HEAVY METALS CONCENTRATION INFLUENCE ON AQUATIC MACROPHYTES, SEDIMENT AND WATER IN LAGOA DA FRANCESA (PARINTINS -AM)

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SUMMARY – Among environmental contaminants in the water, the heavy metals are relevant for being cumulative and can reach all the trophic chain. Depending on the environmental conditions, these elements may have mobility between sediment, water and plant biomass in an aquatic environment. The concentrations of heavy metals copper (Cu), cadmium (Cd), lead (Pb) and chromium (Cr) in sediment, in water and in two species of aquatic macrophytes (*Eichhornia crassipes* and *Paspalun repens*) identified in the Lagoa da Francesa (Parintins / AM) were measured and evaluated. The samples were collected in July 2012. Cd was not found in the macrophytes and in the sediment. Pb showed higher concentrations in the water. The metals Cu, Pb and Cr presented higher concentrations in the roots of macrophytes, whereas *Paspalun repens* macrophyte cumulated higher concentration of Pb in its shoots (leaves).

1. INTRODUCTION

The degradation of aquatic environments by heavy metals is related to the increase of unbridled human activities mainly the industrial sector. According to Ebrahimpour and Mushrifah (2008) the presence of metals in water comes from natural sources or anthropogenic such as domestic and industrial effluents mining process or by the use of pesticides in agriculture.

The aquatic ecosystems have the capability to assimilate and neutralize toxic substances, through biological, chemical, and physical mechanisms. However, according to Cooney (1995) when the contaminants exceed the capacity of purification of those water bodies, the present organisms in the aquatic environment can suffer mischief in its cycle of life or even in its behavior. For Goulart and Callisto (2003) as a result of these activities, is a sharp decline in water quality and loss of aquatic biodiversity, according to the breakdown in the physical environment, chemical and amendment of natural dynamics of the biological communities.

The heavy metals become one of the main environmental problems due to their low degradability, its power of bioaccumulation and toxicity to living organisms. Levent Tuna *et al.*

(2007) described metals as stable and persistent environmental contaminants that cannot be degraded or destroyed. They may affect the biota to be incorporated into the food chain and therefore cause damage to human health (Khan *et al.*, 2005).

According to Chen and Folt (2000) the concentration of metals in water, nor always expresses the concentration of metals in biota, and may be available in water, sediment and in living organisms present in the environment. As well as others composed, Shrivastava *et Al.* (2003) reported that the metals can occupy different compartments in the aquatic environment, the sediment can accumulate metals may make them available to the water column depending on the environmental conditions, making them bioavailable.

In addition, according to Samecka-Cymerman and Kempers (2007) the concentration of metals in aquatic macrophytes can be greater than the concentration of the aquatic environment in which they are inserted. Mishra *et al*. (2008) reported that this value can be up to 100 thousand times greater. For Mikryakova (2002), aquatic macrophytes are considered resistant organisms to heavy metals, and may absorb high concentrations of these elements, and Brekhovskikh *et al*. (2002) affirm that such a condition may not alter functional changes evident. Therefore, according to Valitutto *et al*. (2006) they can be used as biomediators.

In this context, this study aimed to evaluate the provision of copper (Cu), cadmium (Cd), lead (Pb) and chromium (Cr) in water, sediment and in the species of aquatic macrophytes *Eichhornia crassipes* and *Paspalun repens* presented in “Lagoa da Francesa” that may be associated with the indiscriminate release of domestic and industrial sewage.

1.1. Description of the localities of study

“Lagoa da Francesa” is located in the municipality of Parintins/AM, has an area of 5,952 km^2 and a population of 102,033 inhabitants (IBGE, 2010). The municipality stands out as one of the main cultural heritage of Latin America because of the "Parintins Folk Festival", which currently occurs throughout last weekend in the month of June. This event causes an intense flow of tourists and an increase of vessels that remain anchored on the edge of the city during the festive period. It has tropical climate, rainy, with small dry season (August to October), relative humidity around 71% and precipitation annual rainfall of 2,327 mm.

The city is surrounded by lakes and “Lagoa da Francesa”, place of study as shown in Figure 1, which is of vital importance in the economy of the city, because it serves as port for the regional boats of small size. By bathe the seat of the municipality, the lagoon is more susceptible to damage caused by anthropic influence. At the margins of “Lagoa da Francesa” is located one of the most wanted hotels by tourists, which happens to improve the quality of water in “Lagoa da Francesa” a factor of considerable importance also for the economy of the city.

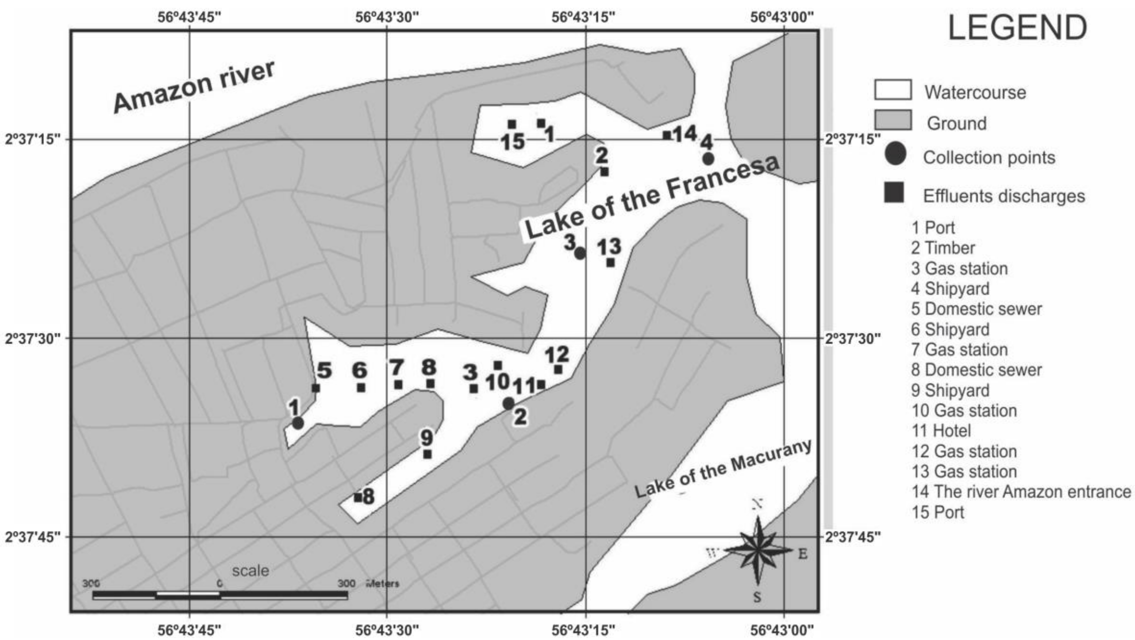

Figure 1 – Location of collection points of "Lagoa da Francesa" (Parintins – AM).

2. MATERIAL AND METHODS

The collections were carried out the in July of 2012. For the selection of sampling points the influences of environmental impacts generated by urbanization, by service activities in the lagoon were considered. The sampling locations were geolocated and are described in Table 1.

Table 1- Location and description of the sampling points.

Point of collection	Description	Geographical Coordinates
F1	Staircase in the lagoon - influence of sewage Domestic, dumps of vessels	(S) 02º37.604 (W) 056º43.610
F2	Hotel / fuel Station Floating - influence of domestic sewage	(S) 02º37.577 (W) 056º43.343
F3	Timber / fuel Station Floating	(S) 02º37.391 (W) 056º43.255
F4	Entrance/Exit of the lagoon - Area of lower urbanization	(S) 02º37.278 (W) 056º43.112

2.1. Samples of water, sediment, and macrophytes

The water samples were collected with a bottle type Van Dorn, filtered 100 mL in field membrane with 0.70 µm, fixed with 2 mL of concentrated nitric acid and wrapped in bottle of polyethylenes were washed with a solution of nitric acid (HNO_3) 10 %. In the laboratory was made digestion where we used hydrogen peroxide (H_2O_2) 30% Merck, reserved and forwarded to read in a spectrophotometer, atomic absorption.

The sediment samples were collected at the same locations for collection of water, using a piece of equipment called Core. Surface sampling composed of 5 cm was used the samples were labeled and packed in plastic bags and sent to the laboratory for drying and digestion. Was used the method of double extractor acid (HCl 0.05 mol.L^{-1} and H_2SO_4 0.0125 mol.L^{-1}), and then were filtered and reserved for reading the elements in spectrophotometer atomic absorption.

The sampling locations of macrophytes were determined *in situ* after observation in accordance with the arrangement of seats of macrophytes. It was used an apparatus made of wood with 50 cm^2. The species which have fitted into the apparatus were then collected, separated the parts of air root, packed in plastic bags. Each point of sample was chosen considering the maximum number of species observed for a better representativeness. However, many plants can exist only under certain conditions of hydrological regimes and hidrochemicals. All samples of water, sediment, and macrophytes were initially forwarded to the laboratories of the INPA for treatment and subsequently forwarded to the Laboratory for Engineering and Environmental Processes - FEQ for reading in spectrophotometer, atomic absorption of mark Perkin Elmer, model Analyst 100, which uses specific lamp for each metal.

3. RESULTS AND ARGUMENT

In Table 2 are presented the results of the concentrations of heavy metals Cu, Cd, Pb and Cr observed in samples of water and sediment from the “Lagoa da Francesa” also referred to some results of physical and chemical parameters that are being monitored *in situ* in the lagoa da Francesa and that influence the quality of water and the concentration of metals. The pH values ranged from 6.51 to 6.61, electrical conductivity of 46.6 to 63.6 µS cm^{-1}, temperature of 29.9 to 30.6 ºC and the transparency of 65 to 70 cm. However, these values are consistent with the period of the year and with the hydrological regime in the Amazon region, with the exception of electrical conductivity that showed higher values for the period. The temperature values of water are consistent with the values of the temperature of the air, which are related to the precipitation in the region. According to Guimarães *et al*. (1998), the water temperature is a parameter of great significance for the ecosystem, as it influences the chemical reactions, biochemical and biological processes and the solubility of dissolved gases.

According to Table 2, it can be observed that the metals are present in the water and sediment compartments. Cadmium (Cd) presented low concentration in water, ranging from 2 to 22 µg L^{-1}, and their presence was not detected in bay sediment nor in species of macrophytes.

Table 2 - Heavy metals found in bays water and sediment - July/2012 in "Lagoa da Francesa" (Parintins-AM).

Heavy Metals (µg/L)	Bay	Collection Point			
		F1	F2	F3	F4
Cu	Water	40	10	20	50
	Sediment	14100	12200	9500	12000
Cd	Water	22	11	2	2
	Sediment	N/A	N/A	N/A	N/A
Pb	Water	3692	3738	3522	3542
	Sediment	NA	NA	NA	0057
Cr	Water	155	157	222	34
	Sediment	26	68	54	25

ND- Nothing Detected

The concentration of copper (Cu) in water ranged from 10 to 50 µg L^{-1} and in the sediment from 9500 to 14100 μgL^{-1}. The majority of copper in water is in the form of particulate matter, is adsorbed by organic matter, clay or by oxides hydroxides of iron and manganese, and is deposited or precipitates in sediments depending on environmental conditions. Was done tests of precipitation for copper Figure 2 (a), here represented by point F1. The test indicates the formation of precipitates in the ranges of pH 6 to 7, the pH of water found ranged from 6.51 to 6.61, thereby maintaining, condition of precipitation of copper. The pH of the water as well as other factors influence in the concentration of metals.

(a) (b)

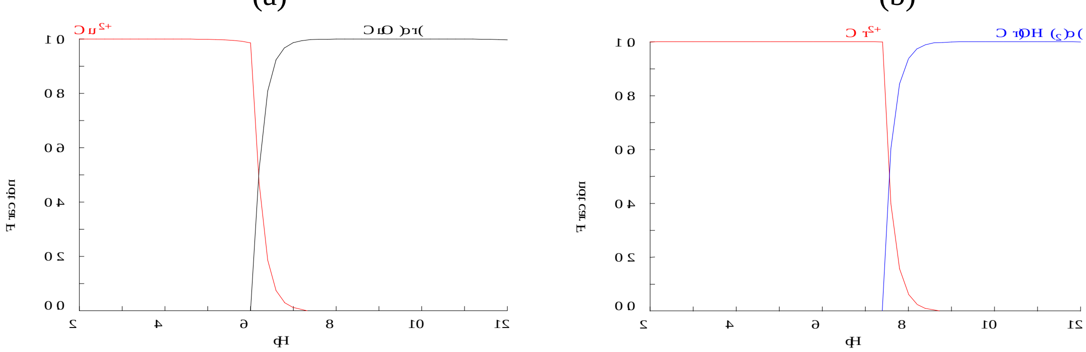

Figure 2 - Metal Speciation as a function of pH of precipitation for heavy metals: copper (a) and chromium (b).

Another condition to consider is the high level of water in the lagoon in the month of July, which can reduce the concentration of copper per dilution. This was observed in a study by Pinto et *al.* (2009) in "Rio Negro", which shows the relationship between the behavior (concentration) of the pollutants and the level of the waters. As chromium (Cr), the greatest provision in water ranging from its concentration of 34 to 222 µg L^{-1} and 25 to 68 µg L^{-1} for the sediment. The pH of precipitation for the chromium is 7.4, according the curve of metal speciation applied to this element (Figure 2 (b)). However, the pH of the water was below, ranging from 6.51 to 6.61 favoring the provision of this metal in the bay water.

Although the curve of lead speciation indicate a range of pH for favorable precipitation of approximately 5.8 to 7.0 (Figure 3), it was the metal that presented the highest concentration in the water, with the exception of the point F4 that had a concentration of 57 µg L^{-1}. Possibly, another factor here not showed is interfering in the behavior of this element. However, the concentrations of the metals are above the values established for water of class 3 according to the CONAMA's 357/05 Resolution.

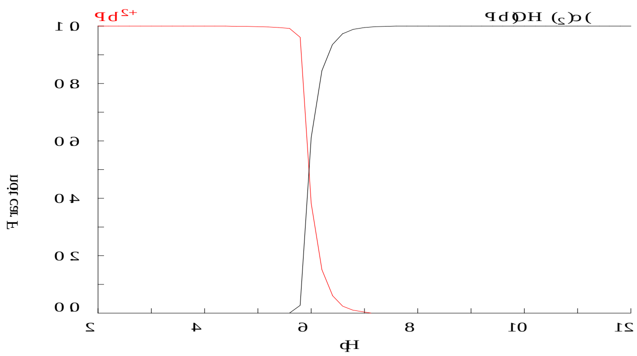

Figure 3 - Metal Speciation as a function of pH for the lead.

The values of copper (Cu), cadmium (Cd), lead (Pb) and chromium (Cr) obtained for the macrophytes are presented in Table 3. Only cadmium was not detected in both species.

When compared to the aerial part of *E. crassipes* and its root. Low and Lee (1994) observed the ability of this species to the removal of heavy metals from contaminated areas and in most cases the metals were concentrated in the roots. Klumpp *et al.* (2002) used *E. crassipes* as cumulative metals (Cu and Cr) in the evaluation of the quality of the water and found larger concentrations in roots. Similar results were obtained by Soltan and Rashed (2003) the potential for bioaccumulation of metals, among them the Cu and Cr and obtained higher values of metals in the roots. For Larcher (2000), the absorption of metals by the roots is facilitated by mechanisms of transports and accumulation, several heavy metals are important micronutrients for the plant and this cannot avoid the entrance of toxic elements by the same mechanism. According to Clemens (2001) the formation of complexes with metal ions with the phytochelatins and organic acids can capture and accumulate metals in the plasma membrane of the cells of the plants. For Martins et al (2005), there are also changes in aquatic macrophytes such as for example the increase in tissues of capture of gases and increase in the capacity of perspiration that can facilitate the entry of heavy metals by the leaves.

As the species *Paspalun repens*, was also obtained the highest concentration at the root, with the exception of Pb that presented a similarity between the aerial part and root. In general, copper

(Cu) was the metal with the highest concentration in both species, followed by the lead (Pb) and chromium (Cr).

Table 3 - Results of heavy metals in the species of aquatic macrophytes - July/2012 in "Lagoa da Francesa" (Parintins-AM).

Species		Cu	Cd	Pb	Cr
		µg L^{-1}			
Eichhornia crassipes	Leaf	10000	NA	423	188
	Root	23670	NA	503	217
Paspalun repens	Leave	6667	NA	276	160
	Root	12330	NA	253	175

4. CONCLUSION

The deposition of the metals in the compartments of water and sediment of "Lagoa da Francesa" indicate the anthropic intervention in the lagoon highlighting the presence of lead with significant concentrations in water. The aquatic macrophytes *Eichhornia crassipes* and *Paspalun repens* confirm the presence of heavy metals and their efficiency in the bioaccumulation of metallic elements is in the roots.

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