AID ON THE IMPLEMENTATION OF LEGISLATION IN THE WATER QUALITY: A CASE STUDY IN THE STATE OF MATO GROSSO, BRAZIL

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Abstract

As in the great civilizations, in Brazil, the first settlements were established and developed near major waterways creating a great responsibility in maintaining them. The aim of this study was to assist in the implementation of environmental legislation as there is consensus on the need for urgent measures. Almost all Brazilian legislation, including the 1988 Federal Constitution and Federal Law No. 9.433/97, consider rivers and streams conservation. This study was conducted in an urban stretch of the Cuiabá River (Mato Grosso, Brazil) along a gradient of organic pollution. Analyses were performed in times of drought and flood, with the aim of assessing the sanitary quality, biological and physical-chemical water properties. Moreover, algae and cyanobacteria indicators of different degrees of organic pollution were inventoried. The samples were collected along the river channel in February and August 1999. Fecal coliforms, total coliforms and others were quantified. The cyanobacterium *Oscillatoria* spp. showed higher densities in locations with high organic content, phosphorus, turbidity, suspended solids indicators of discharge from tributaries polluted with domestic sewage.

Keywords: Cyanobacteria, organic pollution, environmental law

1 - INTRODUCTION

The great civilizations were born, flourished and developed where there was a great amount of water. In Brazil, the settlements were established where there was water in abundance. Among the rivers was where the advancement in the process of pioneering of the country happened.

In a far distant past, Mato Grosso drew attention through a large contingent of migration in search of gold; today, the State of Mato Grosso is among the largest grain producers in the world. The Cerrado (Brazilian savannah) is shown as the last major world reserve in cropland.

The new agricultural activities based on intensive use of capital are the result of market forces nationally and internationally. The intensive exploration of natural resources has affected the use of space, affecting the urban landscape and human relationships. Agriculture is the largest user of fresh water worldwide and one of the main factors of degradation of surface and groundwater, with the wide use of pesticides and chemical fertilizers, embedded in the different agricultural practices. The pesticides are transported from the soil by leaching to the aquatic environment. The amount of material suspended in water, coming from the soil, influences the concentration of organochlorine compounds, since most of them have high adsorption by organic matter. Specifically, the total nitrogen and phosphorus when in excess in water bodies, cause environmental changes with imbalance in the aquatic biota and compromising water quality.

The quality of water in many regions of the world reveals the disregard with which industrial, urban and agricultural discharges have been treated, as well as inadequate planning and poor use of the resource. The improper handling of bodies of water often accelerates the process of eutrophication, or rather the enrichment of a body of water by organic nutrients and minerals leading to selection of the biological community and declining quality of water used for various purposes.

Brazil has the intention of achieving first place in the agro-export, since it holds great untapped lands. The conversion of virgin forests into farms began in the 1960s with the arrival in the state of Mato Grosso of immigrants from the southern states of the country. In this set of interests, the Cuiabá River basin is inserted, where about 88% of its total area is formed by natural vegetation and 12% by human occupation (PCBAP, 1997).

Promoting agricultural expansion with the preservation of natural resources present large technical, economic and environmental challenges in the implementation of Complementary Law No. 233 of 21 December 2005 (which deals with the Forest Policy in the state of Mato Grosso). This Law has principles for the conservation of natural resources, preserving the structure of biomes and their functions, the maintenance of biological diversity and regional socioeconomic development. These tools require a solid foundation of data and analysis instruments sufficient to assist in the management plans and quality targets of the basin.

Within this context, the objective of this study was to investigate the variations of water quality by integrating health aspects, biological and physical-chemical environmental variables in an urban stretch of the Cuiabá River in the cities of Cuiabá and Várzea Grande. This study is relevant due to the fact that the Cuiabá River basin is inserted upstream of the Pantanal complex, and it belongs to a state with an agricultural vocation.

The state of Mato Grosso has 141 municipalities and a population of 2.5 million inhabitants (Brazil, 2010). In Mato Grosso, only nine districts (6% of total) have over 50,000 inhabitants, however, there is a tendency of population growth due to the expansion of agricultural activity and the installation of new hydroelectric projects (Brazil, 2010).

While the state of Mato Grosso is primarily agricultural, several other land uses occur in the Cuiabá River basin, as follows: 1) planting grass to feed cattle, 2) mining in the headwaters of the River Casca, 3) dredging sand in the bed and banks of the river in Rosário Oeste and Cuiabá, and 4) exploration of limestone in Nobres. These activities lead to an increase in sediments carried to the banks of the river bed, causing siltation in the Cuiabá River and affecting the water both in quantity and quality.

This study aimed to: 1) identify indicators of organic pollution from associations between the microbiological, chemical and physical variables 2) verify the sanitary conditions of the Cuiabá River in the stretch of the study, 3) conduct an inventory of phytophthora on all three sampler locations by performing studies of phytoplankton community structure that assists in assessing the present environmental conditions.

2 – STUDY AREA

The state of Mato Grosso is located in the Midwest region of Brazil and it has around 900,000 Km^2 of territorial extension. In the state we find the main sources of three major Brazilian river basins: Amazon, Araguaia/Tocantins and Platina.

Platina has a basin drainage area of 176,800.60 km^2 and is located between parallels 14 ° and 22 ° S and longitudes 53 ° and 61 ° W, covering the lands of Bolivia, Paraguay and Brazil. The Paraguay River is the main watercourse of the basin and it is characterized as one of the most important lowland rivers of Brazil. It rises in the Serra de Tapirapuã near the Chapada dos Parecis. Its main tributaries are: Sepotuba, Jaurú and Cuiabá (Cavinatto *et al*., 1995).

The Cuiabá River travels about 828 km from its source in the Serra Azul in the city of Rosario Oeste to its confluence with the Paraguay River. According Cavinatto (1995), the Cuiabá River basin is located between latitude 14 ° 18 '17 ° 00' S and meridians 54 ° 40 'and 56 ° 55' W and according to the Conservation Plan of the Upper Paraguay - PCBAP (1997) approximately 29,000 km^2, with a perimeter of 841 km, covering the headwaters of the Cuiabá of Larga`s city and  Cuiabá of Bonito`s city, who are trainers of the Cuiabá River, to the confluence of the river Coxipó-Assu, little downstream of the city of Santo Antonio do Leverger. The Cuiabá River basin has the main water body itself wich is the Cuiabá River, which drains an area of approximately 28.732km^2, located between the geographic coordinates 14 ° 18'e 17 ° 00'S 54 ° 40'E and 56 ° 55 ' W (Cavinatto *et al*., 1995).

This study was conducted on the section that covers around 17 km of the Cuiabá River, located along the perimeter of the urban towns of Varzea Grande and the state capital, Cuiabá. The study involved three collection points, located between the geographic coordinates 15 ° 38 '53"S and 56 ° 08' 27"W - Passagem da Conceição, 15 ° 38 '00"S and 56 ° 07' 36 ' 'W - Porto, 15 ° 39' 30"and 56 ° 04 '11"W - São Gonçalo. Figure 1 shows the Cuiabá River basin, showing the sub-basins that constitutes the urban perimeter.

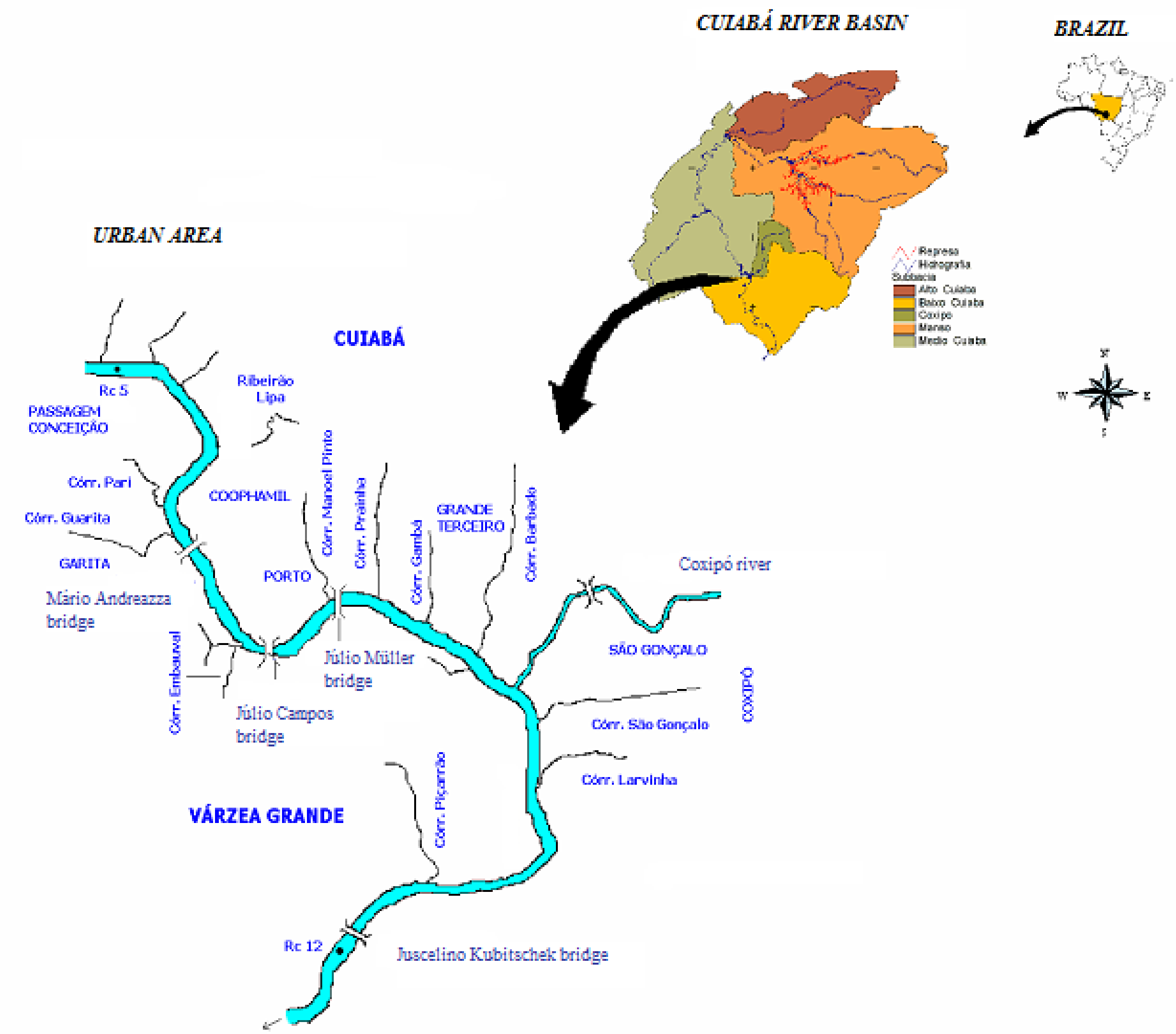

Figure 1 - Cuiabá River basin, and the urban area of Cuiabá River basin, showing the sub-basins that constitutes. Source: Rondon Lima, 2001 (adapted).

According to the Köppen classification, the climate is AW Tropical Moist, with the dry seasons (May-October) and rainy (November to April) well defined (Cavinatto *et al*., 1995). The thermal regime is characterized by the temperature variation with altitude, with small amplitudes and thermal variation over the course of the year. However, between the months of May and September, there is a climate phenomenon called by the locals to "friagem" which is the rapid drop in temperature of 10° to 15°C due to the entry of polar air masses originating from the Antarctic Continent.

The average annual temperature for the region is 26.8°C, the maximum of about 42°C and a minimum of 15°C with relative humidity averaging 74%, total stroke average of 2,179 hours total and normal evaporation of 992 mm. Average annual rainfall, maximum and minimum observed range from 1000 mm to 1800 mm, with an annual average of 1,500 mm, occurring with high intensity rainfall and short duration (Cavinatto *et al*., 1995).

3 – MATERIALS AND METHODS

For the characterization of water quality in the Cuiabá River section corresponding to the urban cities of Cuiaba and Várzea Grande, physical, chemical, physical, microbiological analyses and an inventory of algae present in these locations were performed.

3. 1 – Locations of the sample collection

Three sampling stations were selected along the River in the urban perimeter of the two most populous cities in the state. One station was located in the central city of Cuiaba and the other two regions roughly equidistant from the first, one upstream and one downstream.

The reasons for selecting these stations are listed below. Figure 2 shows a diagram in a straight line with the main contributions of domestic and industrial effluents along the Cuiabá River in the stretch under study.

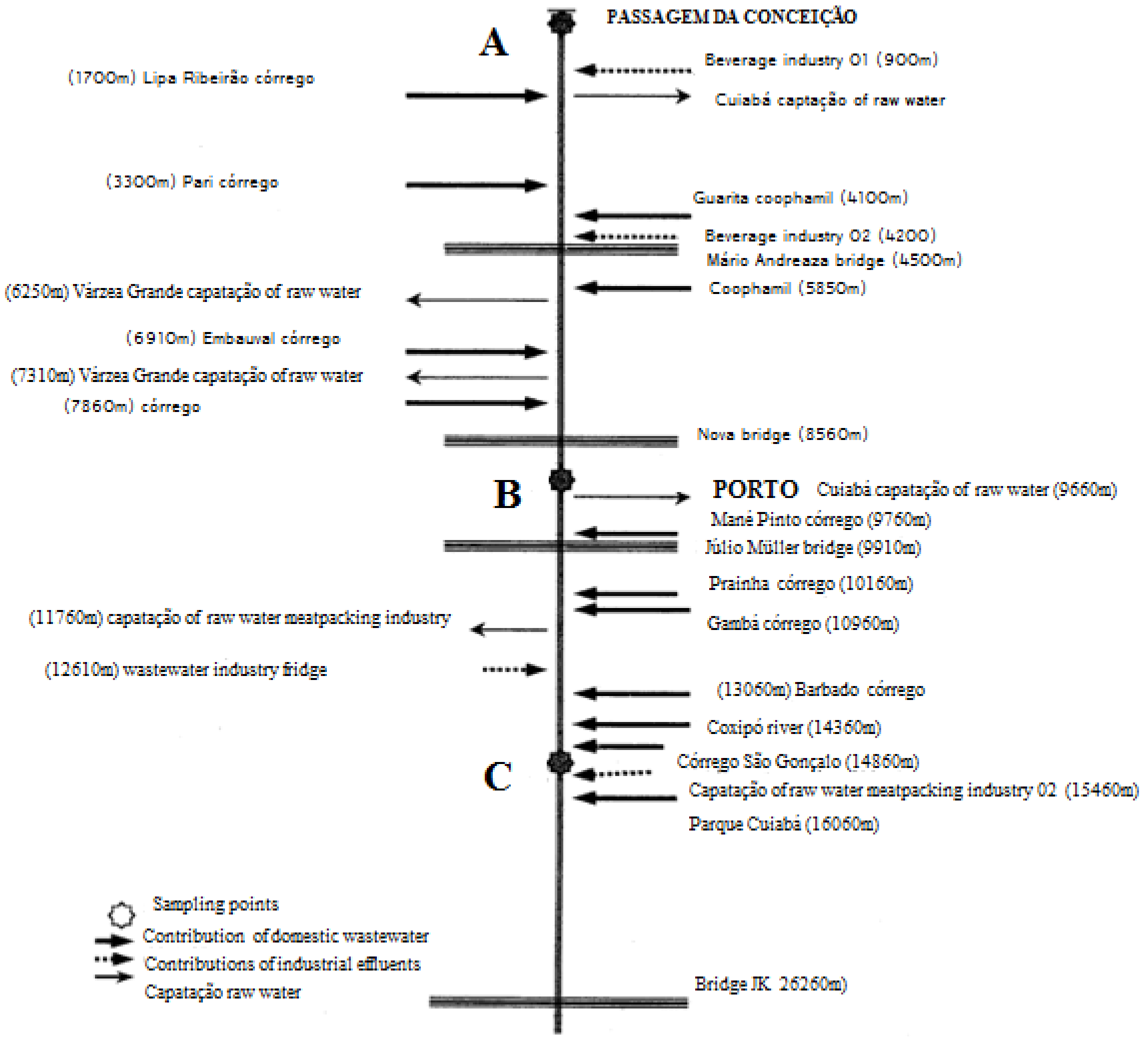

Figure 2 – Diagram on a straight line showing contributions from domestic and industrial effluents along the Cuiabá River, also showing the sampling stations Passage of Conception (A), Porto (B) and São Gonçalo (C). Source: Rondon Lima, 2001 (adapted).

1st Station – Passagem da Conceição, located in Várzea Grande, Mato Grosso (MT), is located upstream of the two other stations. Even in the urban area it receives a lesser charge of effluents, both domestic and industrial states that are less impacted (by urban-industrial wastewater) than the other two downstream, and can be used as a control station (to compare the data).

2nd Station - Porto, located in the city of Cuiaba, Mato Grosso (MT). It is assumed that this station is the one that receives more effluent, due to its location being on the central perimeter of the capital. In this station there is a significant amount of streams and they all, without exception, are open sewers, therefore, are within the city and receive the whole load of raw sewage from residences, businesses, health centers, small industries and many others who can contribute to the deterioration of the waters of these small streams.

3rd Station - Community of São Gonçalo, located in the city of Cuiaba, Mato Grosso, it is assumed that in this stretch all the significant contributions of sewage had occurred upstream, both domestic and industrial, but not excluding the possibility that there may be some local point releases of sewage, and medium-sized tributaries that run through the capital and flow in this location.

3.2 - Sample Collection

Samples were collected on 17th and 18th February, 1999 and 22nd and 23rd August, 1999. To a greater distinction and reliability of data, the researcher obeyed the seasonality of the river. For a more detailed analysis, in which natural and anthropogenic factors had equal weight, it was attempted to analyze the behavior of the biotic community in the study over 24 hours.

In the three sampling stations subsurface water in the channel and the banks were sampled at intervals of 6 hours between each collection. There were a total of 30 consecutive hours of field work/campaign, with five sets of samples for each station.

Both during flood and drought, the collections were performed as shown in Table 1.

Table 1 - Timetable for collections in the study stations during periods of flood and drought of 1999 - River Cuiabá, MT

Passagem da Conceição	Porto	Comunidade São Gonçalo
06h00	08h00	10h00
12h00	14h00	16h00
18h00	20h00	22h00
00h00	02h00	04h00
06h00	08h00	10h00

The procedures for collection and preservation of samples followed the recommendations of Branco (1978) and Esteves (1988), Frason (1992), Perez (1992), Carmouze (1994), Mackereth et al. (1978), Goltermam *et al*. (1978) and CETESB (1978, 1991).

3.3 - Variables Analyzed

The criterion to define the variables to be analyzed was based on its importance for the trophic characterization of water bodies and health. Additional factors for selection were the limitations of budget and infrastructure of the laboratory. Table 2 shows the parameters and their methods and equipment used.

Table 2 - Parameters evaluated and their respective methods and equipment used

Limnological Variables	Analysis method	Equipment/Author
Water transparency	Visual comparison	Secchi disc
Water temperature	Visual	Thermometer
Color	Visual comparison	
Turbidity	Direct reading	(Franson, 1992)
pH	Potentiometric	(Franson, 1992)
Water eletrical conductivity	Direct reading	(Franson, 1992)
Suspendend materialo	Gravimetric	(Franson, 1992)
Total calcium	Atomic absorption spectrophotometry	(Franson, 1992; Carmouze, 1994)
Total iron	Orto-fenantrolina	(Franson, 1992; Carmouze, 1994)
Nitrogen Kjeldahl (NKT)	Nitrogen determination	(Mackereth *et al*., 1978)
Dissolved oxygen	Winkler (changed)	(Golterman *et al*., 1978)
Biochemical oxygen demand (BOD)	Technical Standardization	(CETESB, 1978)
Total phosporus	Ascorbic Acid	(Franson,1992)
Total silica	comparisons	(Franson, 1992)

3.3.1 - Limnological Variables

Samples for physical, chemical and physico-chemical data were collected in the subsurface water with polyethylene bottles (1000ml) properly prepared in the laboratory and rinsed with the water of the location in study. The bottles were horizontally submerged to a depth of approximately 30 cm from the surface. The samples were determined in the laboratory of physical and chemical analysis of the Sanitary Engineering Department, Federal University of Mato Grosso - ESA / UFMT.

3.3.2 - Biological variables

3.3.2.1 - Colimetric assays

For samples intended for analysis of total coliforms and fecal coliforms were used sterilized wide-mouth bottles and protected from light. At the time of collection, these jars were poured on site water and submerged to a depth of approximately 30 cm, when they were still inverted in the water and taken out full. Immediately after collection, the bottles were packed properly by the time of analysis, no longer than 24 hours. To assess the sanitary conditions of water, the technique of multiple tubes was used (CETESB, 1991).

3.3.2.2 – Phytoplankton

- Procedure for collection and preservation of phytoplankton in the field

The collections of plankton were made in the same station of limnological variables and colimetric assays, at the same depth, including stations located in Passagem da Conceição, Porto and São Gonçalo. The samples were collected with a net (Hydro-Bios, 38μm mesh opening).

During the collection the net was introduced in water at a depth of approximately 30 cm, then proceeded to drag it through a horizontal extension of about 50 cm. The net was moved in various directions within the mass of water in order to get a better representation of the individuals. After seining, the sample was placed in appropriate containers. The material was fixed and preserved in "Transeau" solution using a 1:1 ratio with water from the sample, according to Sant 'Anna *et al*. (1984). This material was intended to definitive tests in order to identify the organisms surveyed.

- Systematic identification

For a better distribution of all individuals present in the samples, the bottles were inverted gently 50 times. The material was examined between slide and coverslip in binocular optical microscope. The count of microorganisms was accomplished through "continuous field" (Branco, 1978).

The number of slides prepared from each sample was determined by the collector curve (Ricklefs, 1993). Using ten random samples, which plates were prepared in order to be observed until it reached the asymptote of the curve, that is, a maximum number of species new to each blade, to stabilize the readings. That said, it was determined that twelve slides per sample should be analyzed. A total of 1080 slides were analyzed during the study.

The taxonomic identifications were made by comparing the material found with what already exists in the specialized literature. Fundamentally, it was used monographic work, floras and revisions, especially De-Lamonica-Freire (1985); Bourrelly (1972, 1985, 1988).

3.3.3 – Ecological Analysis

- Population Density

After homogenization, by manual shaking of the bottle, 3 drops of sample to be analyzed were removed with a pipette and placed between slide and coverslip, starting the count of individuals of phytoplankton. Each sample analyzed totaled 1.2 ml, and the density of algae was estimated by transforming these values into numbers of individuals per milliliter of sample (n °. Ind.mL^{-1}).

- Relative Abundance of species

The relative abundance is equal to the percentage of individuals in a sample (Ricklefs, 1993). Were considered abundant, those species whose occurrences were higher than the numerical average of the total number of individuals of the species present in the sample.

- Species richness and dominance

Dominant species considered were those whose occurrence number exceeded 50% of the total number of individuals sampled. The diversity tends to be reduced by biotic communities that suffer stress, but may also be reduced by competition in ancient communities and stable physical environments. Species richness was determined by considering the total number of species.

3.3.4 – Statistical analysis

The correspondence analysis with removal of the effect of the arc - DCA (Hill and Gauch, 1980), was based on the density of algae and cyanobacteria, in order to sort and verify the similarity patterns of the samples surveyed in the collection stations: Passagem da Conceição, Porto and São Gonçalo, observing schedules, sample points (left and right banks of the River and channel) and seasonality.

Factor analysis in principal components (PCA) was performed with abiotic variables; as a result, it was possible to characterize the samples according to the full range of environmental data.

Analysis of variance components was carried out to determine which were the main sources of variation (location, sample points, schedules and season), which acted on patterns of similarity generated by correspondence analysis of the effect of removing arc (DCA) and principal component analysis (PCA). To this end, the scores of the first axes of ordinates were used as response variable and were used as factors, hydrological phases, sampling stations, sampling points and different times.

4 – RESULTS

4.1 - Analysis of correspondence with removal of the effect of arc (DCA) and principal component analysis (PCA).

The PCA indicated that most of the environmental variability can be attributed by the differences observed between the periods. Table 3 shows the components of variance calculated with the first axes derived from sorted (PCA and DCA).

In each of the factor levels chosen (sampling station, sampling points, schedules and seasonal period) one sample was observed. It was noted that the seasonal period was the main factor for the general differentiation of the samples. The variables shown are those with the highest Pearson correlations with the two main axes of the PCA

Table 3 - Components of variance (CV, 5) calculated with the first axes derived from sorted (PCA and DCA

	CV (Axis 1 da PCA)	CV (Axis 1 da DCA)
{1}Local	1,53	1,99
{2}Margem	0,00	0,00
{3}Hora	0,00	0,00
{4}Período	92,18	60,65
1*2	0,00	0,06
1*3	0,00	3,27
1*4	0,00	4,78
2*3	0,11	2,74
2*4	0,47	1,34
3*4	1,67	3,81
1*2*3	0,12	0,00
1*2*4	0,10	1,10
1*3*4	2,24	0,00
2*3*4	0,00	0,00
1*2*3*4	1,58	20,27
total	100,00	100,00

The scores along the first axis of PCA demonstrate, graphically, the importance of the collection period on the limnological variability observed between the periods of drought and flood, Figure 3 shows the ordination of samples according to principal component analysis.

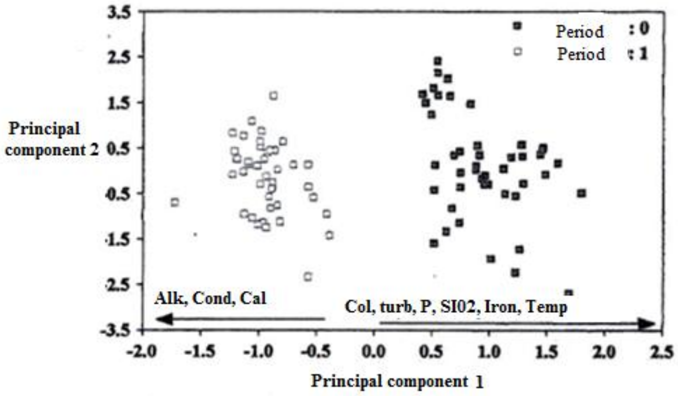

Figure 3 - Sorting the samples according to a principal components analysis (PCA). At 0 = flood period, 1 = drought period

Correlations of original variables with the scores of PCA axis 1 indicate that during the flood period the highest values of color, turbidity, phosphorus, silica, iron and temperature were observed. Table 4 presents the Pearson correlations between original variables and the scores derived from axes 1 and 2 of the Principal Component analysis.

On the other hand, the drought was characterized by alkaline water with higher ionic concentrations and higher calcium concentrations, Table 4 shows these characteristics. These interpretations are based on the signs of correlation coefficients (between the original variables and the scores) greater than 0.7. As a whole, these results are consistent, considering that the first PCA axis explained about 53% of the total data variability.

Table 4 - Pearson's correlation between the original variables and the scores derived from the analysis Principal Components.

Variables	Axis 1	Axis 2
Temperature	0,74	0,19
pH	-0,45	0,44
Color	0,95	0,01
Turbidity	0,94	-0,02
Alkaline	-0,96	-0,13
Conductivity	-0,82	-0,06
OD. concentration	-0,54	0,72
OD. Saturation	-0,05	0,94
DBO	0,43	0,38
Phosphorus	0,71	0,04
Nitrogen	0,38	-0,39
Calcium	-0,80	-0,04
silica	0,93	0,17
Iron	0,93	0,09
Solids	0,54	0,04
Variance explaine	**7,91**	**1,99**
Var. explained (%)	**52,75**	**13,28**

The results obtained in the PCA analysis indicate that the differentiation was made of the sampling periods, considering that this was the main factor that characterized the general differentiation of the samples. Figure 4 shows the ordination of samples according to a correspondence analysis of the effect of removing arc (DCA), using data densities of phytoplankton and cyanobacteria and comparing the seasonality in the presence of cyanobacteria and other algae. The flood period is mostly preferred by this group of microorganisms. Figures 5 and 6 show the scores of species obtained from the DCA.

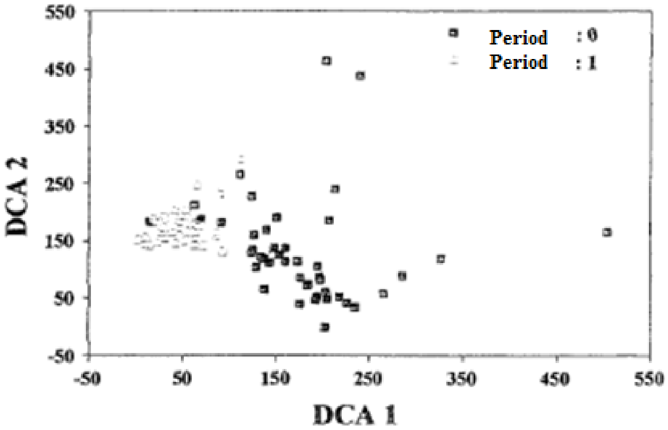

Figure 4 - Sorting the samples according to correspondence analysis to remove the effect of arc (DCA) using the data density of phytoplankton and cyanobacteria. 0 = Flood period and 1 = drought period.

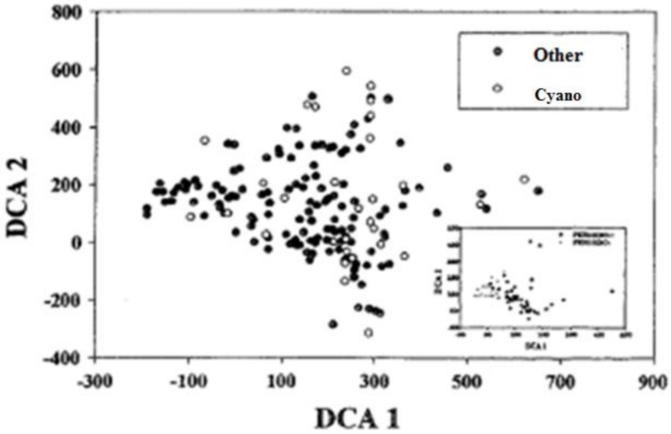

Figure 5 - Scores of species obtained from the DCA. The species are differentiated according to the criterion: cyan = Cyanobacteria and other.

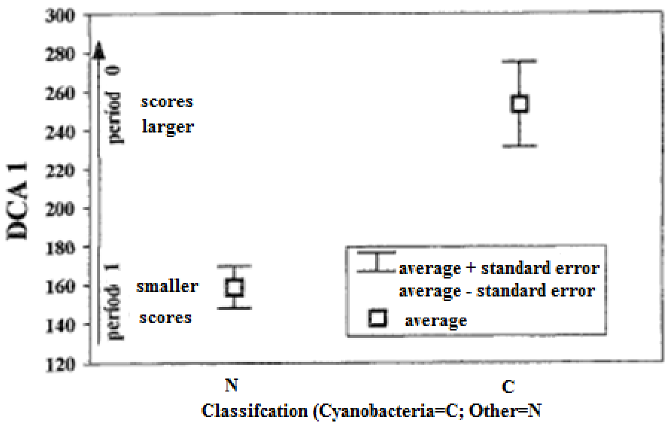

Figure 6 - Mean scores of species along axis 1 of the DCA in accordance with the criteria: Cyanobacteria (C) and other (N).

A positive correlation between density and species richness was detected. For a similar value of density, species richness was on average higher during flood, Figure 7 shows the relationship between density (log + 1) and species richness (*S*). The samples are differentiated according to the period in which they were obtained.

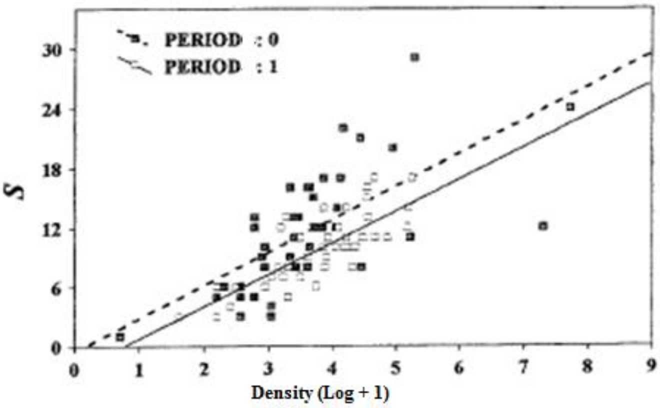

Figure 7 - Relationship between density (logo + 1) and species richness (S). The samples are differentiated according to the season. 0 = Rainy season, period 1 = Drought.

4.2 - Biological variables: Fecal and total coliform, algae and cyanobacteria

With respect to total coliform and fecal coliform Table 5 shows the variability presented by these microorganisms during the study at the three locations sampled.

Table 5 - Total Coliforms and fecal (NMP/100ml), PC – Passagem da Conceição, P – Porto, and SG-São Gonçalo in the left and right banks and channel, in the rainy and dry seasons in the Cuiabá River in the year 1999. Cuiabá, MT.

Location		**RAINY SEASON**				**DRY SEASON**			
		Total Coliforms		Fecal Coliforms		Total Coliforms		Fecal Coliforms	
		2/17/99	02/18/99	02/17//99	02/18/99	08/22/99	08/23/99	08/22/99	08/23/99
PC	Right	1,700	11,000	300	5,000	130	140	40	140
	Channel	2,200	11,000	700	8,000	170	700	40	230
	Left	2,200	14,000	800	8,000	110	230	40	-
P	Right	1,700	5,000	1,300	2,300	500	13,000	5,000	13,000
	Channel	2,400	8,000	500	1,300	8,000	8,000	5,000	2,200
	Left	3,000	13,000	* 2,400	8,000	2,300	13,000	* 23,000	8,000
SG	Right	5,000	2,700	800	1,700	30,000	23,000	17,000	5,000
	Channel	24,000	13,000	3,000	8,000	70,000	13,000	17,000	5,000
	Left	50,000	30,000	30,000	24,000	50,000	30,000	30,000	17,000

Legend: * points of raw water supply abduction by the Cuiaba Water Treatment Company (ETA) to water treatment stations.

- Fecal and total coliform

It was observed that during the drought season in the 'Passagem da Conceição' fecal coliforms were present in the river margins and channel with values of 40 and up to the maximum of 230 NMP.100mL^{-1}. However, during the rainy season the numbers varied from 300 up to 8,000 NMP.100mL^{-1}. Total coliforms at the 'Passagem da Conceição' during drought season varied from 110 and 700 NMP.100mL^{-1}, during the rainy season 1,700 up to 14,000 NMP.100mL^{-1}.

At 'Porto' during drought season fecal coliforms carried from 2,200 up to 23,000 NMP.100mL^{-1}, and during rainy season they varied from 500 to 8,000 NMP.100mL^{-1}. Total coliforms at 'Porto' during the drought season were 500 NMP.100mL^{-1} the lowest and the highest were 13,000 NMP.100mL^{-1}; moreover, during the rainy season the numbers varied from 1,700 to 13,000 NMP.100mL^{-1}.

At São Gonçalo during the drought season fecal coliforms varied from 5,000 to 30,000 NMP.100mL^{-1} and during the rainy season the numbers varied from 800 to 30,000 NMP.100mL^{-1}. Total coliforms at São Gonçalo during the drought season varied from 13,000 to 70,000 NMP.100mL^{-1}, and during the rainy season 2,700 and 50,000 NMP.100mL^{-1}.

- Algae and Cyanobacteria

The highest density observed during the rainy season at São Gonçalo was composed by the following cyanobacteria species: *Oscillatoria (Sect. Attenuate) janthiphora* and *Oscillatoria pseudogeminata.*

During the rainy season at Passagem da Conceição 75 species of algae and cyanobacteria were inventoried, during the drought season 40 species were catalogued. At Porto during the rainy season there were 98 species catalogued and 58 during the drought season. At São Gonçalo 121 species were catalogued during the rainy season and 52 during the drought.

The highest level of species occurred during the rainy season for all three sample locations: Passagem da Conceição, Porto, and São Gonçalo, 134, 185, and 227 algae and cyanobacteria identified respectively. During the drought season 126 species were identified at Passagem da Conceição, 153 at Porto, and 156 at São Gonçalo.

During the period of this case study the richness of the system was represented by 121 species of *Chlorophyceae*, 83 *Bacillariophyceae*, 39 Cyanobacteria, 5 *Euglenophyceae,* and 3 *Xanthophyceae.*

At Passagem da Conceição the five most abundant species during the rainy season were *Eunotia robusta* with 148 individuals, with a frequency of 67% of all samples, *Fragilaria virescens* was present with 67 individuals and 60% of frequency. *Oscillatoria subsalsa* and *Synedra ulna* were present with 18 individuals each, however with different frequencies*, Cyanobacteria* was present in 20% of the samples*.* Bacillariophyta was registered with 11 individuals from sp. *Surirella linearis*, with 46.7% frequency.

During the drought season at Passagem da Conceição the following frequencies were observed: *Surirella robusta* 93,33%, *Fragilaria virescens* with 80%, *Surirella linearis* 80%*, Synedra goulardii* 73%, *Amphipleura lindeheimeri* 53.33%, *Navicula oblonga* 47%, such species were the most abundant during this season and had 106, 365, 57, 26 e 131 individuals respectively.

During the rainy season the most abundant species at Porto were *Pinnularia divergentissima* with 135 individuals and 13,33% frequency, *Eunotia robusta* with 96 individuals and 86,67% occurrence, *Fragilaria virescens* with 83 individuals and 73,33% frequency, *Oscillatoria anguinis* with 40 individuals and 46,67% frequency, and *Closterium acerosum* with 32 individuals and 13,33% frequency.

At Porto during the drought season the five most abundant species were registered as follows: *Fragilaria virescens* with 506 individuals and 86,67% frequency, *Surirella robusta* with 119 individuals and 86,67% frequency, *Surirella linearis* with 58 individuals and 73,3% frequency, *Synedra goulardii* with 49 individuals and 66,6% frequency, and *Oedogonium* sp. with 35 individuals and 40% de frequency.

At São Gonçalo during the rainy season the five most abundant species were registered as follows: *Oscillatoria janthiphora* and *O. pseudogeminata* with more than 1000 individuals (maximum number stipulated by visual calculation) with a frequency of only 6.67% and 20% respectively. The cyanobacteria *Oscillatoria anguini* was present with more than individuals and 73.33% frequency. The species *Oscillatoria margaritifera* had more than 247 individuals and a frequency of only 6.67%, this same frequency was registered for *Oscillatoria sancta* with a total of more than 110 individuals.

At São Gonçalo during the drought season the specie *Fragilaria virescens* was present in the samples with 470 individuals and a frequency of 100%. The same did not occur with the specie *Synedra goulardii*, which had 98 individuals and 80% frequency, *Surirella robusta* had 51 individulas and a 60% frequency, *Surirella linearis* had 42 individuals in a total of 60% of the samples. Cyanobacteria were represented by *Oscillatoria anguinis* with 32 individulas and 46.67% frequency.

The abundance of phytoplankton and cyanobacteria during both seasons in the Cuiaba River, for the three locations studied, was represented by five groups: *Chlorophyceae, Bacillariophyceae, Euglenophyceae, Xanthophyceae* and Cyanobacteria*.*

5 - DISCUSSION

5.1 – DCA and PCA statistical analyses

The results of the principal component analyses of variance applied to the axis derived from DCA, for the algae and cyanobacteria, highlighted the unequivocal importance of the time of the collection in the sample differentiation.

Moreover, the ordinance of the samples, utilizing DCA scores which synthetized the data of the algae and cyanobacteria shows that the rainy season was the one that obtained the highest alternation turnover of species.

The scores of each specie, derivate from DCA, were classified as cyanobacteria or not with the objective of verifying the importance of this criterion in the separation of the identified periods. The results indicated that the cyanobacteria occurred, preponderantly, in the rainy season. Thus, cyanobacteria presented its highest level at this period, as shown in the PCA in Figure 4. Cyanobacteria had preference for highest temperatures, less transparent water, indicating affinity for high turbidness, with high P, Iron, and $SI0_2$ levels.

The highest abundance of phytoplankton and cyanobacteria for this case study was observed during the rainy season, as shown in Figures 5 and 7. Such abundance can be related with the nitrogen, phosphorus and organic matter drag by the superficial waters.

Consequently, the periods were different, especially in regards to richness, level of change in the species composition among the samples, and the predominance of cyanobacteria. Specifically, all three characteristics were higher during the rainy season.

The predominance of flourishing cyanobacteria at the location studied is worrisome, as some genera found in this study have specie cited as capable of producing toxins and releasing them into the river. Furthermore, the excessive proliferations of this specie alter the aquatic biota. The release of toxins by these species promotes human intoxication, by drinking such water or recreational activities, and it also alters the water quality produced by the water treatment stations. Its predominance is a result of the enrichment of the waters with nutrients, a direct result of the discharge of raw sewage into the river (Messias, 2002).

5.2 - Physico-chemical properties

- Water transparency

The transparency of the Cuiaba River water presented seasonal variation pattern. The highest water transparency level were obtained during the drought season months (July – August) to all three location. The highest level of water transparency was 1,40 m at Passagem da Conceição between 6 a.m. and 12 noon on August 22. The lowest levels were registered during the rainy season: 0.20 m.

- Total solids

The increase on total solids, in all three locations, during the rainy season, ranging from 82 to 577mg.L^{-1} was due to the soil leaching into the river. During drought seasons solid total levels were low varying from 39 to 280mg.L^{-1}.

- Turbidness

Turbidness was highly variable at the three locations in relation to seasonality: low during the drought season between 5 and 10 uT. During the rainy season turbidness was relatively high at all locations. At São Gonçalo the values varied from 20 to 70 uT. Porto presented intermediate properties between 20 and 40 uT. Similarly at Passagem da Conceição the results varied from 20 to 50 uT. A slight increase in turbidness was noted, in case turbidness levels reflected the anthropic influence on aquatically organisms, from the rural area until the urban area, which are manifested by the increase in organic and inorganic solids in suspension.

In regards to the seasonal distribution, the highest turbidness level occurred during the rainy season, and it was associated with the entrance of materials in suspension with superficial water, a disturbance of the water column. A positive association between turbidness and precipitation was observed at São Gonçalo at 4 p.m., right after a severe thunderstorm.

- Color

All three locations, during the drought season, maintained a homogenous distribution between 2.5 and 10 uC if compared with the rainy season where the levels were between 80 and 185 uC. At São Gonçalo there was a high variance between the margins and the channel.

- Water temperature

The water temperature values were homogeneous in all three locations, with maximum of 28°C and 31°C during the rainy season, and 23 to 25°C during the drought season. The seasonal variations of temperature at a same location were superior or equal to the ones observed between the different locations. As a result, this variable could not have influenced the physico-chemical and biological differences at this excerpt of the river. Such small extent can be explained by the fact that the local weather is hot and humid with small temperature variation during the entire year.

- Electrical conductivity

The values of electrical conductivity showed an annual variation, probably controlled by the water cycle, presenting during the drought season a profile with similar values. Likely, during the rainy season, due to the high precipitation, salts were diluted by the highest water volume, which registered low values of electrical conductivity, varying from 57 to 82,3 $\mu S.cm^{-1}$. Such numerical oscillation can have happened due to the allochthonous material carried by the rain. Data highly varied in all locations during the nychthemeral study.

- pH

The pH dominant at all stations sampled was neutral, with lower values at São Gonçalo, around 7.77 in the rainy season and 7.75 during the dry season. These values can be related to the concentration of carbonate and bicarbonate, naturally present in its waters, the influence of soil type and weathering of rocks, and the photosynthetic production.

At São Gonçalo, in the rainy season, the lowest values 7.02 and 7.12 indicate that it may correspond to entry points of water with industrial waste, it also occurs in the dry with the values 7.30 and 7 32. Such numbers are related to the lower pH of these wastes and the decomposition activity of microorganisms that release CO2 and organic acids.

- Alkalinity

Low concentrations of alkalinity were observed in the flood season, with values of 10mg.L-1 CaCO3 in 'São Goncalo'. The highest average concentrations were recorded during the drought period, with values of CaCO3 40mg.L^{-1} for the season 'Passagem da Conceição', 43mg.L^{-1} CaCO3 at Porto, and 37mg.L^{-1} CaCO3 at São Gonçalo.

This pattern of maximum concentration in the dry season is due to ion-rich groundwater of the Cuiaba River. In contrast, the lowest concentrations observed during the rainy season indicate a dilution effect that is characteristic of seasonal tropical rivers (Payne, 1986).

- Dissolved Oxygen (DO)

In all three locations predominated high concentrations of dissolved oxygen, with close averages, and in three points higher than the saturation levels. This behavior was observed in the two seasons, both in the center and margins of the river.

Passagem da Conceição, Porto, and São Gonçalo in the rainy season had the highest values of saturation ranging from 100%, 101% and 101%, respectively, on the right bank and the channel, during the hours of 8:00 a.m. for Porto, 12 p.m. for Passagem da Conceição, and 10 a.m. for São Gonçalo. Cuiabá River has rocky outcrops in the riverbed, with significant slopes and this may contribute to the oxygenation of the River.

The values closer to saturation, and even higher during rainy periods occurred at times of intense lighting and the right edges of Porto and São Gonçalo. The left bank of the Cuiabá River receives most impacted tributaries that flow into the areas around Porto and São Gonçalo. Passagem da Conceição, which is upstream of the other two locations, higher saturation values were recorded at 12 p.m. in the River channel.

On Passagem da Conceição in the rainy season, between the hours of 6:00 a.m., 12:00 a.m., 6:00 p.m., and midnight, large variations in oxygen occurred, but no significant differences between the points and the banks of the canal. The lowest dissolved oxygen occurred at 6:00 p.m. in all sampling points for this location.

On the other hand, during the dry season, there was little variation of dissolved oxygen at midnight, indicating a slight difference between the banks and channel. It was recorded shortly after 6:00 a.m. a slight increase in OD.

At Porto predominated dissolved oxygen concentrations or supersaturated with values close to 105% at 08:00 a.m. This value corresponded to the points in center and the left bank of the river, it was observed in the left margin a high density of algae. The lowest values around 85% to 80% in the right margin were determined at 8:00 a.m. and 2:00 p.m., possibly influenced by discharges of storm water contaminated with sewage and high temperature.

At São Gonçalo in the rainy season the lowest values of dissolved oxygen were observed at 4 p.m., 10 p.m., and 10 a.m., which are associated with the consumption of dissolved oxygen by aerobic microorganisms in the biodegradation of organic matter from sewage, coming from streams with high BOD loads originating from homes, businesses and industries, and agricultural land surrounding the basin. The sharp decrease of DO in São Gonçalo, in the rainy season at 4 p.m., probably could have been caused by water turbidity due to rain on site. For the drought OD curves maintained a homogenous profile, with the exception of samples collected at 4 a.m. with decreasing concentration, which has occurred gradually.

- Total nitrogen

The concentration of these nutrients increased significantly in the station of São Gonçalo in the rainy season. In Passagem da Conceição and Porto were found the lowest concentrations of nitrogen, with values between 0.135 and 0,673mgL^{-1}. In none of the stations studied there was a definite pattern of horizontal distribution and seasonal periods which differentiated between the dry and rainy seasons. At Porto the lowest concentrations observed during the rainy season may be associated with dilution.

The highest amount of nitrogen determined in Porto and São Gonçalo correspond to sites with water discharges from the streams, water from the sewer outlet, which are used as the final destination of sewage, to the final destination of the Treatment Plant Effluents of "Dom Aquino”, sewage industries allocated near the river and also by direct links of the homes and commerce.

- Total phosphorus

Measures of phosphorus showed variations of well marked tracks, low in the dry and high in the flood season. Phosphorus levels were between 0.07 and 0.17 mg.L^{-1} for Passagem da Conceição in the rainy season. In drought periods the values were homogeneous throughout the nychtemeral verification, with a slight variation to the channel and to the margins, between 0.002 and 0.03 mg.L^{-1}.

Similar to what happened at Passagem da Conceição was repeated at Porto: higher concentration of phosphorus in the rainy season. It was also observed only a small change in the left margin, which was expected, due to the contributions of the impacted tributaries which have their outfall at that point.

For the station of São Gonçalo, in the rainy season, the phosphorus concentration was higher in comparison with the other two stations, in regards to the seasonal observation. This nutrient was higher and the sampling sites were always fluctuating. The values for the wet period was between 0.10 to 0.22 mg.L^{-1} and the dry season, from 0.02 – 0.2mg.L^{-1}. The left margin has increased in comparison with the other two.

- Total Calcium, total Iron, and Silica

As for the seasonal and temporal distribution of Total Calcium in the stations studied L^{-1} during the wet season, concentrations of calcium were around 60mg.L^{-1}.

Total iron concentrations did not exceed in the period of drought 1.00mg.L^{-1}, but with a small increase in the rainy season, reaching 5.00 mg.L^{-1}.

The levels of Total Silica observed during the rainy season ranged from 2.96 to 4.44 mg.L^{-1}. Total Silica showed higher concentration in this period than during the dry season, never exceeding 0.50 mg.L^{-1}. The values obtained in the rainy season are due to the factor of entrainment of interstitial waters from the soil.

- BOD_5 – Biochemical oxygen demand

The BOD_5 was very different in all three locations: high and extremely heterogeneous in all seasons and at all points. It reflected the increase in anthropogenic influences associated with the location of streams.

At Passagem da Conceição values ranged from 1.5 to 2.5 mg.L^{-1}.The spatial fluctuations are characterized by higher values at the right margin, in the dry season, by increases in most points during the rainy season. Higher values, between 3 and 3.03 mg.L^{-1}, were recorded in rainy season, and two points on the right margin and the channel. It is assumed that these high values 12h00 are due to the large volume of water, stirring the sediment from the river and also by the mixing of water mass.

BOD_5 values were very different among the three locations, and it is observed that there were marked increases in the rainy season. These differences relate to whether or not input of organic material from the watershed, depending on the type of activity performed in the basin, and the types of waste generated, which are dragged along by the current downstream.

5.3 - Sanitary conditions

Microorganisms indicators of fecal contamination are used for the assessment of water quality, from a bacteriological point of view. Bacteriological standards of water quality at national and international level, are based on the detection and enumeration of coliforms, fecal coliforms and *Escherichia coli*.

The study conducted in the Cuiabá River, in the three sampling stations along a gradient of organic pollution indicated that concentrations of total and fecal coliforms were growing starting at Passagem da Conceição to Porto and from Porto to São Gonçalo, following the increased human influence.

The pattern of spatial variation was similar in both seasonal periods. The highest values were consistently on the left bank of the Cuiabá River, where there is greater impact of pollute discharges.

At Passagem da Conceição in the rainy season, samples collected on the first day, 02/17/1999, presented results of less than 1,000 MPN 100mL-1, and Table 5 shows these values. That same day, after collection, there was a rainfall at 4 p.m., thus altering the results of the collection the following day, 2/18/1999, bringing the number of coliforms to 8,000 MPN 100 mL^{-1}. During dry periods all samples from the Passagem da Conceição results were lower than 100 NMP 100 mL^{-1}.

At Porto, the values of fecal coliform bacteria were high in both seasonal periods. Extreme variations may be associated with the entry of water from streams in the river with a considerable load of domestic sewage.

At São Gonçalo it was registered, for the two times studied, fecal coliform values of up to 30,000 MPN 100 mL^{-1}.

5.4 – Cyanobacteria

Surface waters in recent decades have suffered impacts due to urbanization with increasing loads of pollutants released in water bodies, becoming increasingly prone to eutrophication and excessive proliferation of cyanobacteria and algae.

In aquatic environments can be found representatives of almost all groups of algae and cyanobacteria. The main groups in relation to health aspects, are the Cyanobacteria, chlorophytes, diatoms and phytoflagellates; Cyanobacteria are considered the most problematic due to their toxic potential to public health.

Several cyanobacterial blooms, restated, principally by the genus *Oscillatoria* were observed, identified, and had their genera quantified. Several factors can affect the proliferation of these groups, among them the high loads of nutrients in the water, mainly phosphorus and nitrogen compounds, increased light intensity and water temperature around 15 to 30 ° C, pH between 6 and 9 high evaporation rates during periods of drought (Azevedo *et al*., 2002).

In Brazil, cyanobacterial blooms have been increasing in intensity and frequency. Most cyanobacteria produce toxins inside the cells, cyanotoxins, which are released into the water through the disruption of their cell membrane. This process may occur due to natural mechanism or death, or so induced, for example, using chemicals. Microcystin is one of the cyanotoxins produced by cyanobacteria species found in Brazilian environments and is recognized by WHO (WHO, 2001) as causing intestinal disorders, liver damage and can lead to death. The only confirmed case of death due to cyanotoxins occurred in 1996 in the town of Caruaru (PE), where the water used to perform hemodialysis sessions were contaminated by microcystin, resulting in the death of 60 patients (Azevedo *et al*. 2002).

Faced with this reality, the Ordinance of the Ministry of Health (Brazil, 2004), which "establishes the procedures and responsibility for the control and monitoring of water quality for human consumption and pattern and drinking", inserted the microcystin-LR as required parameter in monitoring treated water with a maximum allowable $1\mu g.L^{-1}$, and at the same time, it recommends monitoring of water bodies.

About 40 species of cyanobacteria can be toxic (Azevedo *et al*., 2002). Among the toxins produced by cyanobacteria stand out hepatoxins and neurotoxins. Carmichael (1989) notes that among the species of cyanobacteria that produce toxins and also form blooms are *Anabaena flos-aquae*, *Oscillatoria* spp*.* and *Nodularina spumigena.*

Hepatoxinas are usually produced by species of *Microcystis, Nodularina, Oscillatoria* and *Nostoc.* Such species act in the liver, causing disintegration and rupture of the internal structure of the organ. The molecules are hepatoxins cyanobacterial cyclic peptides with 5 or 7 and low molecular weight, or nodularinas microcystins. Animals with hepatotoxicosis are put to death after cytoskeletal changes of liver cells, causing lethal intrahepatic hemorrhage or liver failure (Matthiensen *et al*., 1999). On a molecular level, microcystins act as an inhibitor of protein phosphatase 1, so their exposure to sublethal doses can contribute to long-term development of cancerous tumors (Carmichael, 2001).

This was the first study reporting the occurrence of cyanobacteria in this location, with the formation of blooms. Four families of cyanobacteria: *Capsosiraceae, Chroococcaceae, Oscillatoriaceae,* and *Tubiellaceae* were identified*.* Some species of these families are capable of producing microcystins and releasing them in the water mass.

Among the cyanobacterial genera identified in this study, there was a predominance of *Oscillatoria, Crinalium, Lyngbya* and *Lithococcus.* Among the locations sampled, São Gonçalo was the one that, in the rainy season, presented a very high density of cyanobacteria.

The association of the species Oscillatoria with eutrophic conditions (observed at São Gonçalo) in the rainy season, indicated its affinity with polluted and/or contaminated water. The increase in frequency of appearance of this genus tends to follow the plume of pollution. The physical-chemical, biological and health related results and the response from the cyanobacteria community through the alloctones, along with the seasonal period, showed a continuous gradient of pollution.

The group of cyanobacteria was present in all three locations, with less frequent occurrence at Passagem da Conceição and Porto, and high occurance at São Gonçalo. The largest number of individuals was evident on the left bank of the river in the rainy season. It is assumed that the different distribution of cyanobacteria in dry and wet seasons, reflects the circulation pattern of water and pollutants into the stream.

It is essential the constant monitoring of the occurrence of cyanobacteria blooms to understand the life cycles and development of these organisms as well as to assess the potential risk to all aquatic biota and local populations.

At the same time, water from public reservoirs that are supplied by the Cuiabá River and other surface water sources that supply the population must be analyzed, in order to avoid problems caused by cyanobacteria, by controlling the development of blooms.

5.5 – Properties of group populations

Thirty two families of algae were surveyed in the Cuiabá River in the urban stretch. The Class *Chlorophyceae* was the one with the highest frequency, represented predominantly by *Desmidiaceae*, followed by *Bacillariophyceae* with a significant representation of *Naviculaceae,* later by Cyanobacteria *Oscillatoriaceae* whose family was present in greater numbers.

Regarding the composition of communities, São Gonçalo had the highest density in the rainy season. The highlights were the species *Oscillatoria janthiphora, Oscillatoria margaritifera, Oscillatoria anguine,* and *Oscillatoria pseudogeminata subbrevis.* For the dry period, the highest species diversity was represented by the class *Bacillariophyceae, Fragilaria virescens,* which were observed at all times and at all points of this study.

The species of algae of the Cuiabá River revealed, in general, notable differentiation in regards to tolerance to pollution. In the stretch with high pollution load it was observed predominant species of Cyanobacteria that corroborates with the information from Palmer (1969), who considered the group, and particularly the species of *Oscillatoria,* as the most tolerant to organic pollution.

The species *Chlorophyceae* were observed at points not heavily polluted.

In the rainy season, it was registered the presence of different species of algae in most points in all seasons of the study. These results can be explained by considering the entry along with nutrients and organic substrates from the drainage area of the basin, as well as increased endogenous multiplication.

The class *Bacillariophyceae* dominated in abundance in the rainy season in Passagem da Conceição, with species *Eunotia robusta* and *Fragilaria virescens*, and dry season with *Amphipleura lindheimeri*, *Fragilaria virescens, Surirella linearis* and *Surirella robusta.*

At Porto in the rainy season there was an abundance of species *Eunotia robusta* and *Fragilaria virescens*, occurring at all times and sampled points. At Passagem da Conceição and Porto it was observed the predominance of *Bacillariophyceae,* at São Gonçalo, cyanobacteria were also abundant.

Analyzing the results by location, Passagem da Conceição despite having less environmental impact and hence better preserved, showed similarity in prevalence of phytoplankton groups when compared to Porto.

At Porto *Bacillariophyceae* were dominant during the two periods. In the rainy season, both species had high values: *Eunotia robusta*, with 96 individuals and *Fragilaria virescens*, 83 and this indicates a possible dominance of the species. In drought periods, the species *Surirella linearis, and Surirella robusta* and *Surirella goulardii* dominated, while the highest peak of Diatoms, was in the dry season, basically constituted by the species *Fragilaria virescens.*

The location São Gonçalo, place great contribution of domestic and industrial effluents, was represented in a very heterogeneous form from the others. There was alternating predominance of phytoplankton among green algae, especially the species *Geminela minor* and *Plectonma porpurum* and between diatoms, which peaked in the dry season and also in the rainy season, with predominant species of *Eunotia robusta* and *Fragilaria virescens* in all times and points.

Cyanobacteria at São Gonçalo were more dominant in the rainy season, with countless individuals of the species *Oscillatoria janthiphora, Oscillatoria margaritifera, Oscillatoria anguine, Oscillatoria pseudogeminata, Oscillatoria Oscillatoria sancta* and *subbrevis.*

The rainy period showed higher species richness. Among the three locations studied, Porto and São Gonçalo where the ones that during the rainy season had the largest number of species identified. These two locations are located at points of greatest anthropogenic impact. By analyzing the diversity of phytoplankton and cyanobacteria in the Cuiabá River there was a greater diversity and density of these organisms in organic sections where evictions are more pronounced (Porto and São Gonçalo). The lower diversity corresponded to the stretch of lower concentration of organic matter (Passage of the Conception) in the dry season. The study of variations in species richness of phytoplankton and cyanobacteria showed the highest values (130 species) in the rainy season in São Gonçalo.

During the rainy season there was an increase of total solids, turbidity and color, phosphorus, iron, silica and reduction of water transparency, alkalinity, conductivity, calcium, several species showed positive correlations with these variables. Cyanobacteria predominated in high water, indicating higher affinity for eutrophic environments. The species *Oscillatoria anguine* was the most prevalent (73.33%) and took first place in the occurrence of a set of 15 samples analyzed, occurring in 11 samples.

The greater affinity of the genus *Oscillatoria* with most polluted environments was demonstrated in this study. The genus was observed in all three locations, but with a small representation in Passagem da Conceição and Porto in both periods. However, *Oscillatoria* was present in greater numbers in São Gonçalo during the rainy season, indicating a positive association with higher levels of phosphorus and total coliform bacteria which enter with the raw sewage that is discharged on the streams. In the rainy season its presence is possibly an indication that it has been transported with the water runoff from the drainage area or introduced by streams and rivers flowing into the Cuiabá River. Although it can be pondered of a redistribution of endogenous cyanobacteria in surface water from the highest eutrophic sites.

6 – Conclusion

- The sanitary conditions, biological and physic-chemical

The analysis based on the physico-chemical and biological variables shows an increasing gradient of eutrophication. The input of allochtonous material, nutrients and bacteria of fecal origin, coupled with the presence of cyanobacteria was the cause of the deterioration of the trophic conditions and health of the Cuiabá River in the stretch under study.

The variables of turbidity were determined mainly by the rain. In the rainy season increased turbidity and fecal indicator bacteria were consequences of the transport of soil material and the increase in the flow rates of the affluent streams contaminated with sewage.

The exogenous supply of total bacteria/coliforms, dissolved oxygen and nutrients influenced the characterization of the stretch under study. The increase in BOD_5, at certain points, expressed the influence of organic matter committed by the drainage watershed.

The greater presence of *Oscillatoria* spp*.* in the waters impacted by inputs of nutrients, at São Gonçalo, suggested an ongoing process of eutrophication in this excerpt from the study.

In the aquatic system studied there was defined associations between cyanobacteria species and eutrophic levels and both relate to the concentration of biodegradable organic matter. The largest anthropogenic pressure observed in the ecosystem in the study were domestic sewage.

Taking into account that the waters of the River Cuiabá are used for human supply of cities through which it permeates, and that with the population growth of these municipalities, mainly Cuiaba and Várzea Grande, there will be a further pollution of the waters surrounding the basin, it is essential that measures be adopted to reduce water pollution.

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"This article is part of the masters project of the PhD candidate (University of Brasilia - UnB) Orlandina Martins dos Santos Messias which was defended and completed in 2002 at the Federal University of Mato Grosso – UFMT"

The authors are grateful for the translation of this article
by Luanna Martins Jendrey
and Indira Martins Messias.