

2.2.3.4 Fauna of the Foz do Santa Tereza APA

The fauna in the Foz do Santa Tereza APA occur throughout the APA, with species seldom confined to a particular area. A significant example is that of the tapir, which occurs in all *cerrado* segments provided there is access to watercourses in which it can bathe and find food. One species of parrot (the curica: *Amazona xanthops*) occurs in scattered communities, and is endemic to the *cerrado* regions.

In the more open *cerrados*, ecological conditions are fairly uniform. The winds are strong, which reduces the heat and provides a more amenable environment for the animals that inhabit such regions. Although most of the animals are not dependent on specific ecosystems, particularly the predators and birds of prey, there are some species that are most commonly found in the more open floral formations. Among such species, the most obvious are the bird group, and those with special characteristics such as the giant armadillo and the three-banded armadillo, and in the trees and bushes, primates such as the marmoset (*Callithrix penicillata*). Ground birds such as the crested seriema, partridges and quails are also common. Among the reptiles, the rattlesnake (*Crotalus durissus*) is widespread.

The survey carried out by CSL (1996) involved direct visual observation, auditory observation, and the observance of tracks, as well as information gathered from the region's human inhabitants.

a) Birds

The rhea (*Rhea americana*) was recorded several times in different localities, sometimes among the cattle grazing in the pastures that are common in the area studied. The Tinamidae family is well-represented, as are aquatic birds such as the cormorant (*Phalacrocorax olivaceus*), the snakebird (*Anhinga anhinga*) and, in the Threskionithidae family, the white ibis (*Theristicus caudatus*) is particularly common, and the spoonbill (*Ajaja ajaja*) somewhat less so.

The parrot family (Psittacidae) is also well-represented, with the exception of the endangered blue macaw (*Anodorhynchus hyacinthus*), although this does occur in the area according to information given by the local population. Toucans (e.g. *Ramphastus toco*) are commonly seen, as are various doves and pigeons, vultures (*Coragyps atratus* and *Cathartes aura*), and birds of prey, particularly those of the Accipitridae and Falconidae families.

b) Mammals

Little ant-eaters (*Tamandua tetradactyla*) are common in the gallery forests, and the rarer great ant-eater (*Myrmecophaga tridactyla*) also occurs. Armadillos (Dasypodidae family) are also common, and various monkey species (e.g. *Cebus apella*, and the howling monkey *Alouatta caraya*) and skunks (*Didelphis* sp.). The presence of tapirs (*Tapirus terrestris*), which feed on terrestrial and aquatic vegetation and are known to make use of the salt-licks put out for the cattle in ranching areas, was also detected.

The deer family (Cervidae)'s most common representative is of the *Mazama* sp., and two endangered deer species (*Odocoileus virginianus* and *Ozotocerus bezoarticus*) are also present. Pacas (*Agouti paca*), coypu (*Hydrochaeris hydrochaeris*), otter (*Lutra* sp.), and tree porcupines (*Coendou preensilis*) occur in several parts. Members of the canine family (Canidae) such as the grison (*Dusicyon thous*) and the fox (*Dusicyon vetulus*) are fairly common, and one guara wolf (*Chrysocyon brachyurus*) was sighted near swampy ground. A species of Amazon porpoise

(*Inia geoffrensis*), which is generally solitary or in small groups of up to 4 individuals, was spotted where the Santa Tereza River joins the Tocantins. Finally, the presence of feline species such as jaguars (*Panthera onca*), cougars (*Felis concolor*) and spotted leopard cats (*Felis pardalis*) was recorded.

c) Reptiles

Surveying this group is more difficult and demands longer periods of time. Of the reptiles identified, the calango lizards (*Tropidurus torquatus*) were the most common, and chameleons were often found in the region of creeks and along the river. In the Squamata order, various species were recorded, notably boa constrictors and anacondas (Boidae family), pit vipers and rattlesnakes (Viperidae) and several Colubridae species such as the false coral snake, black snake and vine snake.

d) Fish

According to Paiva (1983), the ichthyofauna of the Tocantins basin is most diverse and abundant in the lower reaches. The Foz do Santa Tereza APA is situated in the upper reaches of the Tocantins basin, and although the species abundance is low, the number of species present appears to be high. Fishermen and residents of the town of Peixe report the occurrence of diverse species in the waters of the Tocantins nearby. Among these are *Colossoma* -- much appreciated by the local population -- and some very large and migratory species such as *Arapaima gigas*, *Prochilodus* sp., *Pauliceia litkeni*, *Brachyplatystoma flavicans*, *B. filamentosum* and *Pseudoplatystoma fasciatum*.

Four hydrographic systems can be distinguished in the APA, namely:

- large watercourses -- the Tocantins and Santa Tereza Rivers;
- small watercourses -- numerous streams and creeks in the APA;
- marginal lagoons -- these are located in the floodplains of the large watercourses, receiving water directly from the rivers when these flood;
- lagoons -- not located on floodplains, but influenced indirectly by flood periods (via the water table).

Of these, the Tocantins and Santa Tereza Rivers, and the marginal lagoons are of most significance for the conservation of the APA's fish fauna.

2.2.3.5 Human Impact on the Foz do Santa Tereza APA

The predominant land uses in the area are that of extensive cattle ranching, followed by subsistence agricultural activity (main crops: rice, maize, beans and cassava), and small-scale extractive activities involving fruit, thatching materials, hand-processed timber, sand and clay. The extraction of latter is generally carried out in a haphazard fashion, with no effort made to restore the area thus degraded.

Seeded pastures are located, for the most part, along Route TO-280, just after the bridge over the Santa Tereza River, and on the old Monarek Farm, which has been sold to businessmen from São Paulo. On this property, infringements of the Forest Code were observed, with deforestation along the margins of the lagoons and springs. The selective felling of timber species such as beautyleaf (*Callophyllum brasiliensis*) also occurs in the remnants of waterlogged forest.

Tourist activity in the municipality is significant during the months of July and August, due to the presence of freshwater beaches on the Tocantins River. This tends to stimulate the extraction of timber from gallery forests for the construction of temporary premises for accommodation and commercial purposes. The gallery forest areas also tend to be used for subsistence agriculture using primitive techniques that encourage soil erosion.

Hunting is common in the region, whether as a leisure activity, or for food, or to protect domestically reared animals. The trapping of birds – particularly parrots and songbirds – to be kept as pets is also practised. Other animals captured include the coati racoon, and various monkeys. Such practices are widespread and pose a threat to several species.

Queimadas set by farmers and ranchers to clear land or regenerate pastures have caused significant damage to gallery forests, which are important wildlife refuges and ecological corridors.

The APAs proximity to Route TO-280 unfortunately means that many wildlife species get run-over when straying onto the road, particularly at night. The failure to take adequate measures to prevent erosion by rainwater running off this highway (particularly in areas where the road lies on artificial embankments, or runs through cuttings) has also resulted in the sedimentation of some of the smaller watercourses and *veredas* which are important wildlife habitats.

2.3 Conservation Areas Under the Aegis of the Federal Government

The federal government agency responsible for the administration and supervision of the conservation areas under federal jurisdiction is the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA).

2.3.1 Araguaia National Park, Bananal Island

Bananal Island is divided in the following manner: the northern third is the Araguaia National Park, with an approximate area of 572,000 ha, under the aegis of IBAMA whose headquarters in the Park are located in Macaúba, and the other two thirds (1,600,000 ha) are given over to indian reservations inhabited by the Carajas tribes, with 5 settlements: Canoanã (on the Javaés River), Fontoura, Santa Isabel do Morro, Macaúba and Tapirapé (on the left bank of the Araguaia). These reservations are under the aegis of the National Indian Foundation (FUNAI), and thus the Federal Government is responsible for the whole area of the Island.

The Araguaia National Park covers part of the Pium and Lagoa da Confusão Municipalities between longitude meridians 49°56' - 50°30'W and latitude parallels 09°50' - 11°10S. Its area is given as 562,312 ha. The Park was created on 31/12/59 by Federal Decree N° 47,510, arising from State Law N° 2,370, dated 17/12/58 taking in all 2 million ha



Ranch-hand's dwelling near Mercedes Lake

of the Island. A reduction in the size of the Park was subsequently proposed by Decree N° 68,873, dated 05/07/71, and the boundaries of the Araguaia Indian Reservation were set by Decree N° 69,263, dated 22/09/71. The process culminated in the Decree N° 84,844, dated 24/06/80 which established the boundaries of the Araguaia National Park and the Araguaia Indian Reservation which prevail to this day.

The Araguaia National Park comprises an extensive plain, formed from quaternary fluvial sediments, that is periodically inundated when the Javaés and Araguaia Rivers flood. In some places there is higher ground (average altitude 200m), which remains above water. In one of these areas – Macaúba - the Park headquarters is located (altitude 230 m).

Soils in the Park are predominantly hydromorphic, with low natural fertility. Red-yellow latosols also occur along the Araguaia and its tributaries.

2.3.1.1 Climate

The climate is hot and semi-humid, with four or five dry months. Average annual temperatures are around 24°C. Temperatures are fairly constant throughout the year. Maximum absolute temperature is around 42°C, and the minimum around 8°C. Total annual rainfall is approximately 1,750 mm, with most rain falling in the months from January through March.

2.3.1.2 Vegetation Types in the Araguaia National Park

The Araguaia National Park is located in the transition zone between Amazon Forest and *Cerrado*. Its vegetation is therefore highly diverse, rich in species from both these biomes. Dominant vegetation forms are: *cerradão*, *campo cerrado*, *cerrado* parkland, open savannah, (*campo*), waterlogged forest with aquatic communities, and gallery forests, and in more restricted areas mainly in the north of the Park, tropical rain forest. In the south of the Park, there is a transitional forest zone, lying between *cerrado* and tropical rain forest formations. This area is known as the Mamão Forest, and covers 70,000 ha. Mileski (1994) records that, in the forested areas, trees can grow to 30 m.

Cerradão

This vegetation formation is of very restricted occurrence on Bananal Island, occurring only in isolated patches, particularly on higher ground where flooding is rare. Most occurrences are in the west and south-west of the Island. Floral composition is heterogeneous, and, according to Mileski (1994), is characterised by the dominance of the following tree species: *Curatella americana*, *Qualea grandiflora*, *Q. parviflora*, *Dimorphandra mollis*, *Stryphnodendron* sp., *Pladenia* sp., *Bowdichia virgiloïdes*, *Aspidosperma* sp., *Vitex* sp., *Copaifera* sp., *Schefflera* sp., *Caryocar brasiliense*, among others.



Carajás indians in the Macaúba village

Frederic Mertens / GALAIB-10.

Campo Cerrado

This formation is characterised by continuous grassy/woody surface cover interspersed with trees which are usually stunted or fire-damaged. Its occurrence is limited on Bananal Island, being confined to the driest parts where the effects of flooding are least intense. Among the woody species present are: *Curatella americana*, *Qualea* spp., *Tabebuia* sp., *Byrsonima* spp., and others. Mileski (1994) distinguishes 3 main types of *campo cerrado*, namely the *Byrsonima*, *Vochysia rufa*, and the *Copaifera elliptica* Communities.

Cerrado Parkland

This formation can result from either natural or human influences, and occurs widely throughout much of the Island (Mileski, 1994). In landscape terms, it is characterised by the occurrence of isolated clumps of trees – often situated on termite mounds which provide excellent conditions for their growth and development – in open field-type vegetation made up predominantly of gramineous species. It is these clumps of trees that give the formation its park-like appearance.

The following tree species can be found: *Curatella americana*, *Pseudocladia lateriflora*, *Byrsonima crassiflora*, *Tabebuia ochracea*, *Simaruba* sp., *Caryocar brasiliensis*, *Copaifera elliptica*, *Tabebuia caraiba*, *Terminalia* sp., *Pterodon polygalaeflorum*, *Dalbergia* sp., *Plumeria* sp., among others.

Campo

This is a field formation interspersed with dwarf woody species, but with no arboreal cover apart from the strips of gallery forest that are present in some areas (Mileski, 1994). On the flood plains, the water table lies some 50 cm below the surface and is subject to periodic fluctuations. The soils are poorly aerated.

According to Mileski (1994), species richness is not very high, but well-developed individuals are numerous, and often reach heights of almost 2 m. The main grasses found are *Axonopus* sp. (80 cm tall), *Panicum* sp., *Andropogon leucostachys*, *Ichmantis procurrens*, *Setaria geniculata*, *Paspalum milegrans* (1m tall), *Olvra* sp. (1m tall) *Hockloscholoa granulens*, *Aristida* sp., *Aboboda pulchella* and some *Cyperaceae* species. Since the *campo* formation is extensive, the dominant species may vary from place to place, but those of the *Trachypogon* genus are particularly evident.

Waterlogged Forest with Aquatic Communities

Lacustrine vegetation is also represented on Bananal Island, developing in the circular depressions in which most of the regions lakes are formed. In general these lakes are shallow, which favours the establishment of certain aquatic and semi-aquatic species. Representatives of this type of vegetation are *Cyperus giganteus*, *Rhynchospora* sp., *Scirpus* sp., *Echinodorus macrophylla*, *Eleocharis articulatus* and, in the deeper stretches, species such as waterlilies (*Eichornia* spp). Along the waterlogged edges of these habitats, woody species are present, particularly those in the *Lythraceae*, *Melastomataceae*, and *Scrophulariaceae* families.

On some sandbanks, especially in the Araguaia River, dense vegetation with small-sized trees prevails, among them *Bursera* sp., *Vochysia* sp., to the Leguminosae and Palpighiaceae families.

Gallery Forests

Along the banks of rivers and streams, an evergreen vegetation formed of forest and cerrado elements develops, favoured by the permanent moisture of the soil and the accumulation of

nutrients. These forests should be carefully preserved since, as well as catalysing and maintaining biodiversity, they can also function as wildlife corridors. The commonest arboreal species therein are *Calophyllum brasiliense*, *Xylopia sp.*, *Tabebuia sp.*, *Piranhea trifoliata*, *Jeonia glicicarpa*, *Cynometra spruceana*, *Inga sp.*, *Hymenaea courbaril*, *Licania pruinosa*, *Bowdichia virgiloides*, *Astronium sp.*, and *Aspidosperma tomentosum*. The buriti palm (*Mauritia vinifera*) is particularly apparent. In some of the higher parts along the river banks, cedar trees (*Cedrela sp.*) are present, most often in the north of the Island.

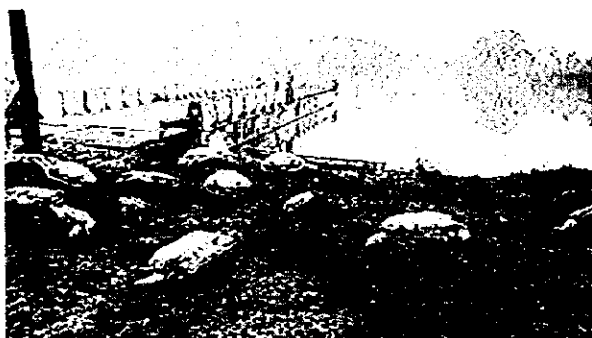
2.3.1.3 Areas of Ecological Transition

These areas, which are also referred to as ecotones, occur at the interface of two or more vegetative domains. Their delimitation is effected either by phytosociological survey when the physical structures of the two domains are similar, or by photographic interpretation when their structures are noticeably different.

In the Araguaia National Park, ecotone areas occur along the Araguaia and Javaés Rivers and in the region known as the Mamão Forest in the centre of the Park which is surrounded by *campo cerrado* vegetation. Here, the transition between the forest and the *cerrado* is abrupt (Mileski, 1994). The formations of Seasonal Semi-deciduous Alluvial Forest and those of the *Cerrado* mingle and blend into each other, somewhat confusingly, since certain species occur in both, notably *Tabebuia serratifolia*, *Piptadenia sp.*, *Physocalimma scaberrimum* and others. Average height is around 20 metres.

Various sampling exercises were undertaken in areas near the Araguaia and Javaés Rivers, and the most frequently occurring species were: *Piranhea sp.*, *Colophyllum brasiliensis*, *Teonia glicicarpa*, *Xylopia sp.*, *Tabebuia sp.*, *Cynometra spruceana*, *Roupala sp.*, *Licania sp.*, *Diploptropis sp.*, *Bixa sp.*, *Duroia macrptylla*, *Vitex sp.*, *Buchenavia sp.*, and *Psidium* sp. The under storeys were little developed, the ground being virtually bare apart from occasional tussocks of gramineous species and some *Pterodophytas* and plants of the Rubiaceae family.

Frederic Meriens / GAIA. 1845



Turtle caught by Carajás Indians on Bananal Island



Arapaima gigas fish being dried; this fish is said to be the largest freshwater species in the world

Frederic Meriens / GAIA. 1843

In more waterlogged places, the bushy vegetation gets thicker, and much intermeshed, with some spine-bearing species present. It is consequently hard to penetrate. Occasional palm groves occur, in which *Astrocaryum* sp., and *Bactris* sp. predominate. Elsewhere, *campo cerrado* features prevail, with the trees tending to cluster on the small, usually circular mounds of soil that are the results of termite activity. The soil is covered with Gramineae and Cyperaceae species, and the predominant tree species is the *Byrsonima crassifolia*.

2.3.1.4 The Fauna of the Araguaia National Park

Consequent on the vegetational features mentioned above, the Araguaia National Park possesses an abundant and highly diverse fauna. IBAMA surveys (1994) made to facilitate Park management, have recorded a large number of aquatic species, and of those associated with aquatic habitats. Lakes, lagoons and swamps provide ideal conditions for a wide variety of wildlife, particularly birds.

Among the mammals found in the Park are the guara wolf (*Chrysocyon brachyurus*), the giant river otter (*Pteromura brasiliensis*), the otter (*Lutra platensis*), the jaguar (*Panthera onca*), cougar (*Felis concolor*), the tapir (*Tapirus terrestris*), the capybara (*Hydrochoerus capybara*), the giant ant-eater (*Myrmecophaga tridactyla*), and the giant armadillo (*Priodontes giganteus*). Swampy areas are an ideal habitat for the swamp deer (*Blastocerus dichotomus*), but their populations have been hard hit by disease transmitted from cattle in unauthorised ranching operations inside Park limits. Other deer species are also present (e.g. *Ozotoceros bezoarticus*), and the two wild pig species found in Brazil (*Tayassu tayacu* and *T. peccari*). Two cetaceous mammal species typical of Amazonian fauna are also found, namely the *Inia* and *Sotalia* species of Amazon porpoise.



Frederic Mertens / GAIA. IB39

Cattle in the Araguaia National Park

Bird fauna is equally rich, with species such as the endangered blue macaw (*Anodorhynchus hyacinthus*), the harpy eagle (*Harpia harpia*), the fishing eagle (*Pandion haliaetus*), the king vulture (*Sarcorampus papa*), the white ibis (*Theristicus caudatus*), the toucan (*Ramphastus toco*), the cormorant (*Phalacrocorax olivaceus*), the spoonbill (*Ajaja ajaja*), the rhea (*Rhea americana*), the partridge (*Rhynchotus rufescens*), and innumerable others. Some birds are particularly common in the gallery forests, notably king-fishers (*Ceryle* sp., and *Chloroceryle* sp.), and the snake-bird (*Anhinga anhinga*).



Amazonian turtle caught for food (IB42)

Reptiles are represented by the Amazonian turtle (*Podocnemis expansa*), the alligator (*Melanosuchus niger*), the caiman (*Caiman crocodilus*), and by snakes such as the anaconda (*Eumeces murinus*), the boa constrictor (*Constrictor constrictor*), the coral snake (*Micrurus* sp.) and the bushmaster (*Lachesis muta*) the largest poisonous snake in Brazil.

Fish species include *Arapaima gigas*, *Phractocephalus corruscans*, *Cichla* sp., *Pseudopoma tystona*, *Pseudosiphastiona corruscans*, *Potomotrygon* sp., *Electrophorus electricus*, and various species of piranhas.

Invertebrate species are innumerable, including representatives of almost all groups.

Of the 38 mammal species identified in the Park's Management Plan, 17 are endangered. 15 fish species are recorded, one of them (*Arapaima gigas*) endangered. Of the 11 species of reptiles, 5 are endangered, among these the Amazon turtle (*Podocnemis expansa*). IBAMA has taken special measures to protect the freshwater turtle species, and results have been positive in the first 12 months of the initiative, allowing the survival of these species despite great human pressure on them.

2.3.1.5 Human Impact on the Araguaia National Park

There are large areas of the Araguaia National Park which have been transformed by human action. In the dry months, June-September, the National Park suffers the impact of the *queimadas* or fires, normally started by deliberate human action. These fires, set to clear land and renew cattle pastures, occasionally get out of control, and even when this does not happen they have serious consequences



Cerrado in the Araguaia National Park showing the effects of *queimadas*

Frederic Mertens / GAIA (IB48)

for the flora and fauna when repeated year after year. In some areas, the landscape has been completely transformed, with an open, field-type vegetation prevailing. The most affected region is in the north of the Park, particularly that between the Araguaia and Riozinho Rivers. On a smaller scale, the indians also use fire, for certain purposes when they make incursions into the National Park.

In many areas, evidence of human occupation in the form of cattle tracks and make-shift dwellings occupied by ranch-hands and squatters, can be detected. The removal of existing vegetation to grow arable crops is not that common, but in areas neighbouring the Island, intensive agriculture is practised on a large scale. In this context, the Formoso Project for irrigated rice production is perhaps the most noteworthy, and the indirect consequences of such activity on the National Park, in terms of sedimentation of watercourses and agrochemical pollution, may well be significant.

2.3.2 The Tabatinga Range Environmental Protection Area

Located in the municipalities of Alto Parnaíba (MA) and Ponte Alta/Mateiros (TO), this APA was created by Presidential Decree N°99,278, dated 06/06/90. The basic purpose behind its creation was to protect the headwaters of the Parnaíba River, ensuring the welfare of urban populations along the main river and its tributaries, as well as guaranteeing the preservation of its flora, fauna and soils.

The APA comprises some 61,000 ha, located between latitudes 10°03'47"-10°23'29"S and longitudes 45°41'42"-46°01'28"W, bounded to the south by the headlands of Galvão and Sassafráz, to the north by the escarpment of the Tabatinga Range, to the west by the Come Assado ridge, and to the east by the Tocantins/Bahia border. It lies approximately 300 km due east of Palmas.

IBAMA (1992) reports that the topography in the Mangabeiras Plateau region is flat or gently undulating, particularly in the watershed between the Tocantins and Parnaíba river basins, with altitudes of around 770 m. On the escarpments, cliff faces occur, and the land falls some 250 m. Much of the soil is sandy, however in regions near springs quaternary alluvial deposits have formed. Data from the Rio Parnaíba Foundation (FURPA, 1997) state that the source of the Parnaíba River – the Água Quente stream – is located at the foot of the Mangabeiras Plateau, at an altitude of 709 m. It runs approximately 50 km until it meets the Corriola River, whenceforth it is known as the Parnaíba River.



A typical dwelling in the Tabatinga APA region



The Baliza rock, near the Tabatinga range APA

2.3.2.1 Climate

The climatic conditions are highly transitory, reflecting the convergence of 3 major morphoclimatic domains: the inter-plain zones covered by semi-arid scrub (*caatinga*) to the east/north-east, the plateaux covered by *cerrados* and penetrated by gallery forests to the west/south-west, and the low-lying forested Amazon lands to the north/north-west (Ab'Saber, 1970).

While the bi-seasonal nature of the climate is typical of tropical zones, the rains in this area have the high inter-annual variability typical of semi-arid areas. Average annual rainfall varies from 934.4 mm in Formosa do Rio Preto (BA) to 1,570 mm in Novo Acordo (TO) (FURPA, 1997). FURPA's Technical Report noted annual water deficits in excess of 300 mm, which characterise the area as having a dry, sub-humid climate.

2.3.2.2 Vegetation in the Tabatinga Range APA

The information in this section is based on the survey undertaken by the River Parnaíba Foundation (FURPA, 1997).

The vegetation is complex and diversified, with dwarfism being observed in species of the *Tabebuia*, *Sclerobium*, *Hymenaea*, *Ouratea* and *Lecythis* genera, among others. The following geo-environmental units/vegetation types are considered:

- The Mangabeiras Plateau: *Campo Cerrado*;
- Plateau Borders and Foothill Areas: *Campo Cerrado*;
- Interfluvial Areas: *Cerrado* and *Campo Cerrado*;
- Veredas: Gallery Forests and *Buriti*-palm Groves.

a) *Campo Cerrado*

Little floral diversity, basically herbaceous/gramineous components and bushes, sparsely distributed. Dwarf species of *Tabebuia*, *Sclerobium*, *Licania* and *Lecythis* are present. Otherwise the most representative species are: *Anacardium*, *Anona*, *Tabebuia*, *Vellozia*, *Lecythis*, *Licania*, *Lippia*, *Pavonia*, *Bombax*, *Aexhynomene*, *Curatella* and *Ouratea*.

b) *Cerrado*

The cerrado ecosystem is present in the Interfluvial Areas, and has bushy and arboreal species, some of which can grow to 12 m. The most representative species are *Anacardium*, *Cordia*, *Xilopia*, *Curatella*, *Caryocar*, *Combretum*, *Croton*, *Calliandra*, *Copaifera*, *Bowdichia*, *Enterolobium*, *Sclerolobium*, *Himenoaea*, *Macherium*, *Parkia*, *Stryphnodendron*, *Dimorphandra*, *Tabebuia*, *Mouriri*, *Vochysia*, *Salvertra*, *Qualea*, *Sterculia*, *Simarouba*, *Magonia* and *Tuplaris*.



Buriti palm groves

Frederic Meriens / GAIA (142).

c) Gallery Forests and Buriti-palm Groves

This formation is dominated by that vegetation known popularly as “buritizal”, and has the appearance of an oasis landscape due to the emergence of ground water. Gramineous species and pteridophytes are common. Representative species are: *Mauritia*, *Lycopodium*, *Drosera*, *Sclerobium*, *Tibouchina*, *Miconia*, *Rumohora*, and *Paepalanthus*, among others.

Fruit-bearing Species in the Tabatinga Range APA

The researchers collected fruit from the most diverse species from which, with the help of bibliographic material and the local population, the edible species were identified as follows:

Annona coriacea, *Anacardium occidentale*, *A. microcarpum*, *A. humile*, *Hymenaea martiana*, *H. courabil*, *H. velutina*, *Mauritia flexuosa*, *Caryocar coriaceum*, *Hancornia speciosa*, *Byrsomina verbasifolium* and *Mouriri pusa*. Of this list, *Hancornia speciosa*, *Mauritia flexuosa*, and the *Anacardium* spp. deserve emphasis since they support cottage industries making sweets and juices.

Endangered Species

Only one floral species, *Myracrodruon urundeuva*, is considered endangered.

Medicinal Plants

The local population use many of the region’s plants for medicinal purposes, and *Stryphonodendron coreaceum* and *Dimorphandra gardneriana* are occasionally exported to major urban centres of the country and even abroad. Examples of other medicinal species include: *Copaifera langsdorffii*, *Cleome spinosa*, *Pterodon poligaliflorum*, *Myracrodruon urundeuva* and *Mauritia flexuosa*.

Timber species

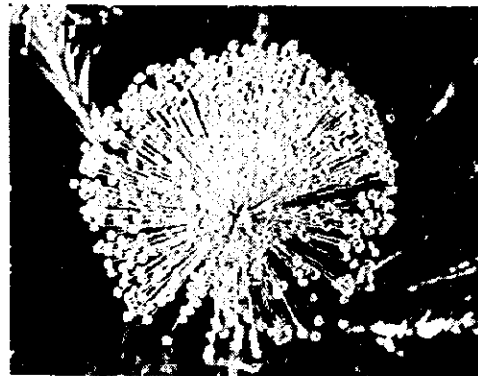
Only the *Myracrodruon urundeuva* suffers significant pressure on account of its value as timber. Other timber-producing species include *Xilopia* sp., *Aspidosperma* sp., *Hirtella* sp., and *Jacaranda* spp.

Ornamental Plants

In this category, species found in the Tabatinga Range APA include: *Bombax* sp., *Calliandra* sp., and *Lycopodium alopecuroides*. The insectivorous species *Drosera* sp., and *Utricularia* sp. are also found.

Species Suitable for Honey Production

Vermonia sp., *Bowdichia virgilioides*, *Pterodon polygaliflorum*, *Parkia platycephala*, and *Hirtella ciliata* can be cited, among others.



Lúcia L. T. Muraishi (c2a).

Vegetation typical of the veredas in the Tabatinga APA



Lúcia L. T. Muraishi (c2b)

A “Canela de Ema” tree in flower

2.3.2.3 The Fauna of the Tabatinga Range APA

The Tabatinga Range's fauna is generally well-preserved, and several endangered species are present. Their status derives from the IBAMA Directives N° 1,552, dated 19/12/89, and N° 106 dated 30/09/92. An example of the Tabatinga Range's quality as a refuge for rare species is evidenced by the fact that of the 211 bird species identified by FURPA's survey (1997), 4 feature on the endangered species list. The fauna are categorised according to the APA's geo-environmental units listed in 2.3.2.2 above.

a) The Mangabeiras Plateau.

In this geo-environmental unit examples of bird species that can be found include: rhea (*Rhea americana*), crested seriema (*Cariama cristata*), partridge (*Rhynchotus rufescens*), pigeon (*Columba speciosa*), tinamou (*Crypturellus undulatus*) and vulture (*Sarcoramphus papa*). Birds of prey include the savanna hawk (*Heterospizias meridionalis*) and the harpy eagle (*Harpia harpia*).

Mammal species include wild boar (*Tayassu* sp.), great ant-eater (*Tamandua bandeira*), giant armadillo (*Priodontes maximus*), three-banded armadillo (*Tolypeutes tricinctus*), fox (*Dusicyon thous*) guara wolf (*Chrysocyon brachyurus*), deer (*Ozotocerus bezoarticus*), and feline species such as jaguars (*Panthera onca*), and cougars (*Felis concolor*).

b) Plateau Borders and Foothill Areas

The escarpments of the Tabatinga Range feature the sources of several rivers but despite this they are not very rich in fauna, especially vertebrates. Bird species encountered include the crested seriema (*Cariama cristata*) and the macaw species (*Ara Macao* and *A. chloropta*) as well as the endangered blue macaw (*Anodorhynchus hyacinthus*). Only one mammal species was recorded, the guinea pig (*Kerodon rupestris*).

c) Interfluvial Areas

These areas suffer from the effects of *queimadas*, and the vegetation is relatively open, with secondary forests. Characteristic bird fauna include several species of parrot (e.g. *Amazona aestiva*), quails (*Nothura boraquira*), crested seriema (*Cariama cristata*), toucans (*Ramphastus toco*), and humming birds (*Eupetomena macroura*). The main mammals present are bat species



Mangabeiras range

(e.g. *Molossus ater ater*, and *Artibeus lituratus lituratus*), ant-eaters (*Tamandua tetradactyla*), skunks (*Conepatus chilensis*) and feline species such as jaguars (*Panthera onca*), and cougars (*Felis concolor*). Reptiles such as the iguana (*Iguana iguana*), tegu (*Tupinambis teguixim*), green pit viper (*Bothrops lilineota*) and rattlesnake (*Crotalus durissus*) were recorded. Fish fauna species included *Hoplerethrinus unitaeniatus*, *Hoplias malabaricus*,

Curimatus elegans, and *Schizodon fasciatus*. Invertebrates include *Melipona* sp., *Coptotermes* sp., *Terias hecabe*, *Tabanus quinquevittatus*, and the butterfly *Papilio thoas brasiliensis* which is on the brink of extinction.

d) Veredas: Gallery Forests and Buriti-palm Groves

Observation of fauna in these regions can be made difficult because of the density of the vegetation, but this geo-environmental unit is the most species-rich of the four, in terms of fauna. In addition to woodpeckers (*Melanerpes candidus*), and bell birds (*Procnias averano*), aquatic bird species, such as teal (*Dendrocygna viduata*), bitterns (*Tigrisoma lineatum*), and white-throated ibis (*Theristicus caudatus*) are present, as are mammals which depend on water such as the giant river otter (*Pteromura brasiliensis*), the capybara (*Hydrochoerus capybara*), and the tapir (*Tapirus terrestris*).

Few reptiles were recorded, but they included the anaconda (*Eunectes murinus*) and the cayman (*Caiman yacare*). In contrast, a considerable number of fish species were recorded, the most characteristic of which are: *Myloplus asterias*, *Acestrorhynchus falcatus*, *Pseudoplatytoma fasciatus*, *Pimelodus* spp., and *Cichla ocellaris*. Among the invertebrates recorded, examples include: *Ectatoma quadridens*, *Monomorium pharaonis*, *Atta capiguara*, and *Labidus praedator*.

2.3.2.4 Human Impact on the Tabatinga Range APA

The APA is subject to human pressure particularly in the form of agricultural and ranching activities, predatory hunting, and the routine practice of *queimadas*, which occur throughout the APA. A visit by a team from GAIA, the environmental NGO, noted substantial areas, especially in the southern and south-eastern regions, that had been deforested and cleared for agricultural purposes, notably soya bean, maize, and rice production. In the Coxilha da Serra property, part of which lies inside the APA, pastures had been seeded in the cleared areas. Significant lengths of fence are put up using local tree species, which is of concern when the species used are endangered – as in the case of certain properties where the fencing material is taken from pepper trees (*Schinus* spp.). There are reports of clandestine trade in this species of timber.

The basis for property rights is occupation and use of the land, with tenure subsequently being recognised by the government agency concerned (ITERTINS). Access to local towns is often difficult. Subsistence agriculture, with rice, cassava and beans being the main crops grown, is practised in some parts of the APA, and rustic dwellings are commonly built from local materials.

In the *veredas*, the topsoils are commonly very sandy and permeable overlying impermeable strata below (FURPA, 1997). When the vegetative cover is removed, these topsoils are particularly vulnerable to erosion, and the quality of the springs themselves is thus prejudiced.

Details of FURPA's land-use zoning for the management of the Tabatinga Range APA and the neighbouring Mangabeiras Plateau APA are given in Table 4.

Table III-4 Environmental Zoning in the Tabatinga Range and the Mangabeiras Plateau APAs (Tocantins, Maranhão and Piauí States)

LAND USE CATEGORY	LOCATION	CHARACTERISTICS	PERMITTED LAND USE	ENVIRONMENTAL GOALS
1-WILDLIFE PRESERVATION	Around <i>veredas</i> and springs.	Presence of virtually undisturbed ecosystems. Maximum protection zone.	<ul style="list-style-type: none"> • Preservation • Scientific research • Ecotourism 	<ul style="list-style-type: none"> • Maintenance of biodiversity • Educational activities • Monitoring of water resources
2-WILDLIFE PRESERVATION AND ENVIRONMENTAL RESTORATION	Plateau edges, degraded <i>veredas</i> and eroded areas.	Presence of slightly disturbed ecosystems, with some strongly degraded <i>veredas</i> . Disciplined land use, with soil conservation a priority.	<ul style="list-style-type: none"> • Preservation/Conservation • Scientific research • Ecotourism • Maintenance of surviving flora • Reforestation with native species 	<ul style="list-style-type: none"> • Ecological management of flora and fauna • Educational activities • Restoration measures • Erosion control
3-WILDLIFE CONSERVATION	Parts of the plateau and the interfluvial region.	Presence of partly altered ecosystems with limited regenerative capabilities. Land use controls apply.	<ul style="list-style-type: none"> • Conservation • Forestry • Extractive agriculture • Extensive and/or semi-intensive ranching 	<ul style="list-style-type: none"> • Restoration measures • Erosion control • Plan for the integrated management of natural resources
4-EXTENSIVE AGRICULTURAL USE	Parts of the interfluvial region.	Presence of modified ecosystems, showing clear evidence of human activity.	<ul style="list-style-type: none"> • Farming and cattle ranching • Forestry • Extractivism 	<ul style="list-style-type: none"> • Restoration and reclamation of natural resources • Erosion control • Soil conservation practices
5-INTENSIVE AGRICULTURAL USE	Parts of the plateau.	Presence of ecosystems that have been much modified by agro-pastoral activity.	<ul style="list-style-type: none"> • Commercial agriculture • Forestry • Extractivism • Intensive/semi-intensive ranching 	<ul style="list-style-type: none"> • Erosion control • Soil conservation practices

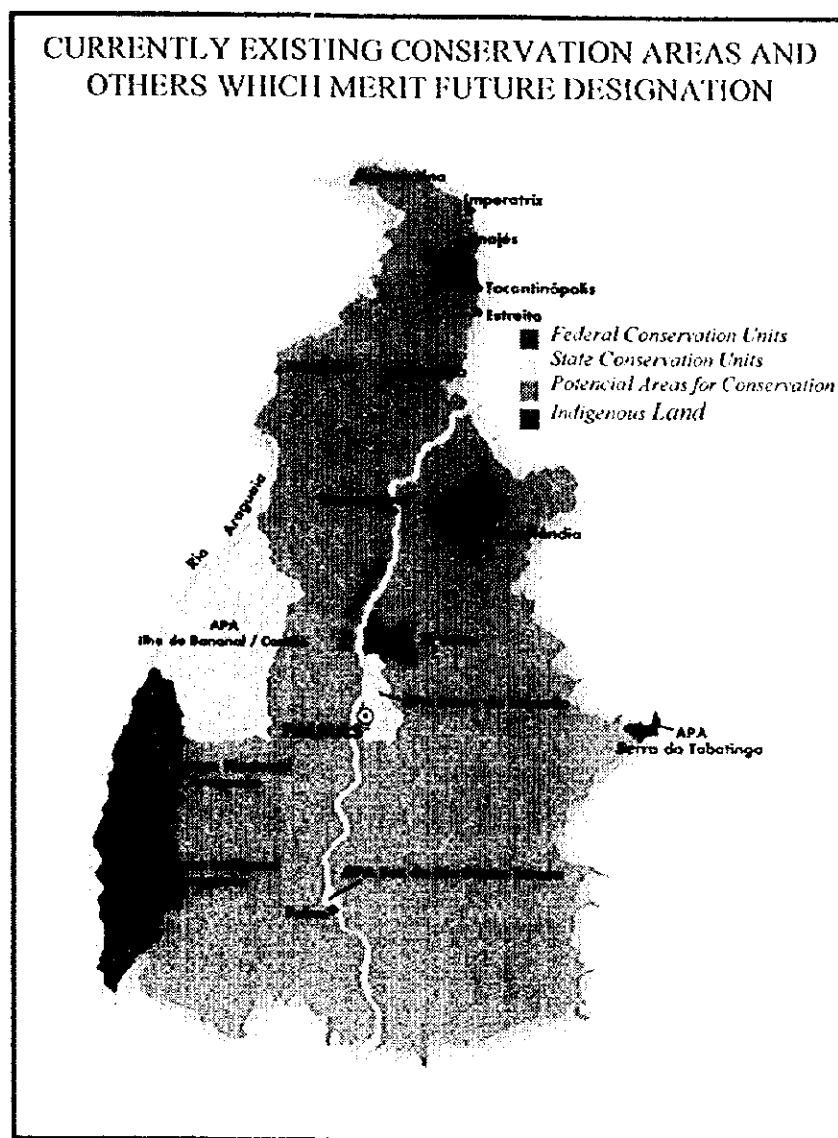
(Source: FURPA, April 1997)

2.4 Municipal Conservation Areas

2.4.1 Araguaína Forest Reserve

This, the only municipal Forest Reserve in Tocantins, was created by Municipal Decree N° 43/95 dated 18/01/95, in Araguaína. Its area is 145,645 m², being bounded by the Mansões do Lago and Jardins do Lago estates. No real study of this conservation area has been undertaken, but it has been noted that the vegetation is characteristic of *cerrado* areas, with *babaçu* palm (*Mauritia* spp.), macaw-palm (*Acrocomia sclerocarpa*), *Curatella americana*, and other typical *cerrado* species present.

With regard to the fauna, human pressures on the area are significant due to its proximity to the urban centre of Araguaína and to the fact that the area has not been enclosed. Few bird species were observed, and those recorded are species adapted to living with Man, notably sparrows, pigeons and doves. The existence of snakes and toads in the waterlogged areas is attested to by local people. The warden of the reserve is the only person living in the area.



Source: The Tocantins State Planning and Environment System - (SEPLAN)

2.5 Recommendations for Conservation Areas

1. Establish new Conservation Areas, particularly to include those vegetation types which are still under-represented, such as *cerrado*, deciduous forests on calcareous outcrops, tropical forests and others. Such areas should be of at least 80,000 ha, and ideally should be greater than 300,000 ha. Smaller areas can be established to serve as corridors linking larger reserves, or to provide refuges for smaller species and/or endemic flora;
2. Maintain currently protected areas by means of measures such as: the hiring of park wardens and qualified technical staff; institutional strengthening of the agencies responsible for their management; ensuring the continuity of on-going initiatives; acquisition of suitable equipment;
3. Promote studies and research projects on the species and ecosystems present in Conservation Areas;
4. Establish Conservation Areas within which the sustainable use of natural resources is promoted, especially in the region surrounding National Parks and Reserves;
5. Undertake boundary demarcation of existing Conservation Areas;
6. Encourage the private sector to establish wildlife refuges in the form of Private Nature Conservation Reserves so as to protect breeding grounds, endangered species and rare habitats.

3. Environmental Problems in Tocantins

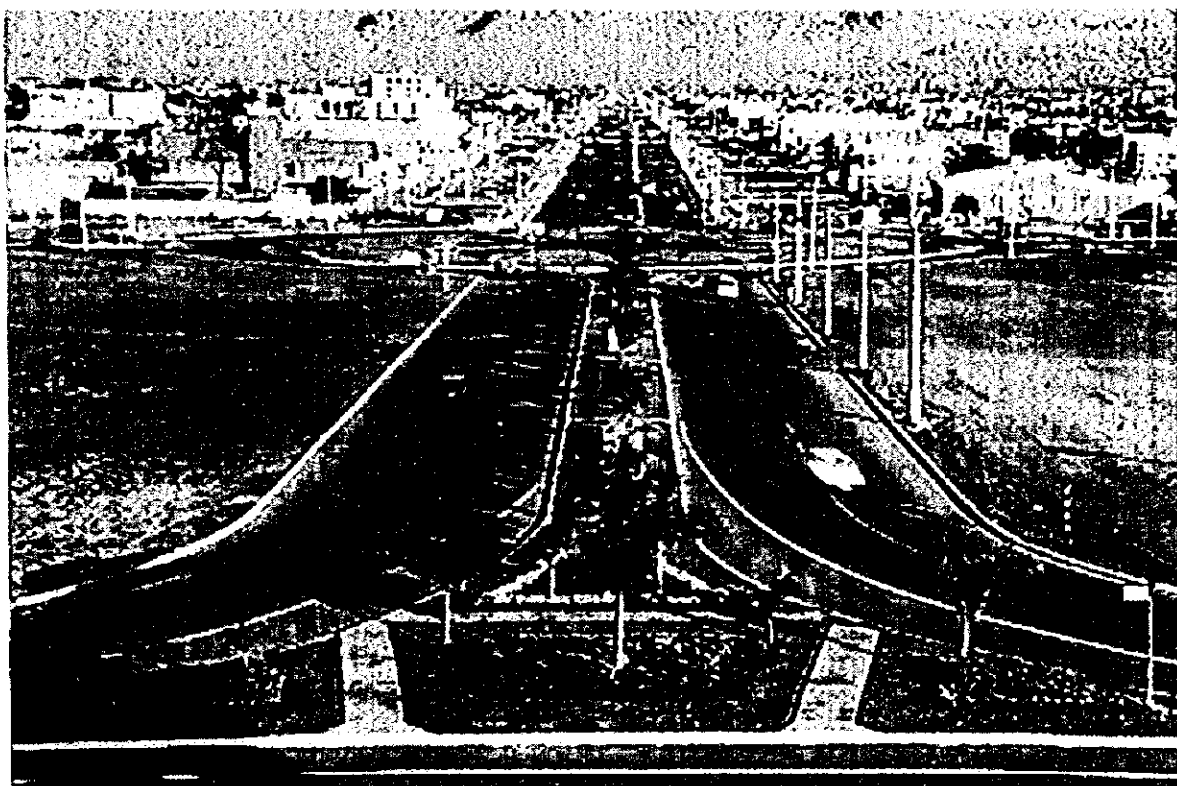
3.1 Introduction

The State of Tocantins was created through the division of the State of Goiás in January 1989. This separation from Goiás can be attributed to the need for an administrative regime that was more in tune with the needs of the Tocantins region. What previously had been the rather neglected northern half of Goiás, had attracted the interest of a few members of the scientific community who were aware of its natural richness. However, concerted efforts to collect data which can convey the current environmental situation in quantitative terms, have only come to be made following the formation of the State. What is well-known is that Tocantins has inherited large areas that have been deforested to raise cattle, desertified areas whose origins have not been studied, and areas that have been degraded by prospecting activities.

This Chapter outlines the main sources of environmental degradation in the State, with particular emphasis being given to the most significant, namely: mining activities; the use of agrochemicals, and the practice of clearing land by means of fire (*queimadas*).

3.2 Overview of Urban and Rural Issues

For the most part, the State of Tocantins is sparsely populated, and policies for the occupation of the *cerrado* regions which make up the bulk of its territory have been somewhat haphazard. To facilitate settlement, road networks needed to be built, and by this means the penetration into what were considered poor areas, isolated from the major urban centres, was assured. These networks helped support development projects, but they also brought social and environmental



Frederic Meriens / GALIA (P. 407)

Aerial photograph of Avenida JK in Palmas

problems, such as: migration from the country to the towns, and inter-regional migrations, provoking decreases and/or concentrations of population and of economic activity, and leading to reductions in the quality of life (public health service crises, insufficient housing, inadequate basic sanitation facilities, and a precarious educational system).

The lack of basic sanitation facilities in the towns necessitated the construction of septic tanks for residences and places of work, thereby facilitating the proliferation of tropical, and water-borne diseases and threatening to contaminate ground water. Tocantins needs to set up a sewage treatment system, otherwise the incidence of clandestine outfalls into the surface water networks will continue to increase. An example of the problem is the Neblina stream, which receives sewage from suburbs of Araguaína, and then discharges into Lagoa Azul, which is now polluted.



Frederic Mertens / GAIA. (PA16)

Waste Collection System in Palmas

Another serious problem is the rubbish generated by human activities (CEMPRE, 1993). While rubbish collection is particularly problematic in large metropolises, it is an issue which is by no means fully resolved in small and medium-sized townships. Here, although the volume of refuse is smaller, the local authorities are confronted with a shortage of resources, not just for its collection, but for its processing and final disposal. Consequently, most of the urban refuse produced in Brazil ends up on the town dump (*lixão*), where it is simply piled up, without any form of treatment. Besides providing attractive habitats for rats, cockroaches and flies, these dumps are often situated near watercourses, and thus tend to pollute both surface and ground water, particularly after heavy rain. The offensive smells emanating from them should also be mentioned (Muçouçah, 1990).

Due to the unplanned nature of the patterns of land use established, natural resources have suffered serious deterioration. The establishment and growth of urban centres has caused the removal of native vegetation, habitat destruction and the degradation of watercourses. Logging and mining



Frederic Mertens / GAIA. (PP21)

Rubbish deposit on Peixe beach



Frederic Mertens / GAIA. (35)

Sawmill in operation

operations have intensified, and agricultural activities have transformed large areas of cerrado. The Formoso Irrigation Project, for example, has affected 22,000 ha, causing many alterations to both aquatic and terrestrial ecosystems.

Agricultural expansion, and the introduction of new technology has resulted in a concentration of land-ownership (cf. Table 5 below), and a failure to generate sufficient employment to absorb the supply of labour available in rural areas (Valverde & Freitas, 1982). As well as exacerbating the social tensions (particularly conflicts over land, which are notoriously prevalent in the *Bico do Papagaio* (Parrot's Beak) area), agricultural expansion has caused environmental problems. The increasing use of agrochemicals, mechanisation and extensive monocultures grown for the external market, have caused erosion and land degradation, and serious impacts on forest and water resources, and on the biological equilibrium that helped keep pests and diseases in check.

Table III-5
Land Tenure in Tocantins State

Class of Holding	Nº of Holdings	% AREA	% of Holdings	TOTALÁREA (ha)
Very small/ Unidentified	8,043	26.7	2.6	347,894.1
Small	12,523	41.6	15.7	2,127,020.0
Medium	7,251	24.1	32.4	4,386,574.5
Large	2,288	7.6	49.3	6,667,473.5

(Source: INCRA/SNCR 1992)



Frederic Mertens / GAIA (45)

Graciosa Beach receives additional sand



Frederic Mertens / GAIA (61)

Erosion on the Natividade Bonfim road

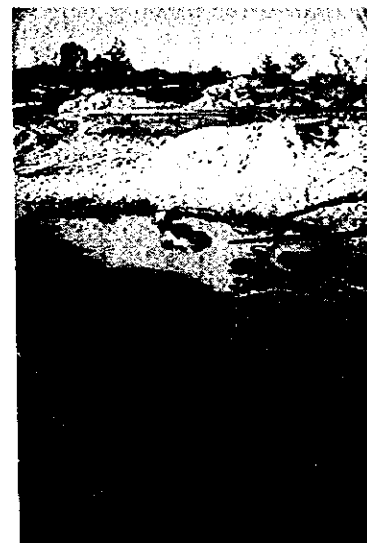
Among the various influences bringing about change in the State's environment, that of the industrial sector remains relatively small, but is expanding. The sector has not yet adopted treatment, recycling and reprocessing technologies, and thus continues to generate effluent and residues that impact directly on the environment. Industry's most common impacts are in the form of the destruction of flora and fauna, atmospheric and water pollution, and that associated with offensive odours and noise.

Water resources in the State deserve greater attention at government level. The issue is made more urgent by concerns about the number of artesian wells being installed in the State. It is thought that measures such as basic monitoring and classification of surface and ground waters could help reduce the water deficit, prevent contamination, and help determine the various uses to which available resources are to be put.

3.3 Mining

In terms of the modifications which human activity causes in the environment, those resulting from mining are perhaps the most severe. The establishment of mineral workings, and their associated processing stations and access routes involves the destruction of vegetation and the removal of soil, provoking the exhaustion of this natural resource, and releasing potentially harmful substances into the wider environment (Gass, 1984).

In the process of gold extraction, for example, pits and trenches are dug, and the gold-bearing material is scraped out. This is then crushed, producing large quantities of very fine material, which is readily dispersed and carried away as sediment in rivers and streams. Debris is piled up into spoil heaps which are left on the site. Such heaps, and the excavations from which they originate, can become unstable, and landslides may result. Gold extraction in river beds occurs on alluvial deposits, and the removal of vegetation and alterations to the stream flow cause serious damage to the environment (Gass, 1984).



Frederic Meriens / GAIA.

Mineral prospectors

In the process of gold extraction, mercury is used to separate the gold from its accompanying impurities. During this procedure, known as amalgamation, the solution containing mercury is heated, and the mercury evaporates into the atmosphere, whence it is returned to the soils and watercourses, contaminating the environment, and human health – not least, that of the prospectors themselves. Mining areas also increase the incidence of prostitution, and the transmission of venereal disease, and tend to encourage criminal activity. The extraction of other minerals, such as lime and china clay, cause similar impacts to those described above.

Frederic Meriens / GAIA (19)



Mineral prospectors

In short, the environmental impacts of mining activities arise particularly from a haphazard

approach to the activity, the lack of previous knowledge about regional geology, the indiscriminate disposal of mining spoil, the siltation of watercourses, pollution by mercury used in the amalgamation process, and the failure to implement restorative measures to reclaim the degraded areas (MAIA, 1993).



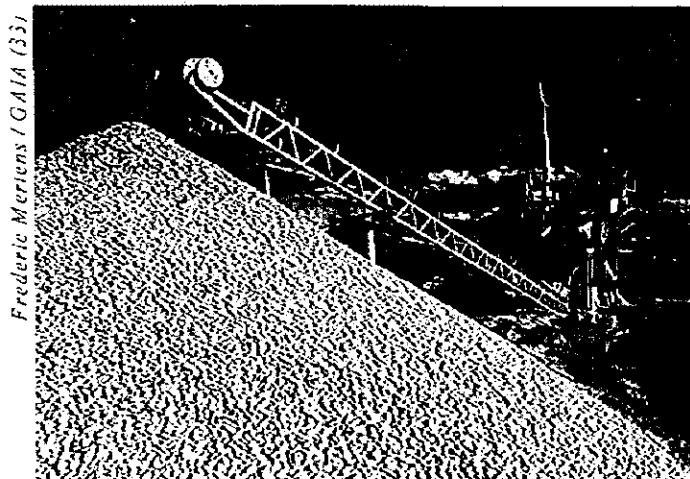
Frederic Mertens / GAIA (23)

Degradation caused by mineral prospectors



Frederic Mertens / GAIA

Quarry in the Lajeado Range



Frederic Mertens / GAIA (33)

Quarry by the Sono river in the Pedro Afonso municipality

3.4 Agrochemicals

In January 1990, Federal Decree N° 98,816 was published. This regulates Law N° 7,802, dated 11/07/89, which deals with the use of agrochemicals in Brazil, and attributes competence in these matters to federal, state and municipal environmental agencies, enabling them to act in the prevention, control and fiscalisation of the use of these products. Law N° 7,802/89 governs the research, experimentation, production, packaging, labelling, transportation, storage, trade, import, export and fiscalisation of agrochemicals, their components and related matters. In these same parameters, the Government of Tocantins sanctioned Law N° 224/90, dated 26/12/90 which regulates agrochemical use in the State. Federal Law N° 7,802/89, and State Law N° 224/90 define agrochemicals thus:

- a) the products and agents of physical, chemical or biological processes that are designed for use in the production, storage and processing of agricultural produce, on pastures, in the protection of native and planted forests and other ecosystems, and also in urban, water and industrial

environments with the objective of altering the composition of the flora or fauna so as to safeguard them from the action of living organisms that are considered harmful;

b) substances and products used as defoliant, drying agents, and growth promoters or regulators.

With regard to the impact of agrochemicals on the environment, the Special Commission's report (1989) cites the use of agrochemicals to slaughter birds in the Formoso Project area in the south-west of the State. The region is part of the Bananal Island Complex which, in the rainy season, is an important spawning ground for fish, and which therefore attracts large numbers of predators, among them birds. The birds began to cause crop damage in this, "the largest continuous irrigation project in the world", and fireworks and agrochemicals were used to combat them. The campaign resulted in the destruction of their habitats and refuges, with serious consequences for all the fauna of the locality.

With regard to the impact of agrochemicals on humans, the Tocantins State Health Secretariat recorded in 1996 and 1997, 18 and 9 cases respectively of poisoning due to agrochemicals, with the figures for 1997 covering the months January-May. Eight of the cases recorded in 1997 occurred in the municipality of Pedro Afonso where the PRODECER agricultural project has been established (cf. 4.3.3 below).

The environmental damage done by agrochemicals in the State is not recorded. Extra-officially, it is known that cases of poisoning and of death among rural labourers have occurred, and that for the most part, these accidents are not brought to the attention of the competent authorities, or are registered as being due to other causes. Given the existence of both federal and state laws governing the use of agrochemicals, it is hard to say if rural labourers use them without due precaution or consideration for the immediate and long-term harm caused by contamination, out of ignorance or because of the economic conditions in which they live (Zambrone, 1986).

In the *Bico do Papagaio* (Parrot's Beak) region, in the extreme north of the State, the use of the agrochemical "Tardon" – a defoliant used to eradicate *babaçu* palms - is very common. Its active agent is the same as was contained in another chemical product, used as a defoliant in the Vietnam War, and which is thought to have been responsible for serious health problems among the soldiers who handled it, and even for congenital defects in their offspring.

Human contamination occurs largely because of ignorance or illiteracy: adequate protective equipment is not worn, and empty agrochemical containers are re-used to hold water or milk. State Law N° 224/90, dated 26/12/90, and Article 17 of Decree N° 4,793, dated 05/11/91, state that: "The re-use of agrochemical packaging and the like, by the user, vendor, distributor, co-operative or service provider and others is prohibited". A further contributory factor is the fact that the labels of these products are hard to read, because of the small print, and the technical language in which the information they contain is expressed.

Cultural influences also affect the way the environment is treated, as can be shown by considering the saying "A stitch in time saves nine". Thus, the agricultural worker increases the dose of agrochemical he applies so as to better prevent future problems, little realising the harm he may be causing to himself and to the environment thereby.

Legislation has been passed, formalising the procedures to be followed when agrochemicals are

sold, thus ensuring the products are appropriate for the problem being addressed, and that they are used by specified people only. However, the supervisory structure needed to enforce this legislation fully is lacking, both on the part of the competent authority and that of the Regional Engineering, Architectural and Agricultural Council of Tocantins State.

The State Agricultural Secretariat, has drawn up a register of agrochemicals, in accordance with State Decree N° 4,793, dated 05/11/91, specifying those which can be used in the State. In addition to the dangers of agrochemicals themselves (cf. Table 6 below), some States in the Federation are becoming aware of the need to recycle agrochemical containers. Such procedures prevent the burning of empty recipients, and their accumulation in inappropriate places.

Table III-6
General Characteristics of Agrochemicals (by chemical group)

CHLORATES	PHOSPHATES AND CHLOROPHOSPHATES	CARBAMATES	PYRETHROIDS
Major environmental pollutant, due to persistence and lack of reactivity.	Often responsible for poisoning incidents involving agricultural workers who use them.	Often responsible for poisoning incidents involving agricultural workers who use them.	Seldom involved in occupational poisoning incidents.
Apolar, slow to degrade, persistent in food chains.	Relatively polar, so breakdown is fast; do not accumulate in food chains.	Relatively polar, so breakdown is fast; do not accumulate in food chains.	Slightly polar; reasonably fast degradation.
Neurotoxins.	Cholinesterase inhibitors: neurotoxins.	Cholinesterase inhibitors: neurotoxins.	Act on nerve impulse transmission: neurotoxins.
Sub-groups include: DDT and its analogues, BHC and lindane.	Esters of phosphoric acids or acids derived from them.	Esters of carbamic acids.	Esters of cyclopropane-carboxylic acids.

Source: Instructor's Manual, SENAR-PR (1997)

In the Course for Instructors in the Application of Phytosanitary Products, held in Palmas (TO) in 1997 by the National Rural Training Service (SENAR-PR), the Programme for the Disposal and Recycling of Empty Agrochemical Containers was presented. This involves the establishment of operational structures such as collection and storage centres, and may provide a solution to part of the problem of environmental contamination. The involvement of diverse governmental, non-governmental, and private sector organisations, especially the agrochemical manufacturers, in the implementation of this programme is crucial.

3.5 Clearing Land by Burning: The Practice of Queimadas

3.5.1 Introduction

Man's acquisition of the ability to manipulate fire has forever changed the natural and cultural history of the Earth, enabling him to interfere in natural systems in a wide variety of ways. Just as Man has assimilated fire as part of his heritage, some natural systems have adapted to anthropogenic fires and have even come to require them for their continuation.

Because of its mastery of fire, the social and cultural development of the human species was stimulated. It still had to live, however, with the catastrophic effects of uncontrolled fires, some of which would have been caused by human activity, and others by natural causes. Even having dominion over fire, men did not always use it with prudence or restraint. Also, it can be suggested that socio-economic pressures frequently distorted man's ecological role. Man sought mastery of fire because fire gave him power. With power, came the matter of choice as to its application, and thus the use of fire became part of Man's moral universe. Practices involving the use of fire reflect values, perceptions, beliefs, and economic, institutional and political influences, in short, all those things that guide Man in an uncertain world, about which he knows precious little.

3.5.2 Natural fires

In recent years scientific studies have been done regarding the role of fire in nature, and it has been shown to have occurred with a certain frequency and to have played a significant role in ecological terms (Soares: Curso de Especialização Tutoria a Distância).

Natural fires can have various origins, namely: volcanic activity, lightning strikes, spontaneous combustion, and attrition between rocks moving in the Earth's crust. Except for lightning strikes, such causes are rare, or of localised importance. Natural fires caused by lightning strikes are much more frequent and widespread, and are of recognised ecological importance, particularly in those regions where their occurrence has been scientifically investigated. Accounts of fires started by lightning in South Africa, North America and Australia are given in the literature (Coutinho, 1980).

3.5.3 Anthropogenic Fires

Man is the main cause of forest fires. In pre-historic times, anthropogenic fires were more frequent than natural ones, and thus it can be seen that his incendiary habits are hardly new (Coutinho, 1980). "Track fire, and you will be tracking human history" (Pyne). Man starts fires for very different reasons: for hunting, in war, to clear land, to ward off venomous or ferocious creatures, to facilitate honey collection, to open thoroughfares in forests, and for agricultural purposes (Soares, : Curso de Especialização Tutoria a Distância).

In the months of June and July, the traditional "*festas juninas*" are held, at which festivities it is customary to release balloons decked-out with tissue paper, and bearing rudimentary paraffin lanterns. It is thought that when these fall in places where the vegetation is tinder dry, they can start fires. In order to warn of this danger, educational campaigns are conducted on TV networks. Vareschi (1962; In: Coutinho, 1980) suggests that anthropogenic fires can also be



Queimada at night

Frederic Meriens / G.A.I.A. (IB+6)

caused by careless smokers, discarding matches or cigarette butts by the roadside.

3.5.4 The Effects of Burning (Queimadas)

3.5.4.1 Air and Soil Temperatures

One of the first effects of a *queimada*, is to raise the temperature of the locality. The *queimada*'s intensity will depend on the quantity of biomass being burnt, the speed and direction of the wind, soil moisture and other factors. Despite these several influences, scientific reports suggest that air temperatures can reach up to 800°C at the peak of a *queimada* (Coutinho, 1980).

In the soil, temperatures a few centimetres below the ground are markedly lower than those on the surface. A study, done in the *cerrado* region at Pirassununga, in São Paulo State by Coutinho (1978), showed that when surface temperature was 74°C, the temperature 50mm below the surface was only 31°C. It appears that the topsoil functions as a highly effective thermal buffer, protecting the subterranean systems of the plants.

Vareschi (1962; In: Coutinho, 1980) calls attention to the fact that solar radiation can raise surface temperatures to similar heights, and hold them constant for several hours, in contrast to *queimadas*, which generate such surface temperatures for only a few instants. The severity of temperature variations during the day/night should also be considered.

3.5.4.2 Mineral Nutrients in the Soil

Queimadas promote the re-mineralisation of the biomass, and the transfer of its mineral nutrients to the soil surface in the form of ash.

Studies done in *cerrados* by Cavalcante (1978, In Coutinho, 1980) showed there to be a pronounced increase in the concentration of certain minerals (Ca, K, Mg) in the topsoil (0.5 cm), immediately after a *queimada*, and that after 4 months or so, levels had returned to their previous concentrations. At depths of more than 5 cm, no alteration was observed, even 120 days after the fire. With regard to aluminium ions, their concentration fell to zero, and toxicity disappeared, but levels had returned to pre-fire concentrations within a few days.

Another aspect noted by Coutinho (1979) is that some of the nutrients are exported in the smoke billowing from the flames. Nitrogen (N) and sulphur (S) are elements which are volatilised fairly readily, and Phosphorous (P) is also lost at temperatures above 600°C. Nutrient loss can also occur if the ashes are taken by the wind, and Coutinho notes that while some areas are exporting nutrients, others will be importing them because of solid particles precipitating out or being dissolved in rainwater.

3.5.4.3 Flora

Fire causes various types of damage to the trees in the *cerrado*, from the wilting and loss of leaves in their canopy, to the death of their branches and trunks. Consequently, frequent *queimadas* may well hinder the growth and development of *cerrado* trees, and progressively reduce their numbers. In this way, the thickly wooded *cerradões* are opened up, and replaced by less dense *campo sujo* and eventually *campo limpo* formations.

Cerrado trees are characterised by their tortuous appearance, which may be attributed to the death of the terminal buds which are most exposed to the fire. The lateral buds survive and grow, and thus give the trees their twisted appearance. Branches and trunks that are protected by a thick covering of cork are not thus affected (Eiten, 1972; Feri, 1971b; Rizini 1971a; Warming, 1908; In: Coutinho, 1980). *Queimadas* also harm the flora indirectly when they leave the soil bare, especially in the rainy season, causing increased surface run-off and reduced infiltration, loss of the ash that is washed away, and erosion of the soil causing sedimentation of watercourses.

Certain species, however, appear to have adapted to fires. Thus, the speed and the vigour with which some species produce new buds following a *queimada* is quite surprising. Indeed, many begin the re-budding sequence by producing flowers, especially in the herbaceous/lower bushy stratum (Rachid, 1956). Another factor which may be correlated with fires is the dehiscence of fruit and seed dispersal. Once the fruits are opened by the heat of the flames, the dispersal of seed by the wind is facilitated, especially since the vegetation and straw material that had accumulated prior to the fire has been burnt off (Coutinho, 1977).

Fire may also stimulate germination by provoking changes in the seed's protective casing, and facilitating the entry of water, or by burning off the fallen leaves which may contain certain germination inhibitors. Some seeds respond positively to thermal changes, and germinate readily. Heringer (1971) noted that many seeds germinate after a *queimada*, but that repeated annual *queimadas* tended to destroy the emerging plants.

Meguro (1969; In: Coutinho, 1980) conducted a physiological study of the saxe grass (*Imperata brasiliensis*) in which he noted a floral response immediately after a fire, regardless of the time of year. If the leaves are cut back, flowering also occurs, although the response is less intense than that provoked by fire. From this, he suggested that fire may perform a dual role: it eliminates the leaves and a possible flowering inhibitor present in them and, because of the effects of the heat or the combustion gases, it promotes the production of a hormone that induces flowering (e.g. gibberelin).

3.5.4.4 Fauna

Little work has been done on the influence of *queimadas* on vertebrates. It is assumed that most of the animals flee to the *veredas* and gallery forests, or that they hide in holes in the ground or, in the case of birds, that they fly away to safety (Coutinho, 1992).

The relationship between animals and fire is somewhat dolorous, but not unnecessary. The places which most vertebrates had previously used for shelter, tend to be wiped out.



Vegetation after *queimada*

The fire moves swiftly across the land, burning all biomass, and destroying or exposing their refuges, making them vulnerable to capture by man or other predators. In this process, many species of the *cerrado* fauna have become threatened with extinction, or have had to adapt to other biogeographic systems. Fires, however, also have beneficial consequences for herbivorous species. It has been shown that fires promote re-growth. Thus they provide the surviving fauna with a vegetation that is tender, and rich in nutrients that the roots have drawn from the ashes.



Frederic Meriens / GAIA (156)

Reservoir by the Palmas-Lajeado road

3.5.4.5 Queimadas and Climate Change

Queimadas provoke chemical changes in the lower levels of the atmosphere (troposphere), with the release and formation of toxic gases. These gases, especially carbon monoxide (CO) and ozone (O³) can cause yield losses in crops, and respiratory tract cancers in humans (Kirchhoff, 1992).

Studies done by Kirchhoff during the rainy season, recorded 30 and 110 ppbv (parts per billion by volume) for O³ and CO respectively, and subsequently, during the *queimada* season, levels of 80-100 ppbv for O³, and up to 1,000 ppbv for CO, with the greatest concentrations occurring at heights of 1.5 - 2 km above the Earth's surface.

3.6 Queimadas in Tocantins State

There is no doubt that Man is currently the main cause of fire in vegetation, and that the number and frequency of these fires exceeds that of naturally occurring fires in pre-human times.

Queimadas are one of the features of Tocantins State, and are most evident in the months from June through October. Their purpose is obvious: to clear the remaining vegetation in deforested areas, dispose of crop residues (Costa, 1980), and to "clean" pastures of dry, fibrous grass that is of little use for grazing. It should also be mentioned that there are people who derive enjoyment from seeing the forests bursting into flame, and the Lajeado Range is often the subject of their attentions, especially in the dry months when, from Palmas, a line of fire, kilometres long, can often be seen lying across the range like some immense, reddish serpent.

According to data from the National Institute for Space Research (INPE), and PREVFOGO/IBAMA using satellite imagery from the NOAA satellite, Tocantins has been classified as one of the three states with the highest incidence of heat foci in the years 1990-1996, with the exception of 1993 when it came in fourth (cf. Table 7 below).

Table III-7
HEAT FOCI IN STATES IN THE NORTHERN REGION, 1990-1996

State / Year	90	91	92	93	94	95	96
Acre	708	529	191	435	248	96	20
Amapá	182	95	0	05	01	07	06
Amazonas	783	1265	871	2038	3770	593	91
Maranhão	70410	56814	16635	14190	2983	11846	2103
Pará	14495	43103	27718	15507	12180	11814	7977
Rondônia	6058	17878	4997	7529	5651	7252	1211
Roraima	-	-	-	-	-	-	0
Tocantins	73029	80913	28210	18338	10528	15809	4318

Source: PREVFOGO/IBAMA, Instituto Nacional de Pesquisa Espacial – INPE.

An analysis of the heat foci observed in the State of Tocantins shows that their number is diminishing over the years. The suggestion presented here is that this diminution can be attributed to economic factors, particularly the shortage of capital which has afflicted rural producers, and the low technological uptake. Over the past decade, as part of the efforts to reduce still further the incidence of *queimadas*, and to change current practices, government environmental agencies (IBAMA and NATURATINS) in partnership with NGOs and trade unions, have conducted educational campaigns involving speeches, puppet shows in schools, sketches on TV and printed leaflets, posters etc.

By law, the practice of *queimadas* may be undertaken provided legal restrictions, contained in Laws N° 4,771, dated 15/09/65, N° 6,938, dated 31/08/81, Articles 2 and 14, and the Brazilian Penal Code, Article 250, are obeyed, and the required authorisation for a "Controlled *Queimada*" is given by the competent agency. Costs of this authorisation currently stand at R\$3.00 for areas of up to 13 ha, and for areas greater than this the charge increases by R\$3.00 for each additional hectare burned. There have been cases of people wrongfully using *queimadas* to clear more than 50% of their properties.

Authorisations are issued at the IBAMA offices in 8 localities: Palmas, Arraias, Dianópolis, Tocantinópolis, Araguaçu, Araguatins, Gurupi, and Araguaína. Each of these encompasses a radius of approximately 280 km. The system is unable to cover the more distant townships, which makes authorisation there difficult. Another relevant factor is that small-holders consider authorisation to be an expensive business.

According to an IBAMA official in the State, there are few requests for copies of the "Terms of Responsibility and Permission for Controlled *Queimadas*". In 1995, 37 authorisations were issued, covering a total area of 2,883 ha, and 48 in 1996 for a total area of 3,571 of which 50% were undertaken to clear pastures.

Restrictions on the use of fire are also imposed by financial organisations that operate in the agricultural sector, such as the Banco da Amazônia S.A., which may insert special clauses prohibiting the use of fire for land clearance or the "cleaning" of pastures.

Rural small-scale producers know through practice, that “stump farming” – deforesting an area and then burning it clear – can yield good harvests, with fewer pests and diseases. But they also know that it is periodically necessary to open up new areas on which to grow crops, because the land soon becomes “weak”. It is then abandoned and secondary vegetation covers it. In short, a form of rotational farming occurs.

Some people have attempted to improve the management of their pastures by restricting the frequency and intensity of *queimadas* so to maintain soil fertility. One such is the manager of a farm in the *Bico do Papagaio* area, Sr Edinho, who hoes the land in January and February “so that the edible grasses overtake the weeds. Then the cattle are put on, and they trample it down, reducing the intensity of the fire by 50-60%. Give pastures a good hoeing during the rainy period, and then in October singe them back after the first rains, burning along the stream banks as well. Fire is not necessary every year, what dictates whether you need it or not is the state of the pastures.”

Coutinho (1993), suggests that *cerrado* areas need 3 years to replace the nutrients lost in *queimadas*. The subject is still inadequately documented, and one of the factors which hinder this is the sheer size of the *cerrado* domain, and its wide variation in latitude (Latitudes 4°-25°S).

3.7 Epilogue

One point worth noting in this, is the fact that Man can only create an appropriate habitat by acting directly on his surroundings, transforming his space to ensure his survival, and being aware of this process. Different forms of relationship between Man and ecosystems have been observed throughout history. The current development model, founded on the rationalisation of maximum profit and short-term economic surplus, has been severely detrimental to ecosystems because of the scale of Man’s repeated intervention, and his intensification of the rhythm of resource exploitation and consumption, oblivious to natural cycles and the environment’s regenerative capacity. Ecosystems, however, provide the physical support that is essential for the whole productive system, and the growing awareness of this fact may have a transformative influence, working to promote a new set of social and cultural values, associated with intelligent restraint, and communal practices of natural resource use (Nana, 1994).

4. Environmental Management in Tocantins : Actors and Actions

This Chapter gives an overview of the main agencies, both governmental and non-governmental, that are active in the environmental field in Tocantins. It then focuses on environmental problems and initiatives arising from large-scale projects in the agricultural sector. It moves on to outline the main obstacles confronting environmental management in the State, and concludes by making appropriate recommendations.

4.1 Government Environmental Agencies

4.1.1 Federal Agencies

4.1.1.1 The Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA)

The Tocantins Branch of IBAMA is responsible for implementing the Institute's plans, programmes and projects in the area under its jurisdiction, and for supervising the activities of the Training and Research Centres, aquaculture installations, Conservation Areas and all other units under its control. Technical control of its operations is exercised by the Directors of the organisation, and it is administratively subordinate to its President. The remit of the Tocantins branch of IBAMA includes the following:

- I. To propose the development of activities that deal with specific environmental problems and the protection and conservation of renewable natural resources throughout the State.
- II. To undertake studies and make proposals regarding the designation of new Conservation Areas;
- III. To analyse, evaluate, and submit for the consideration of IBAMA's central authority proposals for action presented by the various sectors of society and public institutions at State and municipal level;
- IV. To organise, direct and co-ordinate the implementation of the proper activities of the Institute;
- V. To fulfil the administrative tasks pertaining to the Institute at State level;
- VI. To undertake, throughout the State, other activities of a technical nature for which the Institute is responsible;
- VII. To supervise, under the technical guidance of the various Directorates, the administration of the Training and Research Centres, aquaculture installations, Conservation Areas, and other decentralised operations which implement the Institute's activities in its area of jurisdiction;
- VIII. To ensure, jointly with the State Secretariat for Planning and Co-ordination, the articulation of the Institute's actions with those taken by State and municipal agencies.

4.1.1.2 Environmental Programmes and Projects Undertaken by IBAMA-TO

- **Projects for the Development of Fishing and Aquaculture:**

FOMPESC – Regulation of the Fishing Industry

PROJORD – Promotion of the Fishing Industry

- **Projects for the Protection and Conservation of Ecosystems:**

ESPELEOGIA – Protection and Conservation of Natural Subterranean Caves

MANFLOFAUC – The Protection and Management of Flora and Fauna

RPPN – Surveys for the establishment of Natural Heritage Nature Reserves

VISTZORD – Surveys for the establishment of zoos, orchid collections etc

- **Projects for the Management of Forest Resources:**

PROJREP – Reforestation Projects

PROJFOM – Projects for the Promotion of Forestry

PROJODFLO – Projects for the Regulation of Forestry

4.1.2 Tocantins State Agencies

4.1.2.1 The State Planning and Environment System (SEPLAN)

Administrative changes introduced under Law N° 791/95 created the State Planning and the Environment System, by merging the Secretariat for The Environment and Water Resources, with the Planning and General Co-ordination Secretariat. Among the legal attributes of this agency are:

1. The planning and co-ordination of policies for the environment, natural resources and sustainable development;
2. The Agro-Ecological Zoning of the State;
3. Policy for the management of Water Resources.

4.1.2.1.1 SEPLAN's Environmental Programmes and Projects

The programmes and projects set out in SEPLAN's Pluri-Annual Plan are in keeping with the legal remits of the various environmental agencies of the State and reflect the need for the institutional strengthening of these same agencies.

4.1.2.2 The Tocantins Nature Institute (NATURATINS)

NATURATINS is a self-governing body which is linked to SEPLAN. It participates directly in decisions regarding the environmental planning of the State. Its responsibilities include the implementation of plans, programmes, projects and activities of environmental conservation. Established on 30 June 1989 by means of Decree N° 1,100/89, it became an Institute under Law N° 858/96. Its main objective is to establish norms and standards of environmental control, and to monitor compliance with the relevant legislation. NATURATINS is also permitted to undertake

personnel training, and the provision of certain services.

Naturantins has a duty to safeguard the quality of life for the community, through protection of the natural environment, as mandated by Law N° 261/91. In spite of the many obstacles it faces, NATURATINS seeks to establish guidelines and norms, and thereby guarantee the establishment of a system of monitoring control and environmental inspection, which will enable more effective control of environmentally degrading activities.

The agency plays an important role in the conservation of the State's natural resources. It invests in environmental education and in the training of its staff so as to guarantee the sustainable development of Tocantins. In this context, the principal responsibilities of NATURATINS are:

- To grant environmental licenses to businesses whose activities are polluting or degrading;
- To analyse environmental impact assessments (EIAs);
- To evaluate environmental impacts;
- To call public enquiries;
- To develop programmes and projects in the fields of environmental education and technical/scientific education;
- To promote exchange, conventions, contracts and agreements with national and/or international agencies and organisations.

4.1.2.2.1 Environmental Programmes Run By NATURATINS

- Environmental Education Programme: effected with the participation of the community in urban and rural schools with the aim of inculcating a sense of responsibility for environmental conservation.
- The Ecological Exploration Programme: presenting to, and discussing with the community environmental concepts such as ecosystems, biodiversity and sustainable development.
- The "Tocantins on the Beach" Programme: environmental education on the beaches in the Araguaia-Tocantins river basin. This programme is undertaken in partnership with governmental and non-governmental organisations.
- The "Piracema" Programme: *Piracema* is the season during which fish migrate to their spawning grounds in lakes and rivers. During this season fishing in the Araguaia-Tocantins river system is only permitted if the practitioner is in possession of a suitable licence and using hand lines or fishing rods.
- The Inspection and Environmental Licensing Programme (SELA).
- The Decentralisation Programmes (PRODESCEN): designed to ensure the integration of municipal, State and federal actions, by establishing ten Regional Environmental Offices, as shown in Table 8 below.
- The Pilot Programme for the Conservation of the Brazilian Amazon Forest (PPG-7): this includes monitoring and zoning activities as part of the various integrated sub-projects, and provides for the institutional strengthening of State environmental agencies.
- Programmes for the Study and Establishment of Conservation Areas:
 1. The Lajeado Range APA;
 2. The Foz do Santa Tereza APA;
 3. The Bananal Island/Cantão APA;
 4. The State Park of Cantão-Casara;
 5. The Itapiratins Ecological Reserve;

Table III-8
NATURATINS OFFICES IN TOCANTINS

PROGRAMME AREA	TOWN/CITY
Extreme North (Bico do Papagaio)	Araguatins
North	Araguaína
North-East	Itapiratins
North-West	Couto Magalhães
Central	Palmas
East (Jalapão)	Mateiros
South	Peixe
Central West	Caseara
South-East	Dianópolis
South-West (Bananal Island)	Lagoa da Confusão

6. The State Park of Encontro das Águas (Esperantina, TO).

Programme for the Sustainable development of Indigenous Communities: esigned to present alternative strategies for the appropriate use of natural resources in accordance with indigenous cultural tendencies. The pilot project features apiculture, aviculture, fish-farming, frog-farming, horticulture and environmental education.

4.1.2.2.2 Environmental Projects Run By NATURATINS

Project S.O.Ss. Taquarussu: raising the awareness of people in he Taquarussu locality so as to halt deforestation in the gallery forests, to protect the River Taquarussu from pollution, and avoid the elimination of the aquatic fauna.

Project SOS Queimadas: *Queimadas* refers to the technique of using fire to clear land and stimulate re-growth in cattle pastures (cf. 3.5 - 3.6, above). The Project operates in the period from June through October and focuses on the problem of indiscriminate burning, offering solutions through environmental education initiatives directed at rural land-holders.

Project Peixe Vivo: seeks to safeguard fish and their young which become stranded in irrigation channels, roadside borrow pits and natural lakes. It runs during the dry season (June-September) in the region of Lagoa da Confusão and Formoso. It is financed by the National Environment Fund, and works by encouraging farmers to build drainage channels and escape lagoons so as to avoid



Frederic Mertens / GAIA (ib55)

The Quelónios Project, set up to protect fresh-water turtle populations



Frederic Mertens / GAIA (ib52)

the stranding of fish, and thereby help ensure the preservation of species.

The Tocantins Quelônios Project: designed to protect freshwater turtles, this project is run in the municipality of Lagoa da Confusao on a 50 km stretch of the Formoso River during the months of August through December (the egg-laying season). The Project was begun in 1995, and has so far overseen the hatching of 90, 000 young turtles.

The Municipal Abattoir and Land Fill Project: begun in 1996, this project targets municipal councils. It guarantees environmental control through adequate physical installations, effluent treatment systems and the protection of ground water and watersheds, with the construction of a special unit for domestic and hospital refuse. The project also encompasses the establishment of units for the composting of organic waste, and for the selective collection and recycling of inorganic waste.

The Mobile Environmental Unit: this project is designed for distant communities, enabling them to have access to environmental education. It consists of a vehicle and trailer equipped with a TV, video player, books, slides and a fully-trained crew.

4.1.2.3 The Tocantins State Environment Council (COEMA-TO)

The Tocantins State Environment Council is a deliberative, collegiate body, that is part of the organisational structure of SEPLAN. The office of President of COEMA is held by the Chief Secretary of SEPLAN, and that of the Vice President by the Executive Director of NATURATINS. COEMA-TO was created by Law N° 261/91 and regulated by Decree N° 33/95. Its main responsibilities are:

- To oversee and guide environmental conservation policy so as to improve the quality of life;
- To establish guidelines for the evaluation, full appreciation, and approval of Environmental Impact Assessments (EIAs)
- To consider, and give an opinion on activities proposed by NATURATINS or SEPLAN when requested by representatives of these organisations;
- To take decisions about the protection of flora and fauna, and about the practices which endanger them;
- To decide, jointly with federal bodies, about the establishment of ecotourism projects within the State, requesting EIAs for the same, and requiring procedures which do no harm to ecological cycles.

The organisational structure COEMA-TO is as follows: (1) Presidency (2) Plenary Assembly (3) Executive Secretariat (4) Councillors.

4.1.2.4 The Public Ministry of Tocantins State

The Tocantins Public Ministry acts through its District Attorneys' Offices which have been established in all 45 judicial districts of the State, thus taking in all of the State's municipalities. In each judicial district, the District Attorney's Office functions as the executive organ for the Public Ministry. Each District Attorney is invested with the power and the duty to ensure environmental protection through preventive or representative means. Each District Attorney is responsible for taking all administrative and judicial measures necessary within his/her jurisdiction

to investigate and act upon the denunciations which are brought to his/her attention.

It is worth highlighting the creation of District Attorneys' Offices specialising in Environmental Issues, under the complementary Law N° 12. To encourage integration and exchange between the various offices, the same Law provides for the designation of one of the District Attorneys from the State capital, Palmas, to ensure the co-ordination of the Operational Support Centre.

Thus, it can be seen that the Public Ministry has the legal capacity to act throughout the State of Tocantins. Each District Attorney's Office can act either in isolation, or in conjunction with other bodies and agencies engaged in safeguarding the environment.

4.1.2.5 The Independent Company of Environmental Military Police

The Independent Company of Environmental Military Police was created under Law N° 225/90, dated 26/12/90. It is an offshoot of the Tocantins State Military Police which is responsible for ostensive policing in the state. It was set up with a view to fulfilling the constitutional stipulations regarding environmental conservation. It maintains active contact with local communities, schools, universities, governmental and non-governmental environmental organisations in the realisation of environmental education.

4.1.2.6 The State Commission for Agro-Ecological Zoning (CEZEE-TO)

The Tocantins State Commission for Agro-Ecological Zoning is a part of the organisational structure of SEPLAN. The office of Co-ordinator General of the CEZEE is vested in the Chief Secretary of SEPLAN. The Commission is responsible for analysing, approving and following up the agro-ecological zoning exercises conducted by the Zoning Directorate of SEPLAN. It also has the job of liaising with the Federal Government through the Co-ordinating Commission for Agro-Ecological Zoning to ensure compatibility with the Agro-Ecological Zoning carried out by Federal authorities.

The CEZEE-TO was created under Legal Decree N° 5,562/92, dated 30/04/92, and was given the following powers:

- The Commission Co-ordinator can invite representatives from non-governmental organisations or from government and private institutions to participate in its meetings and/or in the agro-ecological zoning exercises.
- The General Co-ordination section of the Commission is authorised to contract experts in specific issues, and also to draw up such agreements with organisations in the public or private sector as may be necessary to ensure the viability of agro-ecological zoning in Tocantins, in accordance with current legislation.
- The human resources necessary for carrying out the activities involved in the agro-ecological zoning of Tocantins State can be requested from the State Secretariats and from other parts of the State administration, or from federal institutions, non-governmental organisations (NGOs) and private companies.

The structure of the CEZEE is as follows: (1) General Co-ordination (2) Plenary Assembly (3) Executive Secretariat.

4.1.2.7 The State Agricultural Secretariat (SAG)

The remit of the State Agricultural Secretariat involves the development of agriculture and cattle ranching, hunting and fishing, agrarian organisation, climatology and meteorology, research and experimentation and the maintenance of hygiene standards in plant and animal production. Among its activities are the promotion of fish farming, the production of tree saplings and of natural plant essences. Soil and water conservation projects, and projects involving rural extension, are carried out by RURALTINS (The Rural Development Institute) which encourages the introduction of sustainable agricultural techniques and environmental education.

Together with NATURATINS and the Health Secretariat the SAG is responsible for executing Decree N° 4,793/91 which regulates Law N° 334/90 relating to the production, packaging, transport, storage, trade, use and composition of agrochemicals, the disposal of their packaging and similar matters, throughout Tocantins.

4.1.2.8 The State Commission for Environmental Education

The State Commission for Environmental Education is made up of representatives of governmental and non-governmental organisations. Its general objective is to promote Environmental Education at all levels of schooling, and to raise the awareness of the community at large, fostering an integrated understanding of the environment. The Tocantins State Environmental Education Programme was initiated by Decree N° 1,011/90, dated 15/05/90. The specific objectives of the Programme are:

- I. To encourage teachers in urban and rural schools to incorporate environmental themes into the curriculum, in an interdisciplinary fashion;
- II. To support formal and informal Environmental Education initiatives, facilitating the effective integration of the community in the educational process;
- III. To support and encourage the participation of different sectors of society in the formation of environmental, social and cultural policies;
- IV. To ensure the participation of organisations from civil society in public enquiries.

4.1.2.9 The Tocantins State Secretariat for Transport and Public Works (SETO)

With the advent of the Programme for the Management of the State Highway Network, partially financed by the World Bank, the Environmental Unit of the State Secretariat for Transport and Public Works was set up at the request of the World Bank so as to manage environmental issues arising from the Roads Programme. The Environmental Unit began operations in early 1995. It maintains close links with the Planning and Technical Departments of SETO that are responsible for the management of the Highways Programme.

4.1.2.9.1 SETO's Environmental Unit

Functions of the Environmental Unit:

- To accompany and monitor proceedings with a view to ensuring environmental protection;

- To guide and advise SETO on environmental matters;
- To undertake reconnaissance surveys of the natural resources within the zone of influence of highways;
- To evaluate, analyse, classify and quantify the impacts generated by the construction, maintenance, improvement and operation of highways (surveys and EIAs/EISs);
- To carry out checks to ensure that projects comply with environmental requirements;
- To monitor the short, medium and long term effects of investments in roads so as to evaluate investments, and guide future projects;
- To check, analyse, and give opinions on EIAs and EISs;
- To specify and provide estimates of the costs of actions proposed in the same EIAs and EISs;
- To inform and to express opinions on processes which have a bearing on the environment;
- To represent and/or to participate in the representation of SETO in the contacts which are necessary with other organisations and institutions in efforts to resolve environmental problems relating to the highways under SETO's jurisdiction, including those contacts made with the organisations responsible for Environmental Licensing.

Actions of the Environmental Unit:

- Undertaking environmental surveys of the road building operations;
- The submission of reports on these surveys to the World Bank;
- Proposals for the resolution of the environmental problems set out in these same reports;
- Providing on-site guidance for construction companies so as to avoid, mitigate or compensate for the environmental impacts which have been identified;
- The presentation of reports to NATURATINS so as to assist that agency's monitoring work;
- The elaboration of an Environmental Action Plan designed to mitigate the impacts arising from the asphaltting of various stretches of highway, as identified in the EIAs. This Plan will be put into effect during the period October 1996 - December 1997.

4.2 Environmental NGOs

4.2.1 NGOs in Tocantins State

4.2.1.1 GAIA – The Association for Environmental Conservation and Sustainable Food Production of Amazônia

GAIA, a socio-environmental organisation which was founded in 1990, has established itself as one of the most active NGOs in the capital and in the State as a whole. Its administrative structure is as follows: (1) Executive Council [7 members] (2) The President of the Council (3) The Executive Director (4) Project Co-ordinators. The voluntary work done for the Association by students, and by professionals such as journalists, biologists, lawyers and agronomists is of great importance for the realisation of the NGO's activities.

GAIA's Objectives:

- To contribute to awareness-raising so as to protect the environment;
- To undertake social and environmental projects so as to improve the quality of life;
- To call attention to environmentally and socially harmful activities;
- To publicise examples of environmental conservation and promote discussion of major global issues;

- To participate in, to guide and to undertake activities which help improve the quality of life and the preservation of ecosystems;
- To organise various types of activity (educational, social, etc.) for its associate members;
- To put forward proposals on environmental matters for the attention of government, civil institutions and society as a whole.

Areas of Activity:

- Environmental Education
- Food Production
- Drawing attention to environmentally and/or socially harmful activities
- The provision of technical advice to the community

4.2.1.1.1 GAIA's Environmental Projects and Activities

1-The Nursery Project for the Production of Fruit Tree Saplings and Medicinal Herbs

This Project which began in 1994 seeks to produce and distribute fruit tree saplings and plants with medicinal properties which are native to the *cerrado* region. It is run for the benefit of poor communities on the outskirts of Palmas, and small-holders in neighbouring areas, seeking to improve people's diets and encourage the cultivation of fruit trees in the State.



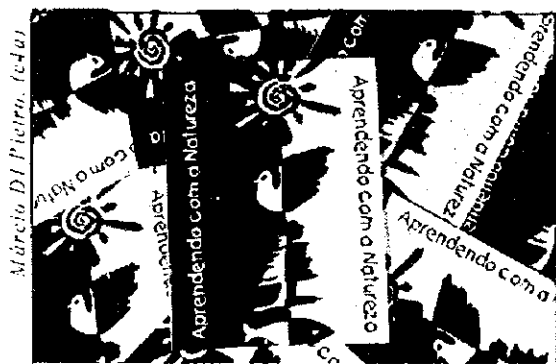
Márcio Di Pietro.(M.F)

Nursery producing fruit-tree saplings

Achievements: 95,000 saplings produced and distributed.
Area Benefited: Palmas and the surrounding municipalities.

2 -The Environmental Reader Project : “Learning with Nature”

In 1995, GAIA brought out a book of texts on regional environmental themes geared towards teachers in the public schools of Palmas. The modular structure of the book allows the teacher to choose themes which he/she considers most relevant for his/her pupils. The five themes dealt with in the book and in the teacher-training course are: The Town, Water, Fire, The Beach, and Bananal Island (biodiversity).



Márcio Di Pietro. (c4a)

Gaia's "Learning with Nature" project in action

At the request of primary school teachers, the teacher-training courses were also offered to their colleagues in secondary school, and to teachers in rural areas. In all, GAIA's Project team held 8 teacher-training courses in 1996. In 1997, training was given to teachers in the town of Tocantinópolis.

Achievements: 680 teachers trained in the use of the reader "*Learning with Nature*"; 900 copies of

the reader have been distributed.
Area Benefited: the Palmas metropolitan area and other areas in the State.

Evaluation of the Environmental Reader Project: participation Rate: 75% of teachers invited attended the training courses; 90% of those who participated considered the training courses to be well-organised and clearly presented. Greater interest among teachers in environmental education has been registered.



Marcio Di Pietro (c4b)

3 -The Beach Project: Environmental Education on the Beaches

In the dry season (June-September) beaches are formed in several municipalities of Tocantins State on the banks of the Araguaia and Tocantins Rivers. These beaches serve as recreational amenities for local inhabitants and for tourists from other regions of Tocantins (who make up 60% of all visitors [SEBRAE,1995]), from neighbouring States, and even from other countries. To cater for the influx of visitors, infrastructure (e.g. commercial premises, camping areas etc) is established on the beaches.



Frederic Mérens / GAIA (pp47)

Graciosa beach, summer of 1996



Frederic Mérens / GAIA (pp32)

Environmental Education on beach

Each year the number of tourists increases, thus aggravating environmental problems such as the waste generated by the visitors, the destruction of the gallery forests and problems relating to public hygiene and noise pollution. Consequently there is a need to raise the awareness of the people who visit the beaches so that they avoid damaging the amenity value of the beaches which they have come to enjoy.

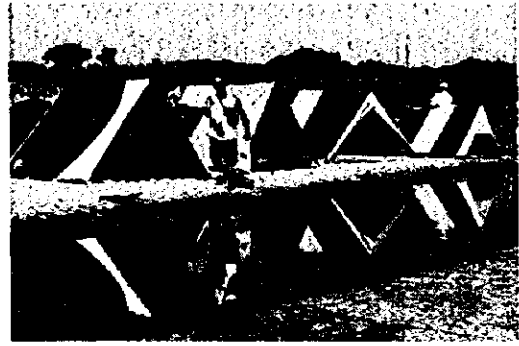
The Beach Project's objectives are:

- To raise the awareness of beach visitors about the need for environmental conservation, informing them of the importance of the gallery forests and the protection of the flora and fauna of the locality.
- To give guidance regarding litter management to the local municipal authorities, owners of commercial premises on the beach and beach visitors, and also to discuss ways of

maintaining acceptable standards of hygiene in the sanitation facilities provided for the public.

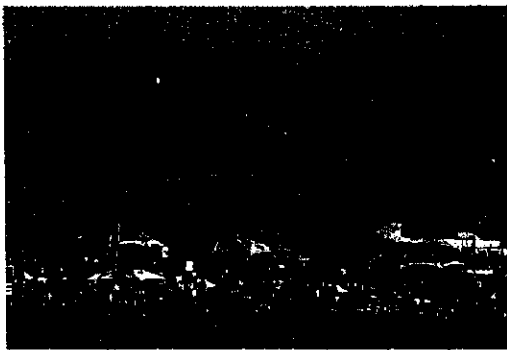
To undertake educational and leisure activities demonstrating the recycling of rubbish and community living.

Achievements: The Beach Project has run during the month of July for 4 years consecutively on the beaches of Araguacema and Lagoa da Confusão, for 3 years at Graciosa Beach (near Palmas) and for one year at Peixe Beach.



Frederic Meriens / GAIA. (pp07)

Environmental Education on beach



Frederic Meriens / GAIA. (pp50)

Graciosa beach (near Palmas), summer of 1996

Evaluation of the Beach Project:

In 1996, Dominic Harbinson, an English university student, carried out an evaluation of the Beach Project, and suggested that although GAIA was playing a valuable role, action by municipal and State authorities was also needed to counter the environmental impacts of tourism on the river beaches.

4 - Project Video: Production of Educational Videos on Environmental Themes

In this project, video clips of 30 seconds duration on environmental themes are produced and broadcast on TV networks. Documentaries on social and environmental matters in Tocantins, and videos registering environmental events are also produced.

Total Video Production over 4 years:

-95 video clips (30 seconds) for TV, and seven 12-minute documentaries;

Area covered:

-Regional/State-wide

5 - Executive Secretary of the Working Group on Amazônia, Tocantins Division (GTA-TO).

GAIA was elected Executive Secretary for the Tocantins division by the General Assembly of the Working Group on Amazônia. The GTA-TO is made up of more than 40 different small-holder associations and environmental NGOs. In its role as Executive Secretary for the GTA-TO, GAIA organised three workshops on the elaboration of proposals for funding from the Demonstrative Project Sub-Programme of the PPG-7. The workshops were held in the regions of Araguaína, Palmas and Gurupi, and were attended by small-holder associations and environmental NGOs.

6 - Agroforestry Project

The agroforestry project involves 40 small-holders in the state of Pará. It includes activities such as fish-farming, apiculture and the use of leguminous species for increasing soil fertility.

7 - Other Activities

- Talks on environmental themes for urban neighbourhood associations and rural small-holders' organisations, schools and universities.
- Technical advice and assistance for the Vila União, a poor neighbourhood on the outskirts of Palmas.
- A course on environmental issues for 60 new recruits to the Palmas Metropolitan Guard.
- The organisation and presentation of Environment Prizes (including the "GAIA Trophy") sponsored by CELTINS (the Tocantins State Electric Utility Company) every year since 1994. Prizes are awarded for environmental action and for the best environmental projects undertaken in the State.

4.2.1.2 The Tocantins Ecological Association (ATE); Porto Nacional (TO).

Objectives:

- Nature conservation
- Promoting the establishment of conservation areas
- Making efforts to improve the environment and human health

Thematic Areas:

- Water resources
- Flora and fauna
- Conservation areas
- The urban environment
- Waste management
- Government policy

Projects and Activities Undertaken by the ATE

- Selective collection of rubbish
- Environmental education in schools and community associations
- Work on the beaches of the Tocantins River
- Activities in support of social movements, trade unions, human and civic rights
- Monitoring activities
- Projects with local communities

4.2.1.3 The Consumers' Association for Reforestation and the Environment (ARFA)

This non-profit making organisation represents associations of consumers of forest products and their sympathisers. It was founded in 1996.

General Objectives:

- To participate in building a free, just and united society;
- To undertake actions which ensure the biological, physical and social welfare of future generations;

- To elaborate and undertake actions for the preservation, afforestation, reforestation and management of forests;
- To maintain exchanges with environmental organisations;
- To encourage and to undertake natural resource management projects.

Activities undertaken by ARFA:

- Production of tree saplings
- Organisation of seminars

4.2.1.4 The Environmental Society of Lajeado (SAL); Lajeado (TO).

This society was established in 1996, and its actions focus on environmental education in the community, addressing the environmental problems caused by rubbish in the “*Cidade Limpa*” (Clean Town) Project.

4.2.1.5. Paraíso Verde: The Association for Environmental Preservation and Sustainable Development; Paraíso (TO).

Paraíso Verde is a non profit-making socio-environmental organisation which seeks to improve conditions in the municipality of Paraíso. Its objectives are:

- To work towards sustainable development
- To enter into partnership with public agencies, NGOs and national and international bodies;
- To promote ecotourism and the preservation of the region’s hydrological and botanic potential;
- To encourage and develop research centres for the preservation of watersheds and of the flora and fauna.

4.2.1.6 Natureza do Tocantins; Tocantinópolis (TO).

Established in 1997, this association campaigns for environmental conservation in the Tocantins-Araguaia river basin. Activities undertaken by Natureza do Tocantins include:

- Project in defence of the River Tocantins
- The realisation, in partnership with GAIA, of training for the teachers in the municipal and state school networks, namely the Environmental Reader Project “*Learning with Nature*” (cf. 4.2.1.1.1 above).
- The realisation of a training course in Environmental Education for educational co-ordinators and supervisors in partnership with the State Education Secretariat and Tocantins State University (UNITINS).
- The organisation and co-ordination of Environment Week in Tocantinópolis in partnership with governmental and non-governmental organisations.

4.2.1.7 The Ecological Movement of Tocantins (METO)

METO was set up in the municipality of Palmas where it undertakes environmental education activities directed at children. It has several years of experience in this field, and boasts an Ecological School in the capital, where visitors are received and talks and other educational activities are held.

4.2.2 Regional NGOs

4.2.2.1 The Working Group on Amazônia (GTA); National Headquarters: Brasília (DF).

The Working Group on Amazônia is a network of organisations which have come together to represent the interests of their affiliates and to promote the participation and interests of civil society, especially the poorer rural communities, in the process of sustainable social, economic and environmental development in the Legal Amazon region. Members of the GTA network in each of the Amazon States are elected to co-ordinate the activities undertaken in their State, and to liaise with the wider GTA organisation. The objectives of the GTA are

- Training personnel
- Identifying partners
- Improving communication
- Making planning viable
- Delegating responsibility
- Ensuring the smooth working of the GTA structure
- Setting guidelines for projects
- Monitoring projects

A list of the organisations co-ordinating the GTA network in Tocantins, and of the network members in the State are included as Appendixes V and VI respectively.

4.3 Environmental Analysis of Agricultural Development Projects in Tocantins

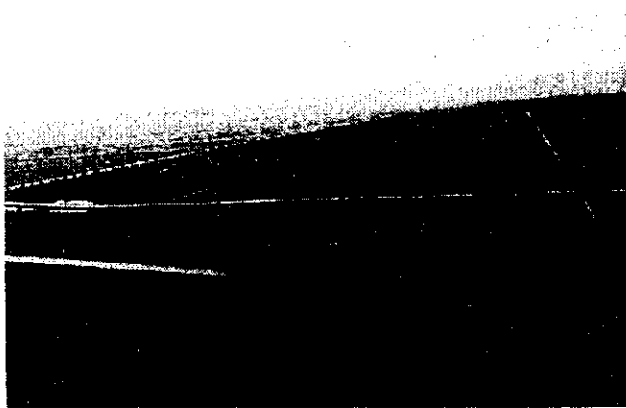
4.3.1 Agricultural and Ranching Activities in the Cerrado

The occupation of the *cerrado* began in the 18th century with the establishment of the first settlements. Some areas of the states of Tocantins and Maranhão were settled in the 19th century by people moving from Belém along the Tocantins-Araguaia river systems. The expansion of agricultural and ranching activities in the *cerrado* region, however, did not occur in a uniform manner.

The agricultural potential of the *cerrado* has attracted much investment, and generated significant changes with the establishment of infrastructure such as reservoirs, roads and support industries stimulating urbanisation and population growth in some towns. These developments can be attributed to the fact that the *cerrado* lands represent one of the last areas of the country which can be immediately converted to cereal production or pastures for livestock.

The root causes of current environmental problems can be traced back to the economic model which came to prevail in the region, one which was geared towards immediate profit with no concern whatsoever for wider environmental issues. Exacerbating this situation is the dearth of scientific research into the *cerrado* which hinders the emergence of concrete proposals for environmental and spatial organisation.

In terms of the commercial crops grown on the *cerrado*, the production of rice has fluctuated but, especially since 1990, there has been a considerable expansion of soy bean and maize production.



Luciano Ribeiro

The Rio Formoso

4.3.2 The Formoso Project

The Formoso Project is located in the Araguaia river basin. It covers a total area of 25,000 ha, of which 22,000 ha have already been made operational. In these areas, the main crop is irrigated rice, which is grown using the floodwaters from the Formoso River, or by pumping water from reservoirs. Other crops are being tried out, such as soya bean for seed production in a semi-irrigated system between harvests, and also maize

for grain production. The project has achieved very high yields and there has also been research by UNITINS and EMBRAPA looking into the introduction of sunflower crops, and the suitability of various rice cultivars.

The Formoso Project was set up prior to the advent of the law requiring Environmental Impact Assessments and virtually no provisions were made for environmental management.

Environmental Problems

Large, continuous areas in agricultural use are prejudicial since they facilitate attack by pests and diseases. Populations of pests such as rats have increased due to favourable conditions, notably the abundant supplies of food and water in the locality. The irrigation channels serve as habitats for the rats. These conditions provoke an environmental imbalance, and production losses of up to 10% of the rice crop. The indiscriminate use of agrochemicals to control the rats has also caused the death of animals which fed on the rats' remains.



Marcio Di Pietro

Soybean production -



Marcio Di Pietro (c4e)

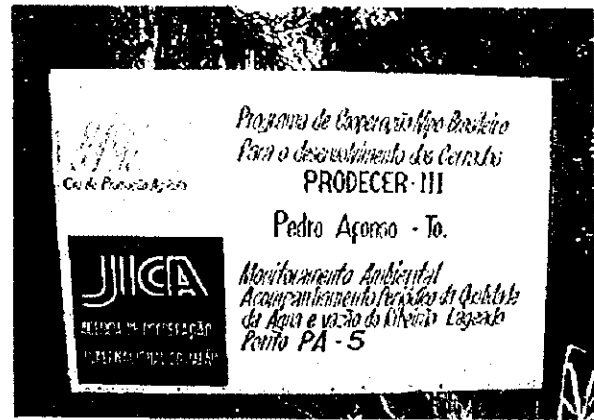
Rice production - Formoso Project

Control Measures

The agrochemical Klerat, which causes the rats' blood to coagulate, has been used. An environmental control plan for irrigation schemes is currently being drawn up by ATURATINS.

4.3.3 The PRODECER III Project

The Programme for the Development of the *Cerrado* (PRODECER) promotes the settlement of experienced Brazilian farmers in the *cerrado* regions of the country. The programme is financed by loans from the Japanese International Cooperation Agency (JICA), with matching funds from the Brazilian government.



Frederic Mértens / G.A.I.A. (68)



Terraces built as part of the Proceder Project

Frederic Mértens / G.A.I.A. (68)

The Programme has been realised in stages, beginning in the west of Minas Gerais (Phase I) and then expanding to areas of Goiás, Mato Grosso do Sul, and Bahia, and more recently reaching Balsas in Maranhão and Pedro Afonso in Tocantins. PRODECER Phase III refers to the Pedro Afonso Agricultural Colonisation Project, which covers an area of 40,000 ha in the Pedro Afonso region of Tocantins. 20,000 ha have already been opened up for the cultivation of crops such as soy beans. Some

40 colonists have received an average area of 1,000 ha, including reserve areas which make up 50% of the total Project area. Also, the project envisions an area for fruit cultivation by the community (e.g. cashews, pineapples) and an area of some 48.4 ha irrigated by means of a central pivot for the cultivation of beans and maize. The farmers have organised themselves along co-operative lines, and construction work on the grain silos has begun.

The environmental impact of the projects already established under the PRODECER Programme is similar to that of other policies for the *cerrado* which promoted the opening up of land for agricultural use. The official limits of the extent of the programme appear not to restrict its area of influence, since the activities which the Programme supports may influence other farmers, especially those in the surrounding areas.



Frederic Mértens / G.A.I.A. (88)

Bags of phosphorous discarded in the project area

4.3.3.1 PRODECER III's Environmental Management Plan

Environmental management for sustainable agriculture begins with the search for suitable management practices through the application of integrated techniques designed to prevent such problems as erosion, the propagation of pests and diseases, soil compaction and loss of fertility, among others. It is thus necessary to extend scientific and technological knowledge about the region's natural resources through programmes of research and monitoring.

PRODECER III's Environmental Management Plan consists of the following programmes:

- a) The Erosion Control Programme
Designed to establish an efficient system for erosion control by monitoring agricultural activities in the project areas, identifying areas susceptible to erosion and allowing for the evaluation and optimisation of corrective measures.



Frederic Mértens / GAMA (66).

- b) The Programme for the Reclamation of Degraded Areas

This programme is intended to reclaim degraded areas by reversing the processes responsible for their degradation and creating favourable conditions for their re-vegetation by natural means or by deliberate intervention.

Rheas in the Proceder Project Area

- c) The *Queimada* Control Programme

This aims to control the number of fires set, and to discipline the practice of the *queimada* technique.

- d) The Programme for the Conservation of Flora and Fauna

- e) The Land Clearance Programme

This is intended to effect the removal of existing vegetation using suitable techniques, thereby guaranteeing the quality of the irrigation water and making use of the vegetable biomass that is removed.

- f) The Programme for Phytosanitary Control

This is concerned with the efficient and effective control of plant health, and involves the optimal use of agro-chemicals when a biological method of control is not available.

- g) The Water Control Programme

This is designed to monitor changes in water quality relative to levels recorded prior to the establishment of the project, so as to eliminate the cause and sources of environmental deterioration. Farmers will be given information regarding the behaviour of water in the soil, and instructed in various management techniques which enable the optimal use of this resource.

- h) Programme for Climatological Monitoring

The aim of this programme is to facilitate the adequate management of the irrigated agricultural systems in the project area.



Frederic Mértens / GAMA (71).

Monitoring water flow and quality in the Lajeado Creek

i) Programme for Training and Technical Assistance.

j) The Environmental Education Programme

k) The Public Health Programme

The institutions involved in the elaboration and implementation of this Environmental Management Plan are: the Agricultural Promotion Agency (CAMPO), the Technical Assistance and Rural Extension Agency (EMATER), The Brazilian Agricultural Research Agency (EMBRAPA), the State Secretariats for Education, Agriculture and Health, SEPLAN, NATURATINS, UNITINS, IBAMA and the Fire Service.

4.4 Factors Hindering Environmental Management in Tocantins

- The divergence between the resources allocated in the budget, and those actually delivered to environmental agencies. This hinders the efficient implementation of environmental policy in the State, and means that action is restricted to dealing with only the most urgent matters.
- The lack of financial resources for environmental management in the State which reduces monitoring, inspection and control activities.
- The lack of integration between environmental agencies at federal, State and municipal level, NGOs and Specialised Curatorships, which results in isolated actions.
- The fact that agro-ecological zoning is still incomplete hampers strategic planning for the rational occupation of the territory and the sustainable utilisation of natural resources.
- The State Environmental Council faces difficulties in carrying out its duties due to a lack of installations and financial support.
- The capacity of the State's environmental agencies is limited by a lack of basic infrastructure and equipment.
- There are deficiencies relating to the human resources available.
- There is an inadequate number of environmental technicians.
- There are not enough qualified staff for the agencies to carry out their duties.
- Staff changes are frequent, diminishing the effectiveness and disrupting the continuity of training programmes.
- Low salary levels act as a disincentive to agency personnel.
- Agency staff need on-the-job training.
- State legislation gives inadequate coverage of environmental issues, with some thematic areas remaining unregulated.
- Training and skills development are needed for the staff of the State's judicial system.
- The Independent Company of the Environmental Military Police lacks the resources to operate, which makes fiscalisation of flora and fauna difficult.
- The COEMA-TO does not have the structure to enable it to carry out policies of environmental licensing, monitoring, control and fiscalisation.
- There is need for more integration between the various sectors of government so as to make policies compatible with appropriate environmental positions.
- There is a lack of co-ordination between the environmental agencies of different States within the Brazilian Federation.

4.5 Policy Recommendations

The *cerrado* is characterised by its great natural diversity, which poses difficulties for its management and for policy adoption, since it requires the development of flexible and variable practices. The existence of this natural heterogeneity demands more human effort to understand and manage it. From a sustainable development perspective, policies for the *cerrado* should concentrate on developing mechanisms which themselves provoke spontaneous change, namely:

- Strengthening government institutions;
- Decision-making powers at a local level should be increased. This will involve local governments, small and large scale farmers, universities, research institutions and NGOs;
- The establishment of legal foundations governing land use, along with a clear exposition of rights relating to land ownership constitute important steps towards sustainable patterns of land use. Programmes of land redistribution should reflect the fact that agriculture in the *cerrado* is complex, and requires the use of advanced technology and inputs. These should be accompanied by credit programmes, price support and technical assistance, so as to avoid falls in production and the degradation of the soil.
- National and international co-operation is important, whether it works through the allocation of resources for the protection of the *cerrado*'s biodiversity, or through collaboration on research into sustainable development in the *cerrado* region. It must be recognised that the *cerrado* is considered to be of secondary importance in terms of external aid allocated for environmental purposes. One factor which possibly contributes to this state of affairs is the perception that the *cerrado* is more suitable for intensive agriculture than Amazônia, and as such it should be used more intensively so as to safeguard Amazonian biodiversity;
- The recognition of land capabilities through zoning and ecological inventories is crucial, with scientific research helping to characterise each sub-region. Only after the zoning exercise and a realistic evaluation of land capabilities can effective policies be developed. This is especially true in places where there is a high probability of land degradation, as is the case in areas such as *veredas*, slopes, gallery forests, sandy soils etc. Previous policies promoting certain forms of land use have failed because they did not take into account the conditions prevailing in the *cerrado* region;
- Natural ecosystems which are still in an untouched state should be protected, and those that have been modified should be utilised in a sustainable manner. Hydrographic basins should set the context for planning for soil conservation and the use of ecosystems. Gallery forests should be rigorously protected in view of their great biodiversity, and the fact that they serve as corridors between conservation areas, enabling genetic flow to occur between populations of the same species;
- There is a need for coherent land-use policies (APAs, arable areas, pastures, etc.) and the definition of suitable production systems which allow for diversification. Efforts to increase yields (both in terms of production per area, and per unit of investment) should also continue, since increasing productivity will slow down the need to open up new agricultural areas;

- The maintenance and stability of the intensive production systems established in the process of occupation should obey the limits set by equilibrium conditions in the region as a whole, combining areas in their native state with those that are cultivated, the latter being located in places with the greatest agricultural potential;
- Controls over the introduction of exotic species should be tightened;
- Government control over the application of fertilisers, pesticides and herbicides should be heightened by the creation of effective legal mechanisms to control the use of these inputs;
- 50% of the *cerrado* area in the state of Tocantins should be set aside as a legal reserve with the aim of providing wildlife refuges which are not isolated within large expanses of monoculture.