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Anthropogenic Effects on the Water Quality at a Pond in the Amazon Region

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The Lake of the Francesa located in the city of Parintins - Brazil, receives industrial and domestic wastes, whose composition is varied by changing the natural characteristics of its waters. Some tests were performed in the water at four different points along the length of the pond in February and June 2010, the period of the low and high level of lake water respectively (period for seasonal phenomenon that is influenced by the region's natural Amazon) and analyzed the following parameters: pH, alkalinity, turbidity, color, hardness, dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD) and fecal coliforms. The values obtained in different periods were compared with the aim of identifying and evaluating the variables that affect water quality in these periods considering the seasonality in the volume of pond water. The parameters alkalinity, turbidity, color and hardness showed lower values during the high water of the pond. The pH tended to neutrality in both periods. For the biological parameters, the values diverged, with no variation for BOD, COD had higher values in the period of high water. And the OD showed lower values in the period of high water. Fecal coliform was the parameter that indicated a greater change in water quality due to domestic and industrial effluents that are released into the pond without proper treatment. The study showed that despite the human contribution, the pond still keeps its ability to dilute pollutants, mainly during the period of high water (flood).

1. Introducion

Nowadays water pollution is a matter to be addressed in a global context. The quality of water for consumption, irrigation, or even the quality of the fish of the river or reservoir, are the most challenged them when they are laid waste. To ensure flora and fauna life of rivers and ensure the intake of a substance that is not harmful to human health, water quality should be evaluated by the analysis of some physical, chemical and biological characteristics parameters.

Water is considered polluted when it contains anthropogenic contaminants, compromising their use for the purposes it is intended. The main ways of contamination of a watercourse are chemical, physical and biological. The chemical changes the composition of the water by reacting with the environment.

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The physical form, in the other hand, although not promote reactions may adversely affect the life of the ecosystem. The organic form is the introduction of foreign microorganisms or organisms to that ecosystem, or the increase of certain harmful organism or an existing microorganism.

Particularly in Brazil, as reported by Pinto (2009), in the Amazon region, the contamination of streams and lakes has become one of the most relevant, because in addition to visual pollution has been growing contamination of water supplies by toxic metals generated by human activities and the treatments are difficult and expensive. Because of high biodiversity and the largest fresh water reserve, it is intended with this study to evaluate, through physico-chemical and biological to human influence in the waters of Lake of the Francesa located within the Amazon region.

2. Materials and Methods

2.1 Discrimination of the study area

The study area called the Lake of the Francesa is located near the urban area of Parintins city - Brazil inside the world's largest river basin, the Amazon basin. The size of the pond is totally seasonal, is directly connected to the natural phenomenon of the inundation that is characteristic of this region.

Figure 1 shows the mapping of the lagoon during the flood season, with the possible pollution sources and water collection points used in this study. During the flood season, the flow of boats is intensive in the lagoon, wich works as a port of embarkation and disembarkation for the local population as well as shelter for the local boats. It is noticeable that the pond is supplied directly by the Amazon river, principal river of the Amazon basin.

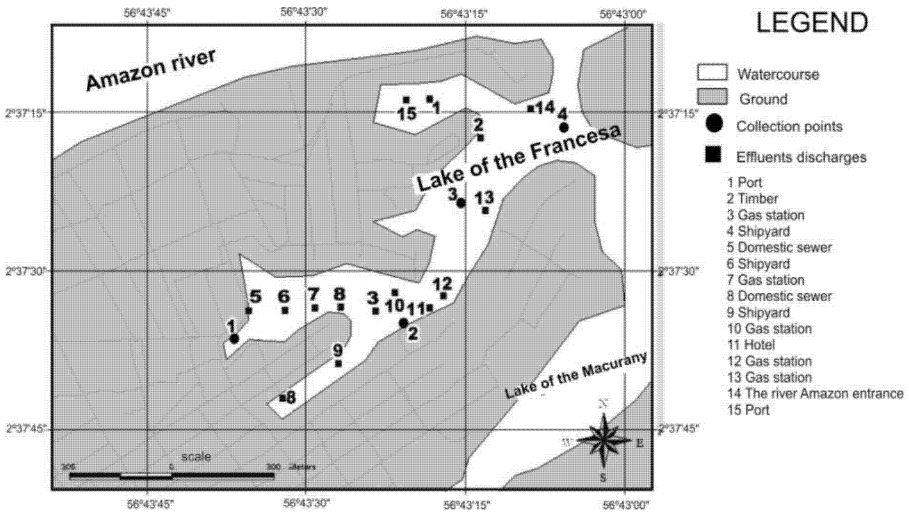

Figure 1 – Location of collection points of the Lake of the Francesa

2.2 Collecting samples

Water samples were collected in duplicate, on the surface to about 20 cm depth at the four points that are represented in Figure 1, in February 2010 (period of flooding of the pond) and in June of 2010 (which corresponds the maximum volume of water from the pond). They have been properly stored in polyethylene containers with a capacity of 500 ml, sealed and transported for analysis.

2.3 Characterization of water

PH measurements in water were determined by potentiometric method using a pH-meter with the brand OAKLON and pH paper.

For determination of the alkalinity was used titration method which consists of electromagnetic titration analysis in water by means of a strong acid to a pH value previously selected. The acid solution was prepared with HCl 0.02 M. The final values of alkalinity were obtained after calculations using Equation 1:

$$\frac{Alk}{mmol/L} = 1000 \times \frac{V_{ác}}{V_a} \times \frac{C_{H^+}}{mol/L} \quad (1)$$

where $V_{ác}$. is the volume of spent acid by titration, V_a. is the sample volume and C_H^+ is the molar concentration of hydrogen in acid solution in mol / L. The method has as a reference pH values as points of equivalence according to the level of alkalinity in mg / L $CaCO_3$, as indicated in Table 1. The pH value was above 4.3 for determining the alkalinity of the samples.

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*Table1 – P*oints of equivalence

$\frac{Alc_{CaCO_3}}{mg/L}$	Total alkalinity pH	Alkalinity to phenolphthalein pH
30	4.9	8.3
150	4.6	8.3
500	4.3	8.3

To determine the true color analysis, was performed the method using the photoelectric, according to World Health Organization - WHO, these standards represent good indicators of contamination in water. The samples were centrifuged to determine the true color. The equipment used was a UV-Visible System HP 8453 and 455 nm wavelength. This same equipment was used for determination of turbidity, with a wavelength of 580 nm. It used formazine as a standard solution (400 NTU).

To determine the hardness was measured the level of concentration of calcium (Ca^{2+}) in water samples by atomic absorption spectrophotometry.

For the analysis of biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), dissolved oxygen (DO) and fecal coliforms were evaluated using the "Standard Methods for the Examination of Water and Wastewater" (2005).

3. Results and Discussion

According to Richards (1954), the strong dependence of water quality in relation to sampling time, being greatly influenced by the variation of water level. This can be observed for some analyzed parameters, as shown in Table 2.

Table 2 - Distribution of results obtained in February and June 2010

Collection points	1		2		3		4	
Collection months	**Feb**	**Jun**	**Feb**	**Jun**	**Feb**	**Jun**	**Feb**	**Jun**
pH	6.38	6.65	6.43	6.75	6.56	6.57	6.78	6.78
Color[UC]	86.57	54.94	74.63	59.13	99.30	61.79	139.7	67.22
Turbidity[UNT]	23.106	14.396	48.385	12.529	63.805	12.155	56.339	11.744
Alkalinity [mg/L $CaCo_3$]	91.700	51.605	67.580	52.386	63.456	48.963	40.355	36.973
HardnessCa^+ [mg/L]	4.015	2.371	3.103	1.971	2.896	1.980	2.757	1.819
BOD[mg/L] O_2	< LQ*	< LQ	< LQ	< LQ	< LQ	< LQ	< LQ	< LQ
COD[mg/L] O_2	24	33	16	55	13.5	31	5	27.5
DO[mg/L] O_2	7.90	2.95	8.05	3.35	8.15	3.55	8.25	4.25

**LQ - Limit of Quantification Method 3 mg/L*

3.1 pH and alkalinity

To Bringel et al (1984), rivers and streams with lower water levels, have higher pH values. However, the pH results described in Table 2 vary from 6.38 to 6.78 (February) and 6.40 to 6.75 (June) showing that this parameter remained closer to neutrality during the different periods of collection. A little variation between the months of February and June, indicates that the effluents presented little influence on this parameter. According to Santos (1988) the pH of the Amazon River main feeder of the lagoon waters, showed a value of 6.39 at the edge of Parintins city - Brazil, and kept for this parameter, the natural characteristics of white-water rivers of the Amazon with a pH around 7.

The alkalinity values were reduced in June at all sampling points, this decrease can be attributed to the solvating power of pond water due to its high level.

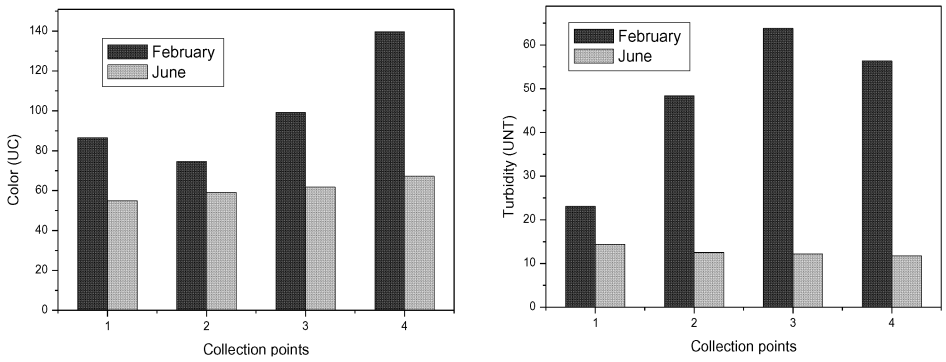
The collections points are arranged according to urban interference, the point 1 is the closest to the urban area and point number 4 the most distant, the variations are very significant from one point to another. Although there was a reduction in alkalinity between the two periods, it is noted in both months that higher values occurred in the immediate vicinity of urbanized area, which can be attributed to the effluents that are released into the pond.

3.2 Color and Turbidity

Compared with February, the color showed a significant decrease in June at all sampling points, as shown in Figure 2a, this difference can be associated with dilution due to the maximum volume of water in the lagoon during this period (high water season - flood).

The high water stain on February sampling (Table 2) is attributed to a natural source. The iron is present in insoluble form (Fe^{2+}) in a large amount of soil type. If water containing the reduced form (Fe^{2+}) is exposed to ambient air, the iron oxidizes back to its insoluble form (Fe^{3+}), which can cause color in water. Geologically, the predominant soil in the region of Parintins is located where the pond is yellow Oxisol alic and red yellow alic podzolic, which are soils rich in iron oxides.

Similarly, the turbidity parameter showed a significant reduction in the sampling in June, according to Figure 2b, which is consistent with the elevation of the pond water, attributing this reduction to the solvating power of water.



(a) (b)

Figure 2 - Distribution of (a) color and (b) turbidity of the lagoon in February and June 2010.

3.3 Hardness

There was also a reduction in hardness for all sites. This reduction occurred in June may have been occasioned by the rise in water level of the pond, which consequently increases the dissolved minerals dilution power. The values reported in Table 2 ranged from 2.757 to 4.015 (February) and from 1.819 to 2.371 (June). The pond water in the "lake of the Francesa" can be considered as very soft and good quality.

3.4 BOD, COD and DO

The DO decreased in June, probably due to increased organic matter coming from the drains of the houses and boats. The high level of water promoted the disposal of these effluents directly into the pond. The organic matter of biological origin is usually oxidized by DO on water. There was no correlation between DO and BOD in June, the figures remained below 3, which may be indicative of poorly biodegradable present in the effluents. In the same period showed an increase in the COD results reinforce this idea.

3.5 Fecal Coliforms

The fecal coliform rate in the sampling points 1, 2 and 3 (Table 2) showed results above the limits recommended by Brazilian legislation with the exception of point 4, which remained within the limits required. These high rates indicated changes in water quality caused by the effluents that were released into the pond. It was not possible to determine values in February. However, this parameter was the best indication of interference on urban water quality pond.

Table 2 - Results of fecal coliform bacteria in June

Collecting point	1	2	3	4
Fecal coliform UFC/100 mL	65.000	45.000	42.000	450

The largest urban concentration is located in Sections 1, 2 and 3, point 4 is the only no urbanized area is located in the lagoon. During the flood, the pond river traffic increases serving as a shelter for vessels, and generates more than one aggravating because they are not equipped with manure storage system for later disposal in appropriate locations.

4. Conclusions

The study showed that the lake still retain its abilities to dilute pollutants especially during the high level water, the flood.

In the rainy season, the values of alkalinity, turbidity, color and hardness showed a significant reduction. The pH showed little variation with a tendency to neutrality in both periods, maintaining the characteristics of the Amazon - Brazil. For BOD, COD and DO values differ between periods. Fecal coliform was the parameter that indicated a greater change in water quality due to effluent from the houses and boats that use the pond for shelter in the rainy season, these effluents are discharged directly into the pond without proper treatment.

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