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TOCANTINS

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Overview of the Tocantins Hydrographic Region Brazil

Graphic Design: TDA Desenho & Arte



Setor Policial Sul Área 5, Quadra 3, Bloco L
70610-200 - Brasília /DF - Brasil
(55) 61 445-5400
www.ana.gov.br

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Superintendency for Administration and Finances
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Technical Coordination:
 João Gilberto Lotufo Conejo

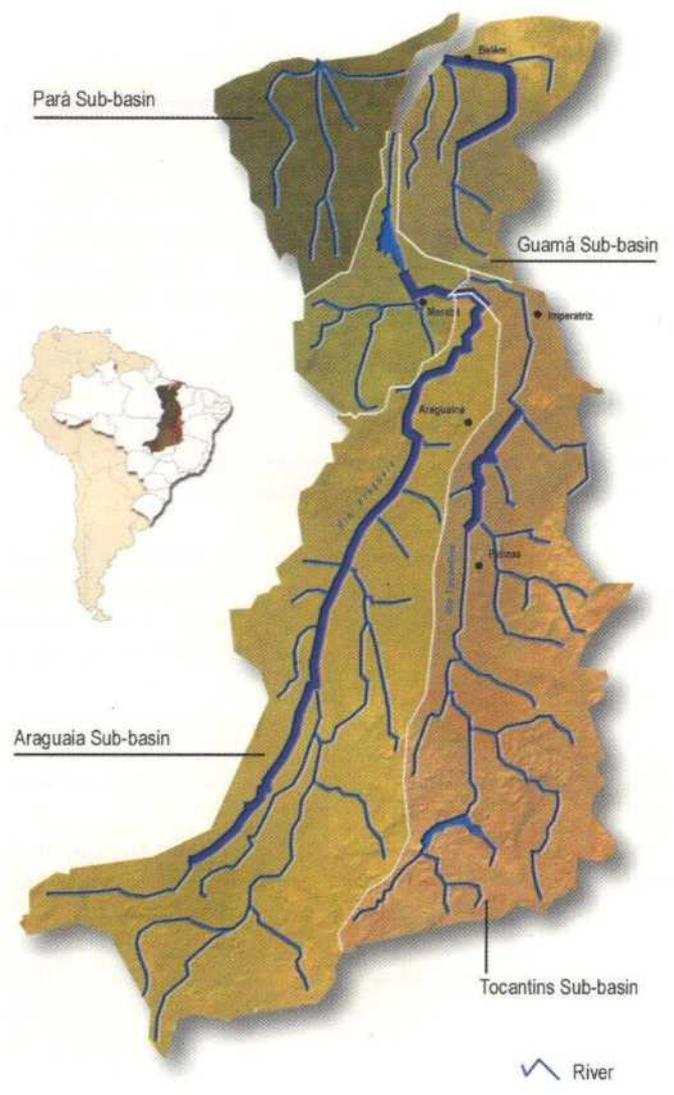
Team Members (ANA):
 Bolivar Antunes Matos
 João Augusto Bernaud Burnett
 José Luiz Gomes Zoby
 Marcelo Pires da Costa
 Nelson Neto de Freitas
 Nilo Nunes
 Osman Fernandes da Silva
 Raimundo Alves Lima Filho

Tocantins Hydrographic Region

The Tocantins Hydrographic Region is of great importance to the country, due to the expansion of the agricultural front, especially with regard to the cultivation of grains, beans and seeds.

The following information aims to present an overview of the region regarding the socio-economic aspects, water use and availability and basic sanitation indicators, in addition to a summary of the current issues regarding the use of water resources and aims for the future.

Figure 1
The Tocantins Hydrographic Area



General Characterization

The Tocantins hydrographic region (Figure 1) occupies an area of 943,006 km² (11% of national territory) and encompasses the states of Goiás (26.8%), Tocantins (34.2%), Pará (20.8%), Maranhão (3.8%), Mato Grosso (14.3%) and the Distrito Federal (0.1%). A significant part lies in the Central-West of Brazil, beginning at the springs of the Araguaia and Tocantins rivers and their confluence, and from there, along its lower reaches, through the North, up to its estuary.

Some 7.7 million people inhabit the hydrographic region (4.6% of the country's population), with 73.0% being situated in urban areas. The population density of the hydrographic region is 8.3 inhabitants/km², far lower than the demographic density of the country (19.8 inhabitants/km²).

The urban network of the Tocantins Hydrographic Region is extremely fragmented, as local authorities with populations up to 5,000 inhabitants predominate, corresponding to 54.3% of the total number of urban centres, but housing only 13% of the urban population of the region. Amongst the main cities are Belém (PA) (1,280,614 inhab.), Imperatriz-MA (230 thousand), Marabá-PA (168 thousand), Palmas-TO (137 thousand) and Araguaína-TO (113 thousand).

Table 1
Denotes the data concerning the urban and rural population and the rate of urbanisation

Sub-basin	Population (inhabitants)			Urbanization (%)
	Urban	Rural	Total	
Tocantins	2,193,301	777,912	2,971,213	73.8
Araguaia	757,894	337,124	1,095,018	69.2
Rio Pará	114,328	198,692	313,020	36.5
Rio Guamá	2,624,833	784,081	3,408,914	76.9
TOTAL	5,690,35	2,097,810	7,788,166	73.0

Most of the population is concentrated in the sub-basins of the Guamá and Tocantins rivers. The hydrographic region comprises 397 municipalities.

The entire hydrographic region is situated in the tropical climate zone. The average annual temperature is 26°C. The rainy season occurs between October and March, with the rest of the year witnessing a dry season. Rainfall increases from the south to the north, with the annual average being 1,721 mm, reaching 2,300 mm in the northern part of the hydrographic region. The average annual evaporation in the region is 1,250 mm.

The Amazon Rainforest, to the north, and *Cerrado* (Savanna), in the remaining area, biomes are present in the Tocantins Hydrographic Region. Deforestation of the region intensified from the 70's, with the construction of the Belém-Brasília highway, the Tucuruí hydroelectric power station and expansion of agriculture and cattle farming and mining. Currently, most deforestation is caused by the timber industry in the states of Pará and Maranhão.

With respect to the socio-economic indicators, the infant mortality rate presents the following values (per thousand live births) in the states which compose the hydrographic region: Distrito Federal (22.24), Goiás (24.65), Mato Grosso (27.03), Tocantins (32.71), Pará (34.43) and Maranhão (52.79), with the national average being 33.55.

The GDP *per capita* in the states which make up the hydrographic region is (in R\$): Maranhão (1,402), Tocantins (1,832), Pará (2,705), Goiás (3,603), Mato Grosso (4,695), Distrito Federal (10,935). Only the GDP per capita of Distrito Federal is greater than the national average (R\$5,740).

The Human Development Index (HDI) in the states which make up the region is: Maranhão (0,547), Tocantins (0,587), Pará (0,703), Mato Grosso (0,767), Goiás (0,786), Distrito Federal (0,869). The national HDI value is 0,830.

With respect to basic sanitation indicators, only the state of Pará has a percentage of urban households connected to the sewage collection systems which falls below the national average (52,5%), (Table 2). The water supply level varies greatly, with values ranging from 0.8% (Tocantins) to 89.7% (Distrito Federal). The urban sewage treatment percentages range from 0.7% (PA) to 45.9% (DF), with only Distrito Federal presenting a value above the national average (20.7%).

The high hydroelectric potential of the region as well as its location to the consumer markets of the Northeast region, puts the Tocantins Hydrographic Region in pole position for the deployment of hydroelectric projects. The actual hydroelectric potential in the states of the hydrographic region is (in kW): Goiás (7,375,398), Pará (4,031,540), Tocantins (427,300), Mato Grosso (366,398), Maranhão (237,300), Distrito Federal (26,000).

Mining is of great importance to the economy of the region, especially in Carajás, in Pará, as around 50% of the country's gold production is from the hydrographic region in addition to the majority of national reserves of asbestos (92%), copper (88%), nickel (86%), bauxite (82%), iron (64%), manganese (60%), silver (21%) and cassiterite (28%).

Table 2
Sanitation Indicators for urban households

State	Water supply (% pop.)	Sewerage (% pop.)	Sewerage (%)
Tocantins	0,8	75,6	1,7
Pará	2,4	47,7	0,7
Maranhão	9,2	58,9	1,9
Mato Grosso	16,9	72,9	13,8
Goiás	40,1	80,1	10,3
Distrito Federal	89,7	92,4	45,9
Brasil	89,2	52,5	20,7

Water Availability and Use

The Tocantins River rises in the Goiás Planalto (tableland), at about 1000m altitude, and is formed by the Almas and Maranhão rivers. Amongst its main tributaries, up to the confluence with the Araguaia river, are the Bagagem, Tocantinzinho, Paraná, dos Sonos, Manoel Alves Grande and Farinha rivers, on the right bank, and the Santa Teresa River on the left bank. Its main tributary is the Araguaia (2,600 km in length), in which lies the island of Bananal, the largest river island in the world (350 km in length and 80 km wide). After the confluence with the Araguaia River, the Itacaúnas River, on the left bank, is the main river. The total length of the Tocantins River is 1,960 km, with its mouth being located at the Baía de Marajó bay, into which the Pará and Guamá rivers also flow.

The Tocantins Hydrographic Region is divided into four sub-basins (Figure 1):

- Tocantins: total area of 391,078 km² (41.5% of the hydrographic region). This corresponds to the section of the Tocantins River, from its headwaters to the confluence with the Araguaia River.
- Araguaia: total area of 358,125 km² (38% of the hydrographic region). This corresponds to the total basin of the Araguaia River, from the headwaters to its fifth on the Tocantins River.
- Pará River: total area of 89,394 km² (9.5% of the hydrographic region).
- Guamá River: total area of 104,408 km² (11% of the hydrographic region).

The Tocantins River records a mean discharge rate of 13,598 m³/s (9% of the national total) and a specific discharge rate of 14.4 l/s/km². The sub-basins have the following specific discharge rates: Tocantins (111 l/s/km²), Araguaia (16 l/s/km²), Pará (17 l/s/km²) and Guamá (21 l/s/km²).

Groundwater is important in the northeast region of Goiás (valley of the Paraná River, São Francisco Province), where the volcanic rock forms a poor standard of river capillarity, favoring a relative abundance of groundwater resources, with hard water prevailing. In the southwest region of Goiás, the use of groundwater from the Paraná province has risen gradually, both for the incipient industrial activity and for crop and pasture lands.

The current situation of the Tocantins Hydrographic Region in terms of availability and demand is laid out in Table 3, in which it can be seen that the sub-basins of the Tocantins and Araguaia rivers present the highest total demands, mainly for irrigation purposes.

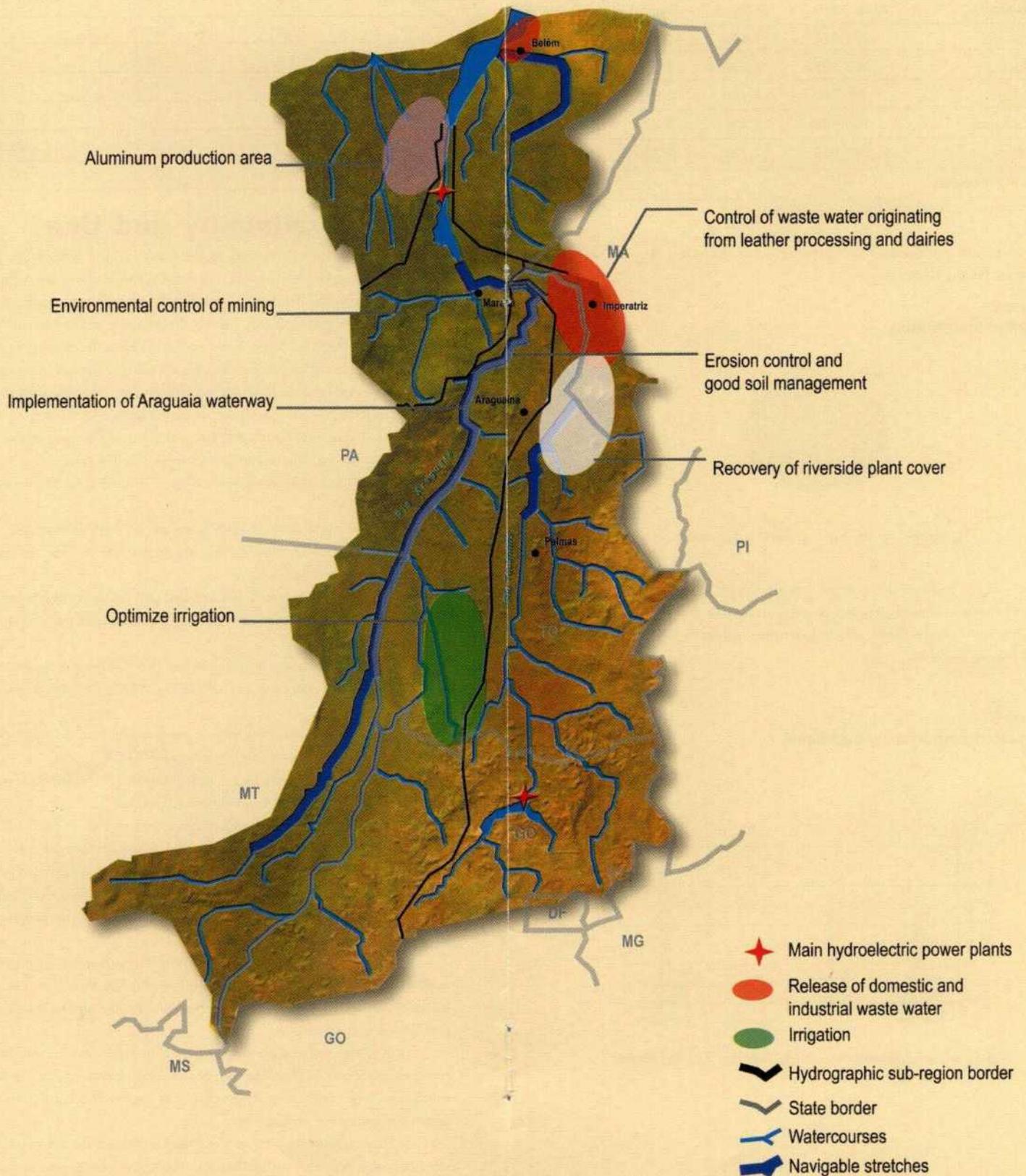
In average and annual terms, the total demand for water in the hydrographic region does not exceed 1% of the average availability, indicating that in general the conflicts on water use that exist do not refer to quantitative issues, thanks to the plentiful abundance of surface waters.

Human demand is 12.06 m³/s (10% of total demand), and around half of it is concentrated in the sub-basin of Guamá, which possesses the most populous city of the hydrographic region, Belém, with 1.28 million inhabitants.

Industrial Demand is not significant, as most of the factories are small-scale operations, in the areas of metallurgy, food, timber processing, furniture, leather, dairy products, ceramics and others. There are also some factories that produce cellulose and its derivatives, in addition to beef and pork processing facilities. Industrial demand is estimated at 2.0 m³/s, which corresponds to 2% of the hydrographic region's total.

Irrigation Demand is 93.49 m³/s (81% of total demand) and is concentrated in the sub-basins of Tocantins and Araguaia, going to flood rice croplands. The potentially irrigable area (by flooding or otherwise) is estimated at more than 2.5 million hectares. The livestock demand is 7.79 m³/s (7% of total demand).

Tocantins Hydrographic Region - Priority Aspects



Priority Aspects

- To evaluate and implement steps that will minimize the impact of mining on the quality of the resources
- To define and implement a program for controlling the erosion and suitable management of the soil, thereby minimizing the contamination brought about by widespread sources, particularly in the springs
- To implement and/or improve the treatment systems of waste water originating from abattoirs and chilling centers and evaluate their impact
- To implement the Tocantins-Araguaia waterway in harmony with environmental conservation

- To optimize the usage of water in irrigation and define economically feasible areas in the hydrographic region
- To improve the efficiency of the distribution systems, thereby minimizing the losses in the water supply systems and implement domestic sewage treatment systems
- To develop the hydroelectrical energy potential through new projects, making environmental preservation compatible with multiple usage and integrating local and regional development

Table 3
Water resource availability and demand table

Sub-basin	Area (km ²)	P (mm)	E (mm)	Q (m ³ /s)	Demand (m ³ /s)				Discharge*(%)	
					Human	Irrigation	Livestock	Industrial		Total
Tocantins	391,078	1,605	1,259	4,290	3.07	22.21	3.90	0.00	29.18	0.7
Araguaia	358,126	1,739	1,246	5,596	1.90	29.18	2.62	0.00	33.69	0.6
Rio Pará	89,394	2,400	1,864	1,520	0.42	0.00	0.69	0.00	1.11	0.07
Rio Guamã	104,408	2,437	1,775	2,192	5.84	42.10	0.58	2.00	50.52	2.3
Total	943,006	1,721	1,266	1,598	12.06	93.49	7.79	2.00	114.5	0.8
% of the country	11	-	-	9	3	7	7	1	5	-

P – precipitation; E – evapotranspiration; Q – discharge rate

Figure 2 illustrates the distribution of the water demand in the Tocantins Hydrographic Region.

Figure 2
Demand distribution

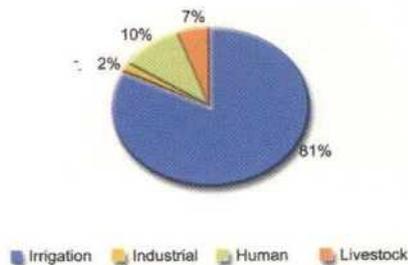
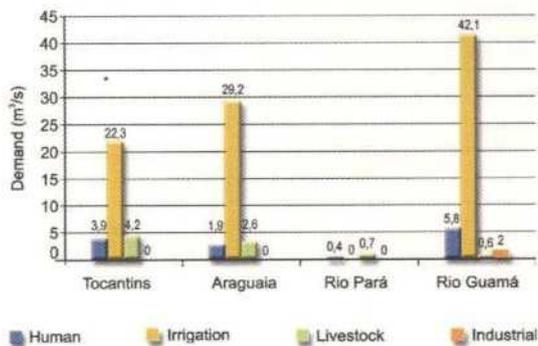


Figure 3 shows the demand distribution by sub-basin, where it can be seen that the highest demand is concentrated in the sub-basins of the Tocantins and Araguaia rivers, which present the highest demand for irrigation and livestock watering.

Figure 3
Demand distribution by sub-basin



The region boasts more than 300 species of fish and has enjoyed a significant increase in fishing tourism, particularly on the Araguaia River, which could lead to sustainable economic development for the region. The deployment of basic infrastructure, with the construction of waterway stations and scafront urbanization, may develop the sector. The multiple use of the lakes of the Tucuruí and Serra da Mesa hydroelectric power stations for tourist purposes. Fishing is also an important activity for the riverside and indigenous populations, and supplements subsistence farming, extractivist and hunting activities. Protecting the water resources and the ecological equilibrium of the rivers is essential to these activities.

One of the main hydroelectric projects is the Tucuruí power plant, which has a final potential of 7,745mW, and is located in the Tocantins lowlands, and the Serra da Mesa highlands power plant, with a nominal potential of 1,200mW, located in the upper Tocantins region. The Tucuruí power plant alone supplies 96% of the electricity used in the state of Pará and 99% of that in Maranhão.

Waterway travel has potential, principally on the Araguaia River, which enables the transportation of 3 million tons of soybeans from the Central-West region. If locks, dredgers and other projects are built, the waterway will be able to boast a navigable main channel of 2,000 km and a further 1,600 km along the tributaries. The environmental impact of this enterprise is currently under discussion.

As for the domestic pollution, the urban organic burden potential is 307 ton of BOD₅/day (4% of the national total) and is mainly concentrated in the vicinities of the Greater Belém Area. Pollution caused by mining mainly results from the actions of mining and sand extractions in small springs.

Events that are considered critical to the water resource are floods, which are a natural characteristic of the hydrographic region. 60% of the vulnerable areas in the River Araguaia basin are situated in the state of Mato Grosso, with the Island of Bananal stretch comprising the largest extension of floodplains. However this area has a low population density. The basin of the River Tocantins possesses almost half the floodable areas situated in the stretch which separates the states of Maranhão and Pará.

Current Conflicts and Aims for the Future

In 2015, the population in the Tocantins Hydrographic Region will reach 5,871,800, with 80% of this being urban.

The region is one of the most promising in terms of economic expansion over the next few decades. With emphasis placed on crop- and cattle-farming and mining, regional development will gain momentum from the increase in hydroelectric energy generation, and may turn out to be an important industrial zone, and already is an important export region.

Water resources will play a decisive and major role in the region's development, through water travel, irrigation, generation of energy, fishing, domestic and industrial supply, tourism and leisure activities.

The hydrographic region presents great potential for irrigated agriculture, especially for the cultivation of rice and other grains (corn and soybeans) and fruit. The huge expanses of areas which are potentially irrigable and the prospect of expanding rice cultivation should lead to a substantial increase in agricultural water demand. The largest increase in water use for irrigation is currently in the basin of the River Araguaia, to the east and south of the Island of Bananal.

If the necessary measures are not taken, degradation of the soil in the rural areas may occur from the intensive use and inappropriate agricultural practices in single-crop areas. The loss of soil fertility increases the need for constant chemical fertilization and makes the soil vulnerable to erosive processes, polluting the waters and leading to the silting up of watercourses.

Amongst the main current issues are:

- Impact of mining activities on the quality of water resources;

- Contamination by various sources (pesticides, fertilizers, silt arising from erosion of badly managed soil, amongst others);

- Release of effluents with large amounts of organic matter from abattoirs and refrigeration facilities which slaughter cattle and pigs in the vicinity of the watercourse, thus reducing the assimilation and river transport capacities.

Amongst the most urgent steps necessary in the hydrographic region are:

- To evaluate and implement steps that will minimize the impact of mining on the quality of the resources

- To define and implement a program for controlling the erosion and suitable management of the soil, thereby minimizing the contamination brought about by widespread sources, particularly in the headwaters;

- To implement and/or improve the treatment systems of waste water originating from abattoirs and refrigeration facilities and evaluate their impact;

- To implement the Tocantins-Araguaia waterway in harmony with environmental conservation;

- To optimize the use of water in irrigation and define economically feasible areas in the hydrographic region;

- To improve the efficiency of the distribution systems, thereby minimizing the losses in the water supply systems and implement domestic sewage treatment systems

- To develop the hydroelectric energy potential through new projects, conciliating environmental preservation with the multiple water uses and integrating local and regional development.