatory measures for future projects.

The diagnosis given in the "Viability Study for the Lajeado Dam, River Tocantins" (THEMAG, 1996) notes that the Tucurui Dam caused changes in icthyological communities. It cites Leite (1993) who found that of the 223 species recorded prior to the dam's completion, only 141 were detected in sampling soon after the floodgates were shut. Although 32 of the missing species were found in subsequent sampling, 50 species have not returned since the formation of the reservoir. The reduction in catch per unit of effort (down 80% below the reservoir, 71% in the reservoir itself, and 56% upstream of it), decreases in the diversity and abundance of species, and alterations in the trophic structure of the community are also recorded by the same author.

Ribeiro et al (1995) report modifications to the spawning grounds of commercial species in the lower Tocantins resulting from the installation of the dam. The THEMAG report distinguishes four types of fishing activity in the Tocantins River: subsistence; local professional fishermen; dam workers; and indians. Total catch does not exceed 4,000 tonnes per year on the most heavily fished stretches, including that near Imperatriz and the Tucurui reservoir (THEMAG, 1996).

The fish catch made between the town of Porto Nacional (TO) and Estreito (MA) does not exceed 400 tonnes per year, which can be attibuted to two factors:

1) the Tocantins River runs through a deep valley, with few floodplains;

2) professional fishing is prohibited and/or discouraged in the States of Goiás, Tocantins and Mato Grosso (Petrere, 1994; Ministry of Agriculture, 1995).

The findings of the THEMAG report suggest that:

- Some lagoons along the margins of the Tocantins River seem to perform ecological functions distinct from those found in floodplains, and as such they should be studied further for management purposes;

- The flood plain of the Araguaia River could be one of the source areas for the fish in the River Tocantins, although this hypothesis has yet to be tested;

- Migratory species occur in the area, making temporary use of the environment as a migratory route and as a place for feeding or reproduction;

- The fact that the Tocantins River runs through a narrow valley and has no flood plains in the stretch surveyed, shows the importance of its tributaries and of some lagoons as spawning grounds.

Prospecting, especially for gold, in the upper reaches of the Tocantins River (THEMAG, 1996) is another human activity that may affect the icthyological fauna of the Tocantins-Araguaia basin. The dispersal of clay in the river causes the sedimentation of its bed and hinders the penetration of sunlight, thereby reducing the productivity of plankton. A further factor to consider in this context is the toxic effects of the mercury used by the miners, once it enters the food chain, contaminating fish, animals and wading birds.

1.7 The Biogeographic System of the Cerrado

The cerrado is the second largest biome in Brazil and in South America. It consists of a great mosaic of natural landscapes, covering 15-20% of the plateaux with deep, well-drained soils in Brazilian territory, and sheltering a rich heritage of renewable natural resources adapted to the harsh climatic, edaphic and hydrological conditions that prevail. The cerrado is situated predominantly on the Central Plateau of Brazil, between latitudes 3°- 24°S, and longitudes 45°-63°W. It occurs in the following states: Bahia (in the west, and on the Diamantina Plateau), Ceará (in parts of the Arraie and Ibiapaba Plateaux), the Federal District, Goiás, Maranhão (in the south and west), Mato Grosso (in the south), Mato Grosso do Sul, Minas Gerais (in the central west and in the Espinhaço Range), Pará (in parts of the southeast), São Paulo (in parts of the central west) and Tocantins (except for the extreme north). It is a natural region that is almost exclusively Brazilian, except for small areas in north-east Bolivia (the high Mamoré). There are also numerous small areas of cerrado in the Atlantic Forest, semi-arid scrub (caatinga), and Amazon regions, not to mention the savannahs in the north of South America, which are similar.

The cerrado region occurs in several hydrographic basins (Amazon, Tocantins, Paraná, Paraguai, São Francisco and Parnaíba), and contains a wide diversity of soils and of climate, which is reflected in the great heterogeneity of its biota. Because of its great extent, it is not surprising to find that the cerrado is not a uniform entity; rather, there are many distinct types of cerrado, each interacting with, and shaped by its own local reality.

The factors determining which type of vegetation occurs in a given part are diverse and may vary from one place to another. The two most important factors are the availability of water

(which is a function of the total annual rainfall, its seasonality, and the water retention capacity of the soil, which in turn depends on its depth and texture), and the availability of nutrients (which is a function of the natural fertility of the soil, the nutrient cycling resulting from biological activity, and the effects of fire -- queimadas) (Avim & Silva, 1980; Goodand & Ferri, 1979; Eiten, 1971; Coutinho, 1990; Frost et al, 1986; Walker, 1987; Sarmiento, 1984; In: Dias, 1996).

As with most tropical and sub-tropical soils, those of the cerrado are, in general, extremely poor in available phosphorous (Goodland & Ferri, 1979). Cerrado soils tend to have low pH and high concentrations of iron and aluminium sesquioxides. Such characteristics lead to a "high capacity to retain phosphorous in poorly soluble forms, that are not readily available to plants" (Goodland & Ferri, 1979). However, Coutinho & Struffalde (1972) studied the nutrient status of areas around leguminous cerrado species. Levels of N, P, K, Ca, and Na in soils underlying 11 leguminous species were measured. Their results tended to undermine prevailing ideas about the 'barren' nature of cerrado soils, since they showed that the leaf-dispersal areas of cerrado leguminous species are a rich source of mineral nutrients and proteins (Goodland & Ferri, 1979).

In 1971, Hering studied the mycological flora of the cerrado and affirmed that: "having compared the frequency of mycological agents on the plants of both eastern forest and cerrado vegetation types, we were surprised to note that the latter contained more mycological species than the former. We also noted that the incidence, per specific unit and per individual, is high." From this unexpected information, it was posited that the mycological flora must have an ecological role in the cerrado. Hering also stated that "mycological agents are present in the reproductive organs, particularly of the higher plants. When climatic conditions are favourable to the fungi, little fruit is produced because of their attacks on the flowers" (cited in Goodland & Ferri, 1979).

The native flora of the cerrado is adapted to its poor soils, said to be dystrophic or oligotrophic. The plants do not appear to show signs of nutrient deficiencies. The species of the cerrado have undoubtedly developed efficient mechanisms to overcome the nutritional difficulties of the soil, absorbing what is needed for their survival (Coutinho, 1980). This paucity of soil nutrients is an important factor influencing cerrado vegetation in many areas.

Vegetative cover consists of grasses, herbs, bushes and trees of various proportions, the cerrado vegetation is striking particularly on account of the tortuous, stunted aspect of its trees and bushes. Various means of adapting to droughty conditions are evident, notably: trunks and stems that are frequently covered with thick protective layers, and leaves that are coriaceous and shiny, or covered in a network of fine hairs giving them a 'furry' appearance.

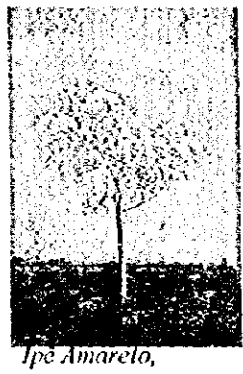
Raewistscher (1900) was the first to consider seriously the possibility that the vegetation was not severely affected by lack of water, since even in the middle of drought periods the large leaves which many cerrado species have, show no signs of wilting. Their abundant flowering and sprouting before the rains seemed to contradict the general notion that the existence of the cerrado was due to the scarcity of water. Many authors have since argued that water is not a limiting factor in the cerrado vegetation.

There are more than 2,000 species of woody plants native to the cerrado (Rizzini [1963] recorded more than 400 tree species endemic to cerrado regions), a larger number of herbaceous species, and an as yet unknown quantity of animal species, with numerous new species being discovered with remarkable frequency. There are probably a few hundred species that are common to all

Faveira

Palmeira de Babaçu

Sucupira



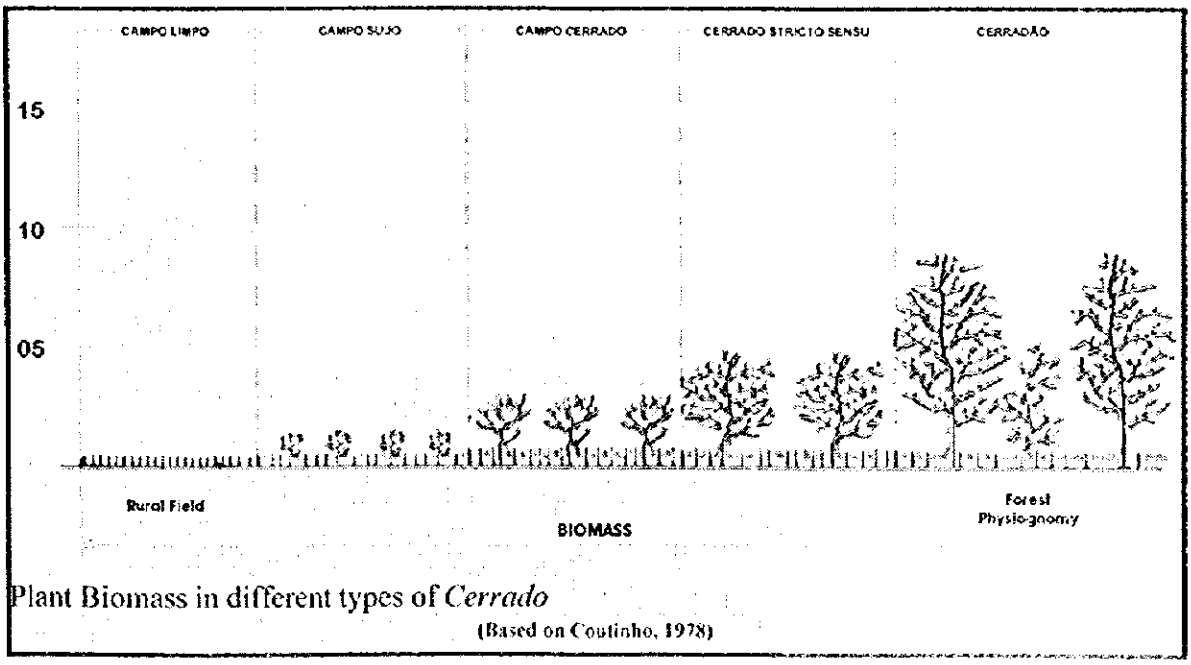
Ipê Amarelo,
Tabebuia umbellata

areas of the cerrado. In addition to these common species, each area may possess an equal or greater number of more local species.

According to Countinho (1980), the cerrado takes different forms. The following classification is based on the presence and size of the bushes and trees observed:

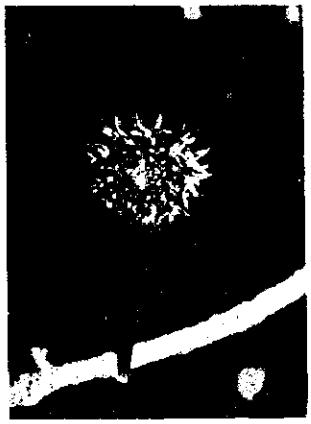
Field-type formations: campo limpo
Savannah-type formations: campo sujo, campo cerrado and cerrado (strictu sensu)
Forest-type formations: cerradão.

Little is known about the biology of the cerrados in general, except for qualitative data showing a high concentration of total biomass, both in plant form (roots descending over 20 metres, tuberous roots, xilopods, fleshy roots, etc. [Rawitscher & Rachid, 1946; Rachid, 1947]), in animals (termites, ants, bees, armadilloes, lizards, rodents, giant earthworms etc. [Vanzolini, 1963; Dias, 1985]), and in microbial form (bacteria, actinomycetes, mycorrhizas, etc. [Drozdowicz, 1977]). Social insects such as the leaf-cutting ants and the termites perform a key role in nutrient-cycling in the cerrados (Coutinho, 1984; Egler, 1984).



Plant Biomass in different types of *Cerrado*
(Based on Coutinho, 1978)

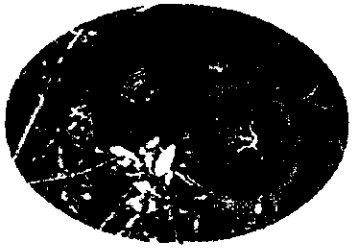
The idea that the cerrado could serve no commercial agricultural purpose, and was only suited to extensive livestock production and extractive industries, notably that of charcoal production, prevailed until the mid-1970s. Despite their edaphic and hydrological restrictions, the cerrados have come to be considered the new agricultural frontier of the country, thanks to research into soil management techniques such as liming, fertiliser applications, and irrigation, and to their favourable topography and soil texture, low land prices, and accessibility to consumption centres. Thus, the cerrados have now become one of the major grain-producing regions of Brazil.



Frederic Mertens / GAIA (124)

Frederic Mertens / GAIA (S120)

There is little specific information about the cerrado in Tocantins State. Some research has been done in response to political interests seeking the socio-economic development of the State, and some has been carried out by university institutions. Still, the published literature relating to this biogeographic system and its occurrence in the Tocantins, is insufficient to adequately convey the tremendous natural variety of the State. Among the researchers who have worked in the region, Rizzo is one of the most important. His "Flora of the State of Goiás" (Rizzo, 1981), relates the species found in parts of what is now Tocantins State. Appendix III lists the Collecting Stations within Tocantins that he established hile compiling his account, and includes his notes on each. Currently, however, more incentive needs to be given to the development of effective research programmes focussing on the Tcantins cerrados, aiming to provide appropriate technology for productive purposes, andfor the conservation of the cerrado ecosystem.



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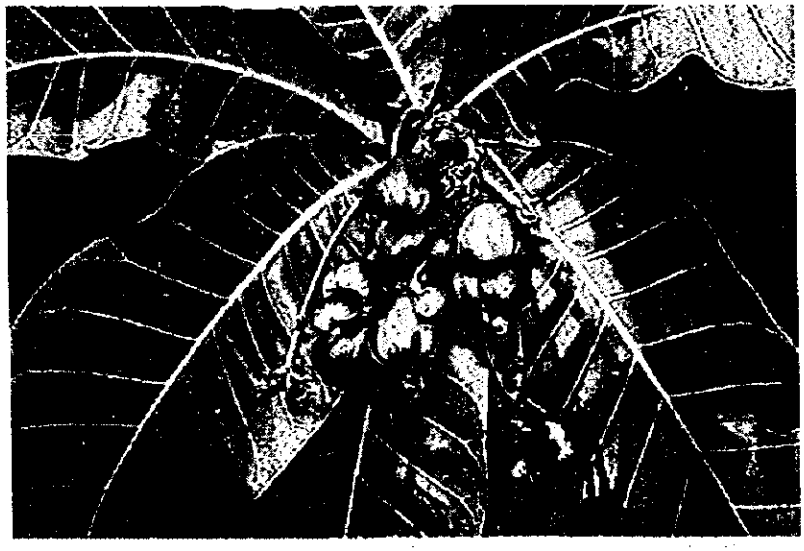
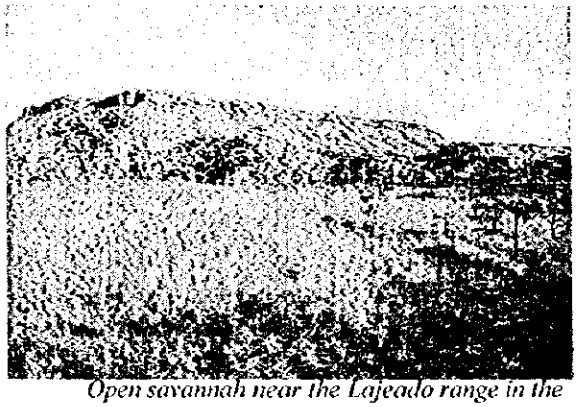


Frederic Mertens / GAIA (S122)

1.8 Biogeographic Subsystems

1.8.1 The field-type subsystem (campo limpo)

This occurs in the highest areas of the system, which are usually flat plateaux. Vegetation is sparse, the trees are stunted and far apart. Its fundamental characteristic is its herbaceous cover, free of bushes and only rarely with shrubs present. The open nature of this subsystem ensures good ventilation throughout the year and a temperature that is generally lower than in the other subsystems. Drainage networks are insignificant (occasional small lagoons, some of which are perennial). Scrub cover is sparse, with grasses predominating.



Frederic Mertens / GAIA (S101)

Open savannah near the Lajeado range in the dry season

This subsystem probably once covered a much larger area than it does currently. This change can be attributed to structural factors in the soil associated with special micro-climates that have not totally recovered from the climatic shocks of the Upper Pleistocene (Perfil Ambiental e Estratégias, Tocantins, 1992).

1.8.2 The cerrado (strictu sensu,) campo cerrado and campo sujo, subsystems.

These intermediate forms have the appearance of savannah, but the woody stratum gradually becomes more important in the landscape, both in terms of the number and the height of the species occurring. (Coutinho 1986),

1.8.3 The cerradão sub-system

This is formed by xeromorphic, semi-deciduous forests. It occurs in isolated patches located primarily in areas where there is little human activity. Its appearance varies greatly, depending on the type of terrain and the properties of the soils. It is usually restricted to areas of leached sandstone, with a highly seasonal tropical climate (Ministério do Interior, 1989). Generally, pH is below 5.0, and exchangeable calcium is very low (less than 1 me per 100 g soil) (Goodland & Ferri, 1979). The trees are interspersed with woody shrubs, and dwarf palms, and their height ranges between 8 and 15 metres, their trunks are straighter and thick-barked, and their leaves large and coriaceous.

Frederic Mertens / GAIA (lib37)

Cerrado vegetation in the Bananal Island region

The relatively open canopy of the trees in cerradão allows light to penetrate and the formation of a lower storey of woody plants which can be quite thick. In terms of composition, its flora is very diverse, since it is made up of cerrado species,

species commonly observed in seasonal forests, and species that are exclusive to cerradão. According to Ferri and Coutinho (1958), it does not dry out as much as the other types of cerrado in the drought period.

1.8.4 Forest and Gallery Forest Subsystems

According to the Programa Internacional de Ecótonos Brasileiros (The International Programme for Brazilian Ecotones – PIEB, 1996), in addition to the various types of cerrado found in Tocantins State, large areas of tropical forest are also present, These can be categorised under the following typology:

- Gallery forests, which are hydrophilic forests, occurring mainly along the banks of the Araguaia and Tocantins rivers and their tributaries, often with areas of secondary vegetation, evidenced by species such as the spur tree (esporão);

- Dense, semi-evergreen rainforests, located in the southwest of the Bico do Papagaio (Parrot's Beak) area in the north of the State, which feature species such as andiras, pepper trees, mahogany and courabil;

- Open sub-evergreen mixed forests, present in the region of Conceição do Araguaia (PA). In addition to mahogany, and courabil, species such as the bacaba and babaçu palms are found. This type of forest is usually of low density;

- Open Maranhão-type forest, which occurs in the municipalities of Imperatriz (MA), and João Lisboa (MA). It is similar to the open sub-evergreen mixed forests described above, but its deciduous qualities are more marked, particularly in the east.

- Semi-deciduous forest, found in the Xingu Park, and stretching thence to the Araguaia valley, especially along the left bank. Characteristic species are pepper trees, mahogany, sucupira, cedar and gum trees.

1.8.5 Veredas and Swampland Subsystem

The occurrence of veredas is occasioned by the welling-up of ground water, owing to the alternation of layers with different permeability in areas of sedimentary Cretaceous and Triassic rocks. (Azevedo, 1966; In: Informe Agropecuário, 1991). They occur in areas of flat topography or on slopes adjacent to rivers and lakes, or in isolated depressions. Generally the area occupied contains one or more springs which drain away in small streams , or collect in shallow lagoons, which may be surrounded by swampland (Ferreira, 1978; EMBRAPA, 1982; In: Informe Agropecuário, 1991). Their soils are hydromorphic, supporting hydrophilic communities. In the early seral stages of such communities, the buriti palm (Mauritia vinifera) tends to be the main arboreal element, with scattered bushy species surrounded by grassy and herbaceous cover, in which species from the Gramineae, Cyperaceae, Eriocaulaceae and Melastomataceae families are present (Martius; Spix, 1938; Mello Barreto, 1949; Rizzini, 1963; Magalhães, 1956, 1963, and 1964; In: Informe Agropecuário, 1991).

The veredas are an important ecosystem in the cerrado zone, since they are responsible for the maintenance and multiplication of its aquatic fauna, as well as contributing to the continuation

and regularity of the rivers in the region. Allied to these features is the fact that vereda environments are sensitive to alteration, and have little or no capacity for self-regeneration.

In conclusion, it can be stated that Tocantins State possesses all types of cerrado, from the most open to the forest formations, with the field-type predominating. The variations in relief associated with the hydrographic network determine the distribution of the vegetation in a complex mosaic. Moist tropical formations along the rivers, for example, permit the coexistence of cerrado species with those that are typical of the Amazon region, and with those that occur in the seasonal forests in other parts of the country. In other places, in contrast, more arid zones with open, field-type features favour species typical of the caatinga (semi-arid scrubland) domain.

In broad terms, cerrado vegetation is found in the dry and nutrient poor areas of the State, aquatic or swampland flora in well-watered areas and, in the intermediate areas, ombrophile or seasonal forests (THEMAG, 1990).

Frederic Mertens / GAIA. (ff21)

Veredas *at sunset*

1.9 Ecotone Areas

From the above it is clear that the State of Tocantins is located in an area of transition between cerrado and forest. It thus presents abundant examples of areas known as "ecotones", in which two or more ecosystems interact. The best-known ecotonal area is that of Bananal Island, where cerrado, forest and pantanal ecosystems occur.

The importance of these areas is due to the great biodiversity that can arise through the ecosystems' interaction, and it is extremely important to study and preserve them, rendering such conservation compatible with development. However, the biological composition of such areas is indeterminate. Distinct biotas can exist, side by side, without mixing, or in other areas blending together in ecotonal stages. In the description below, four ecotonal poles are cited, as defined by the PIEB (1996).

Pole 1
This includes Bananal Island, the Araguaia Indian Reservation and the Araguaia National Park wherein lie Amazon forest, cerrados and swampland, and their various interfaces. The main rivers in this Pole are the Araguaia, the Javaés and the Formoso.

The main soil types are gleyed soils and hydromorphic laterites which underlie large areas of the Island, and the latosols, podzolic soils and alluvial soils in smaller areas. Typical mineral deposits include gold, limestone, chrome, iron, nickel, copper, titanium, crystal, manganese and diamond.

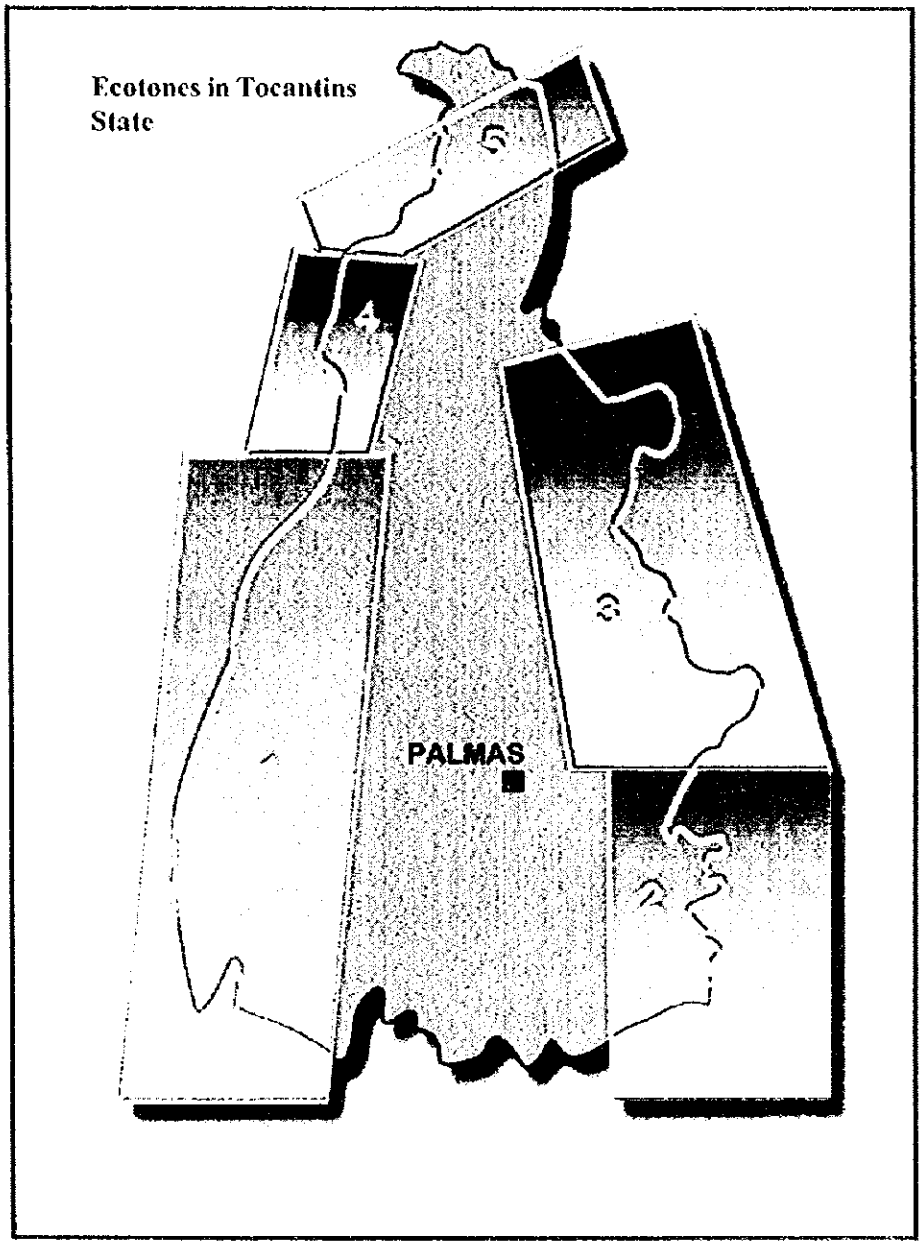
Pole 2
This is bounded to the south by the Geral Range of Goiás, and by the State of Bahia to the east. It is an ecotone area between cerrado and dry forests (mesophytic, with soils having limestone outcrops), and between cerrado and caatinga (semi-arid scrub). It is characterised by its eutrophic soils, but also contains significant portions of quartz sands and concretioned soils. The principal mineral found in the area is fluorite.

Pole 3
This takes in part of the eastern and north-eastern portions of the State, in the region known as Jalapão. It has characteristics peculiar to the ecotone between the cerrado and caatinga, and is bounded by the Mangabeira Plateau in the State of Piauí. The soils are predominantly sandy.

Pole 4
This is located in the north of the State, shaped by sub-montane environments (due to its proximity to the Estrondo Range), with Amazonian forests and cerrados. It is similar to areas in the States of Pará and Maranhão with transitional Amazonian forests. It is in the Araguaia River's area of influence, being located between this and the Tocantins River. The soils are predominantly latosoils and podzolic soils. The main mineral resources are chrome, titanium, graphite, amethyst, diamond and gold.

Frederic Merlens / GAIA.

Cerrado *and forest formationson the Bananal Island*



Source: The International Programme for Brazilian Ecotones

2. Environmental Conservation Areas in Tocantins

2.1 Conservation Areas

2.1.1 Introduction

The purpose of this Chapter is to provide a diagnostic overview of Conservation Areas in Tocantins State. It begins by examining the various designations current in the national context, their purposes, and the type of areas to which they apply. The Conservation Areas in Tocantins (listed in Table 1 below) are then presented, beginning with those for which the State Government is responsible. The exposition deals with the flora and fauna present, and points to the human pressures on the areas. Areas under the aegis of the Federal Authorities are similarly addressed, as is the one Municipal Conservation Area in Tocantins. The legislative foundation of each is noted. Information in the Chapter derives from field surveys and bibliographic research into existing data and photographic archives conducted by a multi-disciplinary team.

2.1.2 Definition of Environmental Conservation Areas

Conservation Areas are those which, because of the value of natural resources therein, should be maintained in their natural state under a suitable management regime (Silva, 1996).

2.1.3 Objectives of Conservation Areas

The purposes of Conservation Areas in the national context, as set out in a Bill drafted in 1980 by CONAMA (IBAMA/CONAMA, 1980), are as follows:

- Preserve biological diversity;
- Protect endangered species;

Table III-1 Conservation Areas in Tocantins State

Conservation Unit	Location	Area (ha)
- Lajeado Range APA	- Palmas, Aparecida do Rio Negro, Tocatínea, and Lajeado Municipalities	121,416
- Foz do Santa Teresa APA	- Peixe Municipality(TO)	17,000
- Bananal Island/Cantão APA	- Caseara, Araguacema, Dois Irmãos, Abreulândia, Divinópolis do Tocantins, and Pium Municipalities	1,678,000
SUBTOTAL (State-Controlled Areas)	- Bananal Island	**1,816,416**
- Araguaia National Park	- Mateiros (TO) and Barreiras (PI) Municipalities	572,000
- Tabatinga Range APA		61,000
SUBTOTAL (Federal-Controlled Areas)		**633,000**
. Araguaína Forest Reserve (Municipal Area)	- Araguaína Municipality	1,456
TOTAL		**2,450,872**

- Preserve and restore diversity and natural ecosystems;
- Encourage sustainable utilisation;
- Promote regional development;
- Manage flora and fauna resources;
- Protect natural and semi-natural landscapes and scenic beauty;
- Safeguard rare features of geological, geomorphological,archaeological, and cultural interest;
- Protect and restore water resources;
- Promote scientific research and environmental monitoring;
- Promote environmental education and recreation;
- Preserve natural areas pending the definition of suitable usage.

2.1.4 Classification

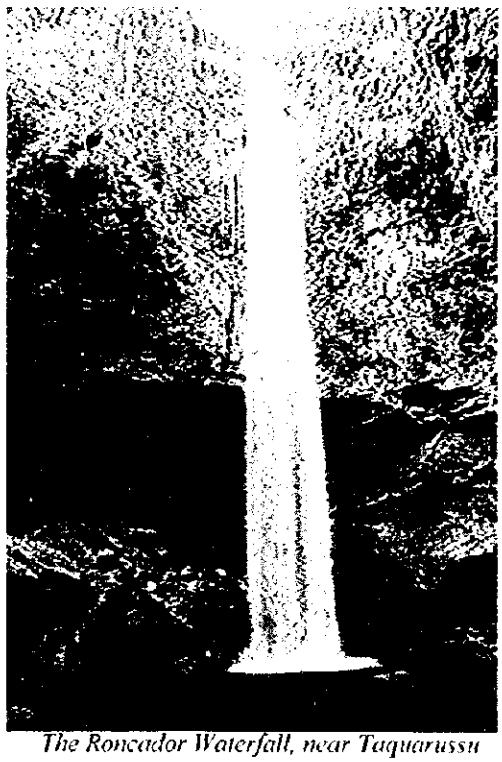
There are different schools of thought with regard to the definition and characterisation of wild areas. As a result there are a considerable number of designations currently in use. Two different classificatory systems are presented in Tables 2 and 3 below. Table 2 identifies the type of area to which the various designations are applied, and Table 3 focuses on the objectives the designations are intended to serve.

2.2 Conservation Areas under the Aegis of Tocantins State

The agency responsible for the establishment, administration and supervision of the conservation areas which come under the jurisdiction of the Tocantins State Government is the Tocantins Nature Foundantion (NATURATINS).

2.2.1 The Lajeado Range Environmental Protection Area

In order to create a green belt area near the capital, Palmas, and thereby safeguard the quality of life of the population, the State Government created the Lajeado Range Area of Ecological Representation (ARESL) by means of Decree N° 213/89, dated 14/02/89, in an attempt to preserve 168,000 ha which was threatened by the rapid population growth resulting from the establishment of the new capital. Since the terminology "Area of Ecological Representation" is not recognised by the Brazilian System for Conservation Areas (SNUC), the Lajeado Range Environmental Protection Area (APA) was created by State Law N° 906, dated 20/05/97. It covers an area of 121,415.49 ha in the municipalities of Palmas, Aparecida do Rio Negro, Tocantínia and Lajeado. This same Law also established the Lajeado Range Joint Management Council, consisting of members designated by the State Governor to manage the area in partnership with NATURATINS.



Frederic Mertens / GAIA.S109

The Roncador Waterfall, near Taquarussu

Table III-2 A Typology of Environmental Conservation Areas in Brazil

DESIGNATION	GENERAL CHARACTERISTICS			
	DEFINITION	BENEFITS	LAND OWNERSHIP	BASIS IN FEDERAL LEGISLATION
National Park	A natural area which is relatively extensive, ecologically representative, and which has not been significantly altered by human activity	Direct and Indirect	Government	Law 4,771, dated 15/09/65; Decree N° 84,017, dated 21/09/79
Biological Reserve	An untouched natural area, the extent of which may vary according to the ecosystem or biological entity of scientific value that it is intended to protect	Indirect	Government	Law 4,771, dated 15/09/65; Law N° 5,197, dated 28/02/67; Decree N° 89,336, dated 31/01/84
Ecological Station	As for Biological Reserve (above), but with alterations to up to 10% of its area being permitted	Indirect	Government	Law 6,902, dated 27/04/81; Law N° 6,938, dated 31/08/81; CONAMA Resolution N° 004/85, dated 08/09/85
Natural Monument	Area of unique natural or landscape value, the size of which can vary according to the environmental characteristics it seeks to protect	Indirect	Government	Decree 56,054, dated 23/03/80
Ecological Reserve	Can share the characteristics of the Biological Reserve or the Ecological Station, or simply constitute a protected area under Article 2 of Law 4,771, dated 15/09/65	Indirect	Government or Private	Law N° 6,938, dated 31/08/81; Decree N° 89,336, dated 31/01/84
National Forest	Usually a vast, predominantly forested area. The forests may be managed productively, where permitted, to ensure multiple use	Indirect	Government	Law 4,771, dated 15/09/65;
Hunting Park	Area whose habitats and fauna populations may be managed for sporting, recreational and/or economic purposes. Its size varies according to the habitats and populations to be managed	Direct and Indirect	Government or Private	Law N° 5,197, dated 28/02/67;
Environmental Protection Area (APA)	Usually a vast area in private hands, in which zoning and regulation determine permitted land uses, so as to maintain environmental quality	Direct and Indirect	Government	Law 6,902, dated 27/04/81; Law N° 6,938, dated 31/08/81;
Area of Ecological Interest	Area of up to 5,000 ha possessing special natural characteristics and/or rare species of regional flora and fauna, and having few or no human inhabitants. May be part of an APA (see above)	Indirect	Government or Private	Law 8,998, dated 31/06/81; Decree N° 59,336, dated 31/01/85; CONAMA Resolution N° 004/85, dated 08/09/85
Area of Special Interest for Tourism	Area with historic, cultural, artistic or natural features of importance for recreation and tourism, for which land-use guidelines are established	Direct and Indirect	Government or Private	Law N° 8,513, dated 20/12/71; Decree N° 85,178, dated 06/08/81
Area under a Preservation Order	Covers a variety of areas, depending on the features/areas being protected. May be applied within other designated zones	Direct and Indirect	Government or Private	Decree N° 25, dated 30/11/37

Based on IUCN Commission on Natural Parks and Conservation Areas (1978)

Table III-3 Brazilian Conservation Areas and Their Objectives

BASIC CONSERVATION OBJECTIVES	MANAGEMENT CATEGORIES FOR NATURAL AREAS															
	Categories of National Importance				Complementary Management Categories				Additional Management Categories						Globally Important Management Categories	
	Wildlife Sanctuary	Natural Monument	Biological Reserve	National Park	Resource Reserve	Roadside Park	Scenic River	Ecological Station	Cultural Monument	Hunting Park	Indian Reservation	National Forest	Natural Park	Fauna Reserve	World Heritage Reserve	Biosphere Reserve
To conserve examples of ecosystems in their natural state	■	■	■	○	○	○	○	○	◆	○	○	○	○	○	■	○
To conserve ecological diversity and the natural equilibrium	■	■	■	■	■	■	■	■	■	○	■	○	○	○	■	○
To preserve genetic heritage	■	■	■	■	■	◆	○	○	◆	○	◆		○	○	■	○
To protect rare or endangered species	■	■	○	■	■	◆			◆		◆		○		○	○
To conserve water resources, protecting hydrographic basins and watersheds	◆	◆	○		◆	○				○	◆					○
To produce protein through fauna management									■		○					
To provide for non-professional hunting													■			
To administer and maintain recreational and tourist services	■		■	○	○	◆	◆		○	■	○		○	○	○	○
To protect sites of cultural, historic, archaeological and geological heritage	◆				◆	○	○			◆		■		■		■
To protect and conserve scenic beauty and green areas	■		■		■		■		○	■	◆				■	○
To provide for flexible management (multiple use)									◆		■		◆		○	
To encourage the rational use and integrated development of undeveloped areas	◆		○	◆	◆				■		○					○
To provide education, research, study and information on natural resources	■	■	■	■	■	■	■		■	○	◆		○	■	■	■
To conserve large areas on a provisional basis								■								

Based on Thelen K. D., Miller, K.R. (1976)

Key: n Primary management objective. u Included as an important secondary, but not indispensable, objective. m Included as an objective when resources and other management objective allow.

2.2.1.1 Location

Frederic Meriens / GAIA S126.

The Lajeado River valley

The Lajeado Range APA is located in the central quadrant of the State, west of the capital, Palmas, and lying between the longitude meridians 48°03' and 48°21'W and latitude parallels 9°43' and 10°28' S.

The region has 3 dominant features. The first of these is the extensive Lajeado plateau, whose top is gently undulating, and which belongs to the elongated orographic strip which runs from Monte do Carmo to the Tocantins River near the town of Tocantínia. In stark contrast to this, the second feature is a fissured, irregular, zone sloping down from the plateau, with escarpments in places. The third feature extends out from the eastern foothills of the Lajeado Range, and corresponds to the channel of the Tocantins River (EMBRAPA, 1992).

Márcio Di Pietro (?).

Waterfall

The Lajeado Range is the watershed between the minor tributaries of the Tocantins River and those of the Sono River. Its general orientation is NNW-SSE, and its highest points range between 250-694 m (EMBRAPA, 1992)

2.2.1.2 Climate

The climatic conditions of the region are relatively homogenous, due to its proximity to the 10°S parallel, its continental geographical aspect, and the constant nature of the air mass above it. It is part of the tropical zone (EMBRAPA, 1992).

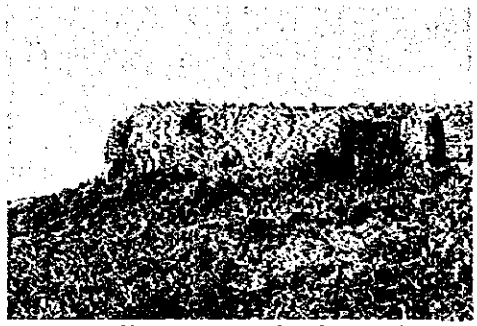
Climatic data from the Meteorological Observatory at Porto National show average monthly temperatures in excess of 25°C, reaching a maximum at the end of the winter, before the advent of the rains. Highest absolute temperatures at that time exceed 41°C. There is virtually no rain at all during the winter months, rainfall being concentrated in the summer months. Annual average rainfall is 1,600 mm. In the dry season, a few small showers may occur in the higher parts of the Range, especially those facing south-east.

2.2.1.3 Vegetation

The Environmental Protection Area (APA) of the Lajeado Range is located in the central region of the *cerrado*, the Brazilian savannah. According to EMBRAPA (1992) which studied land use in the APA based on satellite imagery (dated 16/04/90), 8 broad categories can be distinguished: Seasonal Semi-deciduous Forest on Slopes, Gallery Forests, *Cerradão*, *Cerrado*, *Campo Cerrado/Pasto Sujo*, Intensive Activity, Reservoirs, and Urban Areas. The vegetation categories are briefly described below.

a) Seasonal Semi-deciduous Forest on Slopes

The arboreal elements are deciduous, as a form of adaptation to the shortage of water, and are characteristic of the watersheds and hills in the Lajeado Range. The forest has 4 well-defined strata: herbaceous, low woody (height less than 3 m), medium woody (3-7 m) and tall woody (above 7 m).



Frederic Merlens / GAIA S128.

Vegetation on the slopes of the Lajeado Range

b) Gallery Forests

These formations occur on the banks of watercourses, and also on the plateaux, permeating the *cerrado* areas and on the watersheds associated with the Slope Forests. The structure of the gallery forest is characterised by 3 woody strata, and one herbaceous. The occurrence of moister, more fertile soils is responsible for the great diversity of flora and fauna present. The gallery forests also serve as a refuge for animals in time of *queimadas* or fires in the *cerrado* areas.

Frederic Merlens / GAIA 111

Babaçú palms in gallery forest on the Sono River near Pedro Afonso

According to the Botanical Garden of Brasília (JBB 1994), despite the difficulty of botanic identification to a species level, a phytosociological survey of these forests recorded the occurrence of 42 species in the forest of Córrego Brejo da Lagoa, 40 in that of Água Branca, and 20 in that of Taquarussu Grande.In the forest of Ribeirão Taquarussu Grande, the total density was 1,085.7 individuals per ha (ind/ha), and total dominance 50.49 m²/ha. Species with the highest Index of Importance Values (IVIs) were *Pourouma* sp (Mouraceae), *Erisma cf. incinatum* (Vochysiaceae), *Copaifera langsdorffi* (Caesalpiniaceae).

The forest of Córrego Brejo da Lagoa had a density of 1,360 ind/ha, and a total basal area of 30.8 m². Species with the greatest IVIs were: *Maximiliana regia* (Arecaceae), *Guarea sp.*1 (Meliaceae), *Myrciaria cf. floribunda* (Myrtaceae), and *Tapirira guianensis* (Anacardiaceae). Families with the highest IVIs were: Arecaceae (47,92%), Myrtaceae (41.42%), Meliaceae (18.46%), and Anacardiaceae (27.67%). The forest of Córrego Água Branca had a total density of 1280 ind/ha, and total basal area of 30.82 m². The species with highest IVIs were: *Scheelea phalerata* (Arecaceae), *Guarea guidonea* (Melicaceae), *Protium heptaphyllum* (Burseraceae), *Inga sp.* (Mimosaceae), and *Amaioua* sp (Rubiaceae).

Families with highest IVIs were: Arecaceae (45,50%), Meliaceae (28.24%), Burseraceae (24.33%), Myrtaceae (23.77%), and Rubiaceae (21.36%). The Myrtaceae, Rubiaceae and Sapindaceae families had the greatest relative densities, with Arecaceae, Meliaceae and Burseraceae having the greatest dominance values. Similarity analysis of the Gallery Forests studied produced low values.

c) Cerradão

This is formed by xeromorphic and predominantly arboreal species with a profuse canopy furnished with large, coriaceous, evergreen leaves. The bushy stratum is little pronounced, and the herbaceous one is composed of grassy tussocks, mingled with stunted woody plants and dwarf palms. The differentiation between *cerradão* and the other types of *cerrado* is basically conditioned by the fertility of the soils, with those in the *cerradão* areas being the more fertile. Among the species observed are : *Bowdichia virgiloides, Dalbergia miscolibium, Dimorphandra mollis, Callithene major, Qualea grandiflora, Vochysia thyrsoideae, Caryocar brasiliense, Himatanthus obovata, Strychnos pserdoquina,* and *Xilopia aromatica.*

d) Cerrado

This is a field formation with sparse trees. Its floral composition is similar to that of the *cerradão,* but more open and lower. It covers roughly 40% of the APA. It has 3 strata with herbaceous vegetation and woody species, growing up to 7 m high, predominating. In the Lajeado Range, two *cerrado* types can be observed, both with similar floral compositions with regard to the density of the trees present. *Cerrado* is a vegetative form which occurs mainly on the plateaux of the Range, on flat or gently undulating terrain, spreading in a uniform manner throughout the region.

Among the species identified in the *cerrado* zone by EMBRAPA (1992) are: *Hancomia speciosa, Curatella americana, Kleimeyea petiolaris, K. corymbosa, Ascomium dasycarpum, Anadenanthera macrocarpa, Qualea grandiflora* and *Q. parviflora.*

The phytosociological survey done by the Botanical Garden of Brasília (JBB, 1994) noted that the *cerrados* of the south have more species than those in the north. The *cerrado* of the plateau between Ribeirão Taquarussu Grande and Córrego Taquarussuzinho has the greatest densities (1,587.7 ind/ha) and total dominance (24.65 m²/ha). In contrast, the *cerrado* near Córrego Brejão, despite having the highest total density (1,842.5 ind/ha), has total dominance of 7.98 m²/ha. The Sorensen Similarity Indices (IS) are greater than those found for the forests, which shows that the *cerrados* have many species in common. The lowest IS was 28.57, recorded for the *cerrado* between the Córregos of Ubim and Cedro in the extreme north of the APA.

e) Campo Cerrado/Pasto Sujo

This covers approximately 30% of the APA, and is characterised by what are essentially field formations, both natural and anthropogenic (extensive pastures). The height of the vegetation varies between 0.20 -- 1.50 m, with grasses predominating and with a few low-growing woody plants (bushes). Species diversity is relatively low (EMBRAPA, 1992) and the landscape is dominated principally by flatsedge (*Panicum* sp). This is because of the low fertility of the soils and also the action of fires set by cattle ranchers. The herbaceous stratum of *campo cerrado* consists of many of the species that are common in the *cerrado* formation, among these: *Vellozia glochidea, Campomanesia pubescens, Anarcardium humile, Veronia herbacea, Bulbostylis hirtella, Cochlospermum regium, Euphorbia caecorum, Diandrostachya chryostrix, Echinolaena inflexa, Gymnospegum fliosus, Leptocoriphium lanatum, Arachis glabatra, Cassi tetraphylla, Galactia decumbens, Pavonia speciosa* and *Sida macrodon.*

The floral collections of the JBB (1994) recorded the occurrence of 208 species, in 106 genera and 74 families in the areas of the Lajeado Range APA that it studied. The gallery forest flora contained some species of the Amazon Forest (*Pourouma* sp, *Erisma cf uncinatum*) and species

common to other gallery forest of the *Cerrado* domain, such as *Hymenaea courabil var. stilbocarpara*, and *Copaifera langsdorffii*, among others. Some of these species have medicinal properties, others are used for charcoal or provide edible fruit.

2.2.1.4 The Fauna of the Lajeado Range APA

The greater part of the Lajeado APA is taken up by a sandstone plateau. The distance between its highest and lowest points is approximately 350 m. The region's geomorphology is undoubtedly one of the principal ecological determinants of faunal macro-habitat differentiation. EMBRAPA (1992)'s work on the multi-spectral satellite imagery from LANDSAT TM-5, and topographical maps provided by the Directorate of the Geographical Service produced a five-fold classification of the physiography of the APA:

1. Summit and fissured zones;
2. Summit *veredas*;
3. Scarp Slopes and Watershed Escarpments;
4. Valley bottoms;
5. Foothills.

All the *cerrado* region has a marked dry season, which can last for between 4-6 months with precipitation ceasing towards the end of April, and no further rainfall occurring until the beginning of October. This prolonged drought has a marked influence on the vertebrate fauna in the Lajeado Range, particularly for migratory birds which make temporary use of the APA environment and whose migratory route is oriented in a North-South direction, following the course of the River Tocantins.

The major vegetation formations revealed by the satellite imagery are:

a) ***Campo Cerrado*:** This is occupied by fauna of open environments, with rodents, and insectivorous or seed-eating birds being very common.

b) **Palm groves:** Dominant species in this vegetation are *buriti (Mauritia vinifera)* and *babaçu (Orbignya oleifera)* palms, as well as *Copernicia* and *Acrocomia* and associated palm species. These species tend to favour topographical features such as open or enclosed depressions in the hydrographic network, where soil moisture is high. Such features are found at the foot of the plateau, river headwaters, springs and creeks. Wading birds such as egrets, rails and herons are common.

c) ***Cerrados*:** The vertical structure of the vegetation is irregular, and harbours fauna specialised in exploiting each vegetative stratum.

d) ***Cerradões*:** This is a forest habitat with significant densities of high and low woody species. Species of *cerrado* zones and others of broad-leaved deciduous forest are present. There are numerous fruit-eating species in these habitats.

e) **Forests:** The flora is made up of tall woody deciduous species, and harbours a number of animals specialised in exploiting the resources offered by the tree canopy.

f) **Gallery Forests:** Because of the ready availability of water in these habitats, they are important refuges for a number of species in the dry period.

In its surveys, EMBRAPA (1992) identified species in the study area through direct observation and indirectly, by noting the presence of droppings, feathers, tracks, nests, holes, etc. The researchers occasionally resorted to trapping to help capture and identify some specimens, particularly animals with crepuscular or nocturnal habits.

Costa *et al* (1981) cite roughly 1,500 species of reptiles, birds and mammals found in the Brazilian *cerrados*. In surveys conducted in the Lajeado APA, almost 138 species of invertebrates were identified, of which 87 were birds, 33 mammals, and 18 reptiles. All told, there were 60 families present, of which 36 were birds, 17 mammals and 7 reptiles. The bird group, with approximately 63% of the total species richness of the area, is the best represented. Mammals are next with 23%, and the reptile group has 14% and thus has the least number of species of the three.

Of course, this inventory is by no means complete, but it does give a fairly accurate picture of the Lajeado fauna. The number of vertebrate species probably exceeds several hundred. The species found and recorded are the most dominant, and consequently perform an important role in the composition/structure of fauna populations, and in the equilibrium of the ecological systems of the Lajeado APA. An account of the fauna is given below.

2.2.1.5 Birds, Mammals and Reptiles

The bird group is the richest in species, not only in the area studied, but also in the *cerrados* as a whole. In all 935 bird species are found on the Brazilian *cerrados*. Thus the Lajeado Range, which represents only 0.07% of the total *cerrado* area, contains representatives of almost 10% of all *cerrado* species.

The mammals identified on the *cerrados* number 298 species. In the Lajeado APA, 39 species were recorded by EMBRAPA (1992), which is more than 10% of *cerrado* mammal species. It should be noted that in this group there are large species such as ant-eaters, paca, jaguar, deer and wild dog, which have a high biological value since they are endangered species in other regions of the country. These species tend to survive best in inaccessible areas, little altered by human action. Such areas could include the gallery forests along the Lajeado stream, and probably those along the Água Suja, São Jõao and Mangues creeks. The THEMAG researchers also note that large predators such as the jaguar (*Panthera onca*) and the cougar (*Puma concolor*) are only recorded in the Lajeado Range, and not in the plains of the Tocantins river valley (THEMAG, 1996). Nonetheless, these animals need large areas, and could therefore make use of the gallery forests for their movements, making occasional incursions into the Lajeado area.

The reptiles, with 7 families, are present in modest numbers with most of the species recorded belonging to the serpent group. Of the 268 reptile species known to occur in the *cerrados*, 18 were found and identified in the Lajeado Range, thus representing more than 6% of *cerrado* reptile species. The Colubridae family is the richest, with 6 species present, all of them non-poisonous. Among the lizards, iguanas (chameleon) tegu and *calangos* are most common, and have varied nutritional habits (herbivores, omnivores and carnivores).

Of the 5 classificatory units mentioned in 2.2.1.4 above, the Summit Zone is the richest in terms of fauna, with 106 invertebrate species being found. Among the species which are only found in this zone are the rhea, the wild dog, and the black snake. The second richest unit is the Valley Bottom Zone, where 72 species were recorded, but only 2 of them (the nun bird and the black lizard) are found only in this type of environment.

The Foothills have 65 vertebrate species, typical of the *cerrado* (e.g. field woodpecker, partridge). Only 3 species are unique to this type of micro-habitat, two kingfisher and one teal species.

The Summit *Veredas* revealed 60 vertebrate species, with only 2 being exclusively found in such habitats - the tapir and the otter – both of which are classified as endangered species.

The Scarp Slope fauna was represented by 56 species, 3 of which are unique to this type of micro-habitat. The dense nature of the flora in this classificatory unit, as in the one mentioned just above, made observation and identification of vertebrates difficult. It is worth noting the presence of the harpy eagle (*Harpia harpia*), which is very rare in other regions of Brazil.

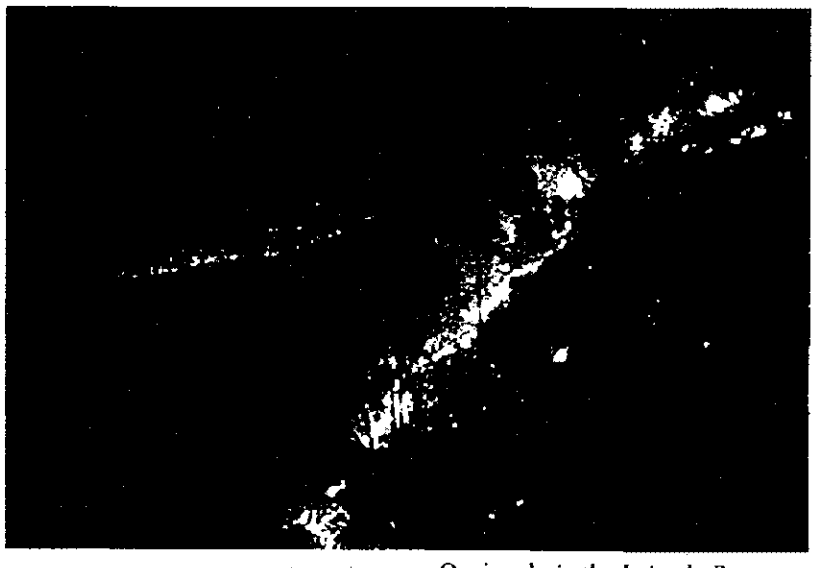
Skunks and field foxes were the most commonly observed mammals during field excursions. Green parakeets and doves were the commonest birds, and the *calango*, tegu lizards, and vine snakes were the commonest reptiles. These species occupy a wide range of habitats and are relatively tolerant of human activities.

2.2.1.6 Sites of Archaeological Interest in the Lajeado Range APA

Through information given by the local population, 19 sites of archaeological interest were recorded within the Lajeado APA, among which are 5 sites where pottery fragments can be found, 1 cemetery, and 12 sites with cave paintings. There are undoubtedly other such sites, both in the valley of the Ribeirão do Lajeado, and in that of the Tocantins River.

2.2.1.7 Human Impact on the Lajeado Range APA

The Lajeado area has experienced significant human influence. Almost all the *cerrado* area is used for extensive cattle grazing. If this area is added to that of the intensive ranching areas, approximately 40% of the Lajeado APA is influenced by ranching activities. Encroachments on the remaining 60% are beginning, particularly on the *cerrado* and *campo cerrado*, and in places this results in the eradication of



Frederic Mertens / GAIA.

Queimada *in the Lajeado Range*

Frederic Meriens / GAIA (S32)

Area of human activity in the valley of the Lajeado River

the natural vegetation on the slopes and in the gallery forests. Often these encroachments are the work of people who establish small-holdings for vegetable production, oriented towards the local urban markets. Native species with commercial or medicinal value, or which can serve as fencing material, or for charcoal production tend to disappear.

Surveys carried out just prior to this report noted greater devastation of the natural landscape in the north of the Lajeado Range APA, and particularly in the forest of Taquarussu Grande, much degradation was observed. Of the forests surveyed, that of the Córrego Brejo da Lagoa appeared the best preserved, although there were signs of disturbance evidenced by the presence of secondary vegetation.

According to the JBB (1994) a significant degree of environmentally destructive activity occurs around the edges of the APA, notably timber extraction in forests and *cerradões*, deforestation of slopes and valley bottoms, and various pastoral activities including *queimadas*. There are also two mining operations extracting aggregate from quarries in the south of the APA. According to NATURATINS, both companies have been prosecuted for mining in the area without the required authorisation, and have been ordered to finance the elaboration of a Management Plan for the APA.

The watercourses which serve to supply the municipalities along the Lajeado Range have been subject to interference and contamination not just from productive activities (e.g. pig-farming upstream of the collecting point for Palmas's water supply) but also from recreational activities (e.g. rubbish accumulating in tourist areas).

Urban pressures, exacerbated by the establishment of the new capital, can be observed in the residential allotments spreading into the APA, particularly around Palmas, taking in Taquaralto and neighbouring municipalities. With the advent of the Lajeado Hydro-Electric Scheme, which will directly affect the APA, interest in real estate in the Lajeado municipality has grown, and the number of urban allotments has increased.

Frederic Meriens / GAIA (S35)

Waterfall from the dam in the Lajeado river valley

2.2.2 The Bananal Island/Cantão Environmental Protection Area

This Environmental Protection Area (APA) is a very recent creation, being established by State Law N° 9,907, dated 20/05/97. It takes in an area of 16,780 km². Its boundary starts at the junction of the Bananal River with the Araguaia River (latitude 08°32'48"S, longitude 49°23'48"), and follows the Bananal upstream until it is crossed by Route 164 (TO-164); from

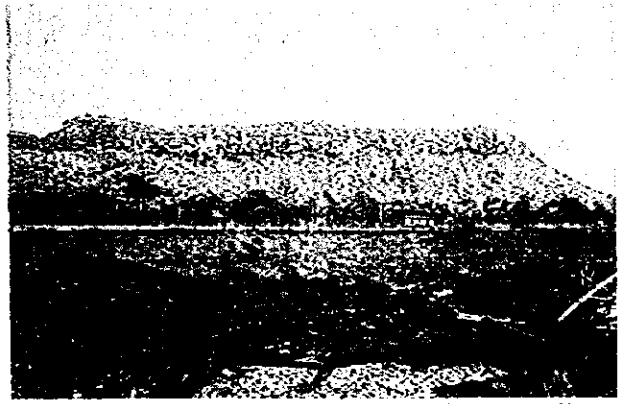
this point, it follows the TO-164 south to Route 342 (TO-342), which it follows westward to Dois Irmãos municipality. Thence it continues south along the TO-164 passing through the municipalities of Abreulândia, Divinópolis do Tocantins and Pium, and on until it crosses the Riozinho River. The boundary runs along this river until it flows into the Javaés River, which it follows down to its junction with the River Araguaia. Then it accompanies this northward, passing through the Caseara and Araguacema municipalities, and closing the circuit by returning to the mouth of the Bananal River.

Frederic Meriens / GAIA (SL30)

Agricultural production in the Lajeado Range

2.2.2.1 Hydrography

The APA is part of the Araguaia basin, and the sub-basins Coco and Javaés (SEPLAN, 1996). All three rivers are permanent and navigable all year round. The drainage patterns of the region are dendritic, with little geological control. In some areas the formation of meanders and lakes is common, and the low-lying land adjacent to the rivers is subject to periodic inundation.



Frederic Meriens / GAIA (SI08)

After a queimada *in the Lajeado River valley*

2.2.2.2 Climate

The region's climate is characteristic of the interior of the Brazilian Plateau – humid tropical – and is classified as type AW in the Koeppen system. There are two well-defined seasons, one dry and the other wet, with the rainy season occurring between September and April/May. Average temperature is in the 22°-26°C range. Annual rainfall in the region is between 1,450 and 1,600 mm, with an average of 130 rainy days each year.

2.2.2.3 Flora

Because of its proximity to the Araguaia River and the complexity of its macro-ecosystems, the APA has very varied floral communities (SEPLAN, 1996). The predominant vegetation formation is open arboreal savannah with gallery forests. This *cerrado*-type vegetation meets rain forest to the north of Caseara, and seasonal forests in the south. Near the Araguaia River riverine forest lying on quaternary fluvial accumulations predominates. Its structure is very similar to that of the gallery forests found throughout the State, with only a few floral differences.

Among the most characteristic tree species of the region are: *Dipterix alata, Hymenaea stilbocarpa, Anadenanthera spp., Apuleia sp., Acrocomia sp., Cocos wedellii, Tabebuia sp., Copaifera langsdorffii, Apeiba echinata, Bambusa sp., Curatella americana, Atronium fraxinifolium, Orbignia matiniana* and *Denocarpus* sp., among others.

2.2.2.4 Fauna

Because of its location in an area with two major vegetative transition zones, the biodiversity of the fauna in the region is very high, with species characteristic of *cerrado* and Amazon rainforest being present.

The River Araguaia and its tributaries possess one of the most diverse sub-aquatic fauna in the planet, and this helps support a very diverse community of birds, mammals, and reptiles. Several endangered species occur in the APA, especially in the south-western segment between the Javaés and Coco Rivers. Here there is a profusion of lakes and swampy terrain, wherein species such as the tapir (*Tapirus terrestris*), the paca (*Agouti paca*), the capybara (*Hidrochoerus capybara*), the peccary (*Tayassu pecari*) and the jaguar (*Panthera onca*) are found. In contrast, animals such as the guara wolf (*Chrysocyon brachyurus*), the great ant-eater (*Myrmecophaga trtidactyla*), brocket deer (*Mazana* sp.) and armadillos (e.g. *Priodontes maximus*) inhabit the *cerrado* regions which predominate in the north and the east of the APA.

2.2.3 The Foz do Santa Tereza Environmental Protection Area

The Foz do Santa Tereza area was identified as being suitable for the establishment of a conservation area during research done as part of the Environmental Impact Assessment (EIA) for the asphalting of the Peixe-Gurupi stretch of Route 280 (TO-280). It was noticed that the area harboured many species of fauna, and had been little altered by human activity.

The total area of the APA is approximately 170 km², located between latitudes 11°45'-12°00'S and longitudes 48°30'-48°40'W, near the town of Peixe in the central-south of Tocantins State.

2.2.3.1 Climate

The climate of the southern region of Tocantins is characterised as tropical, hot and semi-humid, with two seasons, one dry, one rainy. One of the State's meteorological observatories is located in Peixe municipality.

2.2.3.2 Topography

Peixe municipality is located in the valley drained by the River Tocantins, which is delimited by escarpments or more gradual, eroded slopes descending from the plateaux through which the valley runs. The relief is gentle and uniform, with altitudes of between 220-300m. The APA's topography is generally flat, being raised slightly in the central part which corresponds to the interfluvial area between the Tocantins and Santa Tereza Rivers. The areas adjacent to the Santa Tereza River feature floodplains which are periodically inundated, and lagoons.

2.2.3.3 Vegetation in the Foz do Santa Tereza APA

Few studies of the flora in Tocantins State have been carried out. The main texts on the subject are Rizzo's (1981) seminal "*Flora do Estado de Goiás*" ("Flora of the State of Goiás" -- thus titled because it was completed prior to the formation of Tocantins), the RADAMBRASIL project which involved vegetation mapping, and the ecological mapping of the Lajeado Range Reserve done by Miranda *et al* (1992). The information contained in the EIA and the accompanying

Environmental Impact Statement (EIS) of the road-works on Route 280, have also been consulted, but for the purposes of this Section, the main source of reference is the "Viability Study for the Establishment of a Conservation Area in the Foz do Rio Santa Tereza Region", commissioned by the Tocantins State Secretariat for Transport and Public Works (SETO, 1997), and carried out by the CSL consultancy firm.

The Viability Study made use of LANDSAT images (scale 1: 100,000), and the regional IBGE topographic map (scale 1: 100,000), to enable the prior identification of broad vegetative types. The methodology involved the construction of a vegetative typology for the area, as well as preliminary and quantitative surveys of the species present. Surveys and collections were undertaken in 1995, and a photographic registry was compiled in 1997. The vegetative types identified were: *cerrado, campo cerrado, cerradão, vereda*, gallery forest and aquatic communities.

Cerrado is the predominant vegetation type, and its floral composition is similar to the *cerrados* found in the central region of Brazil. In the herbaceous-arboreal stratum species present include *Davilla elliptica, Curatella americana, Qualea grandiflora, Q. parviflora, Caryocar brasiliense, Anoma coriaceae, A. tormentosa, Lafoensia pacari, Alibertia sp., Mouriri cf. elliptica, Eugenia desynterica, Myrcia cf. multiflora, Attalea sp., Pouteria ramiflora, Stryphnodendron sp., Hymenaea stigonocarpa, Hancornia speciosa, Sclerolobium paniculatum, Ouratea spectabilis, Xylopia aromatica*, and *Byrsonima verbascifolia*, among others.

Cerradão vegetation occurs on richer, well-drained soils within the APA, and the species therein grow taller, reaching heights of over 7 m. Species normally associated with forests are also found, particularly in the transition zones between these two formations.

Campo Cerrado is present normally in a narrow ecotonal band running between the hydromorphic *vereda* vegetation and the *cerrado* vegetation. Trees are sparse, with the herbaceous stratum, composed primarily of gramineous species, predominating.

Vereda vegetation is common in the central part of the APA, on sites where the ground water wells up to the surface. It is a seral community, initially dominated by herbaceous species (mainly Gramineae and Cyperaceae) with a few *buriti* palms (*Mauritia vinifera*) which are adapted to the waterlogged soil, and then gradually succeeding into gallery forest vegetation. In such waterlogged forests, species present *include Mauritia vinifera, Mauritia sp., Collophyllum brasiliensis, Licanita sp., Duguetia lanceolata* and *Byrsonima* sp.. A very common bushy species is the *Tococa* sp., which shelters ants in swellingfs on the petioles of its leaves.

In the **Gallery Forests**, which are always associated with watercourses, the herbaceous and bushy strata are little developed, and are frequently made up of species adapted to periodic flooding. Species such as *Hymenaea stilbocarpa, Ficus sp., Triplaris gardneriana, Clitoria fairchildiana, Protium heptaphyllum, Guatteria sp., Duguetia lanceolata, Copaifera langsdorfii, Apeiba tiboubou, Tabebuia serratifolia*, and *Chorisia speciosa* are common in these forests. In frequently flooded areas, common species are *Sapium cf. gladulatum, Salix sp., Protium heptaphyllum, Triplaris gardneriana, Callophyllum brasiliensis, Croton urucurana, Vitex cf. sellowiana*, and *Inga cf. uruguensis*. These forests form a virtually continuous cordon along the Santa Tereza River, meeting up with those on the banks of the Tocantins River which have been disturbed in some places, and are more prone to human intervention.

Aquatic communities have colonised some of the small lagoons located in the central part of the APA, and the borrow pits dug for material used in the construction of the Peixe-Gurupi stretch of Route 280, near the bridge over the Santa Tereza River. The species observed in such communities were *Eleocharis* sp., found in lagoons and borrow pits, *Ludwigia sedioides*, which has extensive populations in the borrow pits, and *Eichornia* sp. observed in lagoons.

The CSL surveys detected 129 flora species belonging to 45 genera and 29 families. Species richness was significant, with values close to that recorded in previous studies. Similar findings were also made in relation to species diversity, with a Shannon Index value of 3.057 being calculated.

Families with most species present are Fabaceae (18), Myrtaceae (7), Rubiaceae (6) and Vochysiaceae (5). Considering the diversity of vegetative types in the area, there are thought to be at least 800 species of angiosperms, occurring as herbs, bushes and trees. The species with the greatest relative density were *Qualea grandiflora, Vochysia rufa, Byrsonima verbascifolia,* and *Roupala montana.*

Some 35% (20) of the species present can be considered rare, being represented by only one individual. The families with the largest number of individuals were Vochysiaceae (25.3%), Myrtaceae (12.2%), Fabaceae and Malpighiaceae (6.6%), and Protaceae (5.9%) representing 57% of the individuals recorded.

Among the species observed, some have ornamental or medicinal value, some provide wood for a number of purposes, and others have nutritional value both for animals and humans. The species with ornamental value can be planted as fences or used for arborisation purposes.

Among the most important are *Pterodon pubescens, Bowdichia virgilioides, Tabebuia serratifolia, Ouratea castanaefolia, Mauritia sp., Lafoensia pacari* and *Clitoria fairchildiana.*

Plants with medicinal value are mainly in folk medicine, among them *Brosimum gaudichaudii, Stryphnodendron adstringens, Dimorphandra mollis, Hancornia speciosa, Hymenaea stigonocarpa, Copaifera langsdorffii, Curatella americana* and *Anacardium occidentale.*
Among those trees whose wood can be put to diverse uses are *Copaifera langsdorffii, Tabebuia serratifolia, Bowdichia virgilioides, Astrontium fraxinofolium, Protium heptaphyllum, Callophyllum brasiliensis, Caryocar brasiliensis, Acrocomia aculeata,* and *Machaeium villosum.*

Various native species produce fruits which are eaten by fauna and/or humans, among them *Hymenaea stigonocarpa, Acroconia aculeata, Caryocar brasiliensis, Campomanesia cf. adamantium,* and *Alibertia sp.*, among others.

None of the species appear in the lists of endangered Brazilian flora (IBAMA Directive N° 6, dated 15/01/92). However, *Caryocar brasiliensis,* and species of the Tabebuia family have been given permanent protection status, and their felling is prohibited by the IBAMA Directives N° 54, dated 05/03/87, and N° 9743, dated 15/12/88. According to the Constitution of Tocantins State, Article 12, species such as the *babaçu* and *buriti* palms, the souari nut tree, the copal tree and the custard apple tree are "indispensable for the survival of the fauna and of the people who make use of them" and are considered protected species.