

Main usages of Sanhauá river water in the area of influence of the former Roger's open dump: revising proposal of its classification

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ABSTRACT

The usages of surface water nearby a decommissioned open dump in João Pessoa-Paraíba-Brazil were investigated by regular visits from March 2006 to September 2010. The following activities were identified: fishing, crustacean and shellfish catchments, primary contact leisure bath and discharge of sewage, leachate and solid waste disposal. Furthermore, social-economical questionnaires were applied to the people living nearby. Results showed that 43,1% of interviewed people stated that use the Sanhauá river water for fishing or crustacean or shellfish catchments; 43,7% said that use the river for primary or secondary contact leisure bath or navigation; 91,5% of interviewed people said that their houses were not attended with sewerage and so that the final disposal site for the sewage was the Sanhauá river. 1,0% of interviewed people said they use Sanhauá river water in their house, although it is not for human consumption. According to these usages and CONAMA Resolution 357/2005 and the water salinity, the Sanhauá river would be classified into class 1 for brackish water, as opposed to its present classification, class 3 for freshwater. Water quality is not compatible with standards for brackish water class 1 or class 2 and therefore the situation should be revised by governmental instances.

KEY-WORDS: water usages; Sanhauá river; Roger's open dump.

1. INTRODUCTION

Water is an extremely important natural resource for human beings and the environmental equilibrium as a role. It takes part in the living being metabolism, regulates Earth temperature and sustains ecosystems. Water is also used by humans in many activities, so that it is important for economical, social and cultural development of a given region. In relation to economical aspects, it can be noticed a massive utilization of water in industrial and agricultural sectors. According to Bassoi and Guazelli (2004), agriculture consumes 69% of water withdrawals from nature, while industries consume 23% and domestic demand consumes 8% of it. Water is also important because it is associated with population welfare when supplied in sufficient quantities and good quality. By the other side, World Health Organization estimates that 25 million people in

the world die each year because of water-related diseases, when water quality is not suitable for consumption (Braga *et al.*, 2005).

Although water importance for life and socio-economical development and its large amounts on Earth, only very little of it is available for human consumption. About 97,5% of water on Earth are salty, comprising the oceans, and only 2,5% are freshwater. Most (68,7%) of this freshwater is located in the glaciers in north and south poles. The most accessible freshwater for humans and the ecosystems is that from rivers and lakes, which corresponds to only 0,27% of freshwater on Earth or only 0,007% of total volume of water on Earth (Setti, 2002).

The hydrological cycle, by means of evaporation, transpiration, precipitation, infiltration and surface and sub-surface flows, is responsible for keeping the water supply on the planet, making of this precious resource a renewable one. However this cycle and water distribution on the planet is not homogeneous, resulting in wet and dry regions.

In Brazil, water distribution is also irregular. Even though Brazil is considered the country with the largest water availability, it presents many discrepancies related to water distribution. The North region presents the largest amount of Brazilian water (68,5%) but concentrates only 7% of its population. On the other hand, the Northeast region, where 29% of Brazilian population lives, only 3% of Brazilian water resources are available (Basso and Guazelli, 2004). An special case of low water availability is that of Paraíba state, where it is as low as 1500m³/inhab.year (Brito, 2008).

Besides water ecological function, it is used for other activities: urban water supply, agricultural irrigation, electricity generation, aquaculture, fishing, navigation, leisure bathing and wastes dilution. The urban water supply is considered as the most important use, since water is used for human consumption and therefore affects people's health. Unfortunately, water is also used as receiving bodies for wastes and this use have been jeopardising water quality.

Water quality can be expressed by an array of physical, chemical and biological parameters. Some natural or human related activities can change the natural quality of water, jeopardising its uses. For this reason, water bodies must have their quality monitored in order to make possible their proper management.

Water heterogeneous distribution, allied to an increase in water consumption and an increase in water pollution, have lead to a stress situation in most regions on the world. Therefore, worries are not only related to quantities of water, but also to its quality. A suitable way of water management is its classification. In Brazil, CNRH Resolution 91/2008 (Brasil, 2008) deals with general procedures for surface water classification, while CONAMA Resolution 357/2005 (Brasil, 2005) classifies water bodies according to its main usages and sets water quality standards for each class.

The water usages listed in CONAMA Resolution 357/2005 are: a) human consumption after disinfection; b) natural equilibrium preservation of aquatic life; c) preservation of aquatic ecosystems in conservation units of fully protection; d) human consumption after simplified treatment; e) protection of aquatic life in indigenous lands; f) primary contact leisure bath; g) irrigation of crops that are eaten uncooked and fruits that grows on the soil and are eaten uncooked and without skin removal; h) human consumption after conventional treatment; i) irrigation of crops and fruits in general, parks, gardens sport fields and leisure places, where people may have direct contact; j) aquaculture and fishing; k) irrigation of trees, cereal and folder crops; l) artisanal fishing; m) secondary contact leisure bath; n) animal feeding; o) navigation; p) contemplation.

CONAMA Resolution 357/2005 classifies water bodies into the following 13 classes:

- Freshwater (special class, class 1, class 2, class 3 and class 4);
- Brackish water (special class, class 1, class 2 and class 3);
- Salty water (special class, class 1, class 2 and class 3).

In this context, this paper aims to characterize the main water usages in Sanhauá river, located in João Pessoa, the capital city in the state of Paraíba. In addition, the assessment of water quality was carried out in order to evaluating the compatibility of its present classification and the existing usages.

2. METHODOLOGY

The identification of Sanhauá River water usages was made by means of *in loco* visits at each six months from March 2006 until September 2010. Theses visits were achieved by means of a motorized boat, making photographs of the activities which uses the river water. The part of Sanhauá considered in this study was the estuarine one. Former Roger's open dump is located in this area, adjacent to the mangrove which surrounds the river (figure 1). Besides the photographs taken, a questionnaire (50 in each visit) was applied to the population living nearby the studied area (figure 2). The questionnaire is presented in table 1.

Besides water usages identification and quantification, its quality monitoring was performed in 4 sampling points (P1, P2, P3 and P4). These points are shown in figure 1. P1 and P2 are located at a water stream in the mangrove, adjacent to the former Roger's open dump, while P3 and P4 are located in Sanhauá River itself, with P3 upstream and P4 downstream in relation to the Roger's stream.

Samples were collected and transported to the Sanitation Laboratory at Universidade Federal da Paraíba. The parameters analysed were chloride, pH, oil and greases, colour, turbidity, nitrite, nitrate, sulphate, BOD₅, COD, aluminium, lead and thermotolerant coliform. Analyses procedures followed recommendations of APHA *et al* (1998).



Figure 1. Studied area of Sanhauá river and the former Roger's open dump (Source: Google Earth, 2009).

Table 1. Applied questionnaire to nearby communities.

Questionnaire	Results		
	Yes (%)	No (%)	Did not answered (%)
Does anybody who lives in your home uses Sanhauá river water for leisure bath of primary or secondary contact or navigation?			
Does anybody who lives in your home uses Sanhauá River for fishing or shellfish or crustacean catchment?			
Sanhauá River water is used in your home (not for human consumption)?			
Is your home attended by water network?			
Is your home attended by sewerage system?			
Is your home attended by solid waste collection system?			
Do you know about solid waste disposal on Sanhauá River?			
Is Sanhauá River used for contemplation?			



Figure 2. Questionnaire application on nearby communities

3. RESULTS

3.1. Water usages

During the visits to Sanhauá River, the followings water usages were identified: primary contact leisure bath, tourism, navigation, fishing, shellfish and crustacean catchment, wastewater discharge and solid wastes disposal.

3.1.1. Leisure bath, tourism and navigation

In the visits performed it was observed children from nearby community taking bath and the presence of small boats, motorized or not, for the transport of people and goods (figures 3 and 4). Data from the questionnaires have confirmed that 43% (mean) of interviewed people stated to have knowledge of these usages of Sanhauá river waters (figure 5).



Figure 3. Primary contact leisure bath



Figure 4. Navigation on Sanhauá river

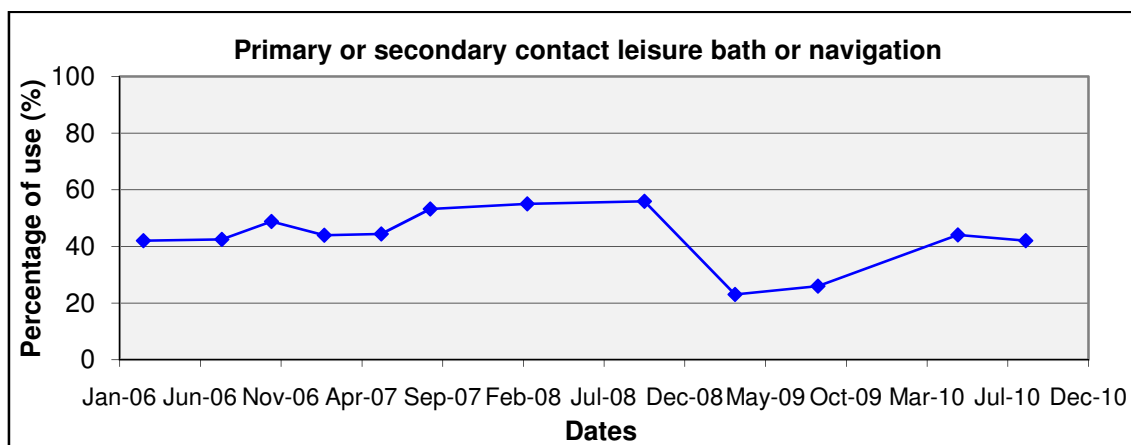


Figure 5. Primary or secondary contact leisure bath or navigation

3.1.2. Fishing and shellfish and crustacean catchment

Fishing and shellfish and crustacean catchment done by local community are artisanal (figures 6 and 7) and only for their own consumption or for local market selling. About 43% (mean) of interviewed people confirmed that make these usages of Sanhauá River (figure 8).



Figure 6. Artisanal fishing on Sanhauhá river



Figure 7. Shellfish catchment from Sanhauhá river

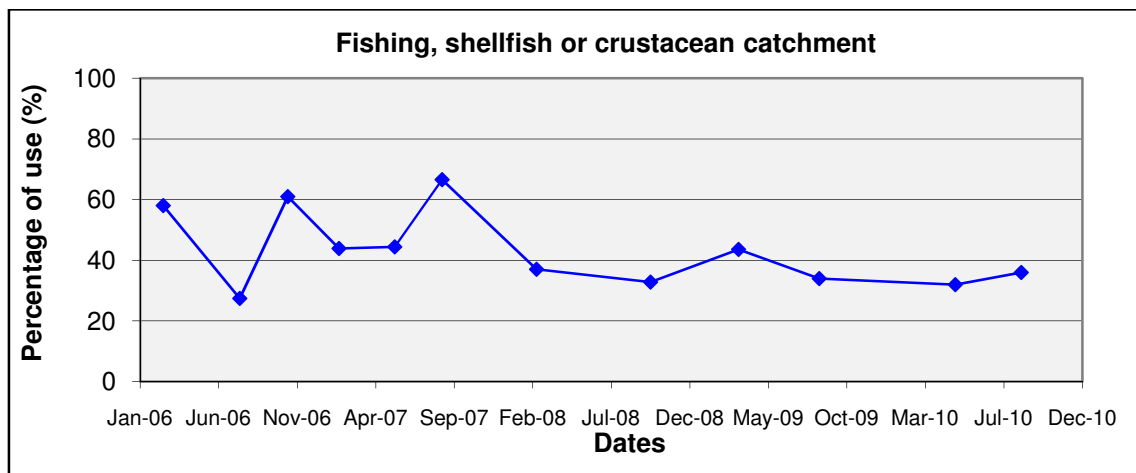


Figure 8. Fishing, shellfish or crustacean catchment

3.1.3. Residential use of Sanhauá river water

According to people living nearby the studied area, 99% (mean) of houses are attended with water supply from the water company (CAGEPA). Nevertheless, still 1% (mean) of interviewed people use Sanhauá river water in their houses (figure 9). These usages were not for human consumption.

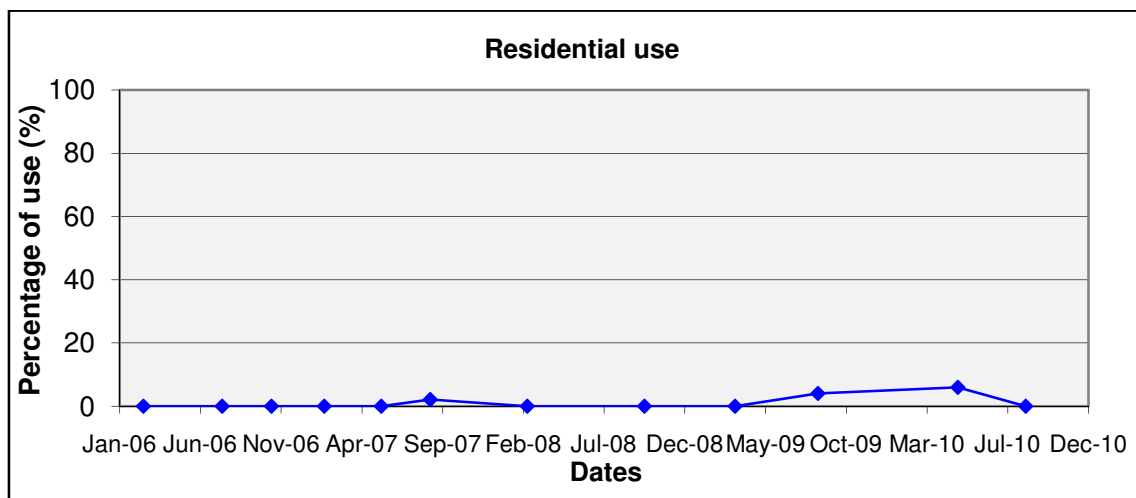


Figure 9. Residential use (not for human consumption)

3.1.4. Wastewater discharge

About 92% (mean) of houses, as stated by interviewed people, have not access to sewerage system (figure 10) and so that the wastewater is discharged into Sanhauá river, as shown in figure 11. Another form of wastewater discharge is indirectly, through the pluvial drainage system (figure 12).

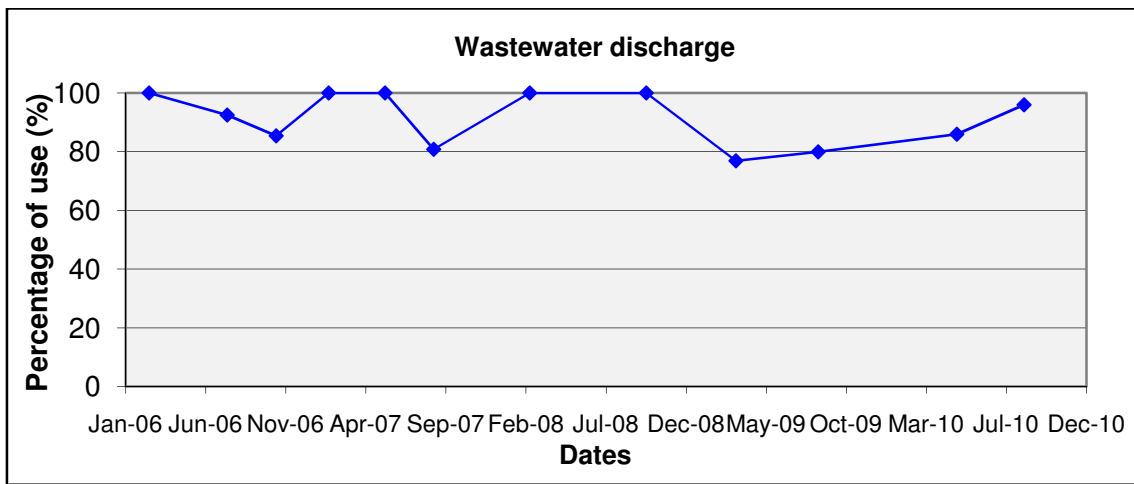


Figure 10. Wastewater discharge



(a)



(b)

Figure 11. Wastewater discharge directly into Sanhauá river



Figure 12. Wastewater discharge into Sanhauá river indirectly through pluvial drainage system

3.1.5. Solid waste disposal

Although 54% (mean) of interviewed people have stated that their houses are served by solid waste collection service (figure 13), it can be noticed the large amount of solid wastes on the banks of Sanhauá river (figure 14)

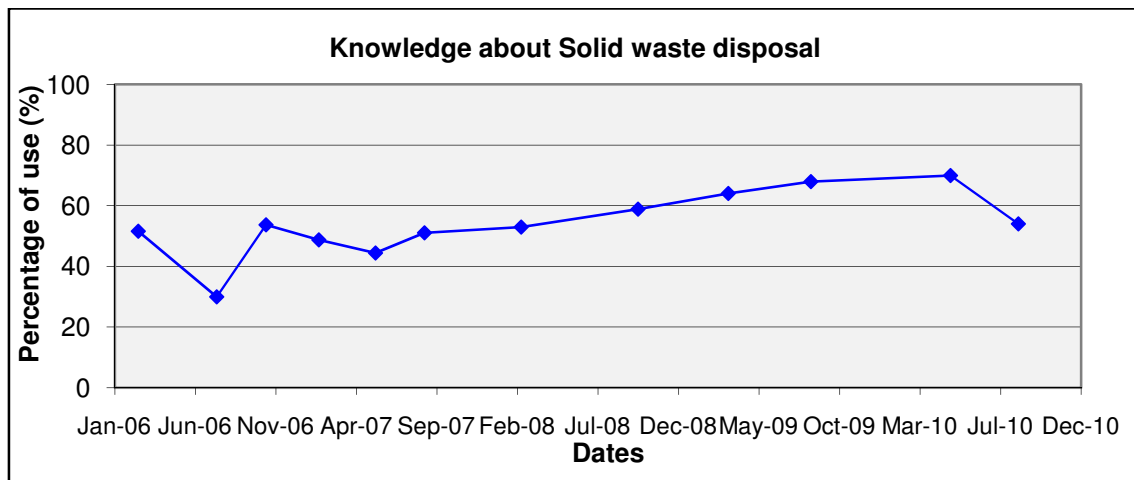


Figure 13. Knowledge about solid waste disposal in Sanhauá river



(a)



(b)

Figure 14. Solid waste disposal in Sanhauá river banks.

3.2. Monitoring of Sanhauá River water quality

Data collected in the monitoring of Sanhauá river water quality for P1, P2, P3 and P4 are shown in figure 15 to figure 24.

Chloride concentration was high in all the points, varying from 1013 to 24575 mg/L (figure 15), what indicates salinity in the range above freshwater and compatible with brackish water. These values can be explained by the tide influence that occurs in the studied part of the river. Thus, the parameters monitored were compared to those for brackish water rather than for freshwater from CONAMA Resolution 357/2005.

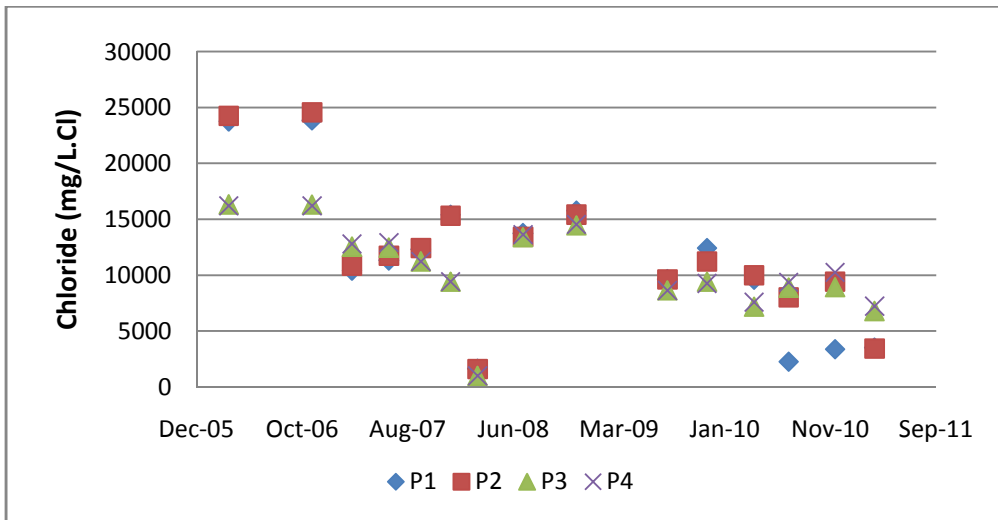


Figure 15. Chloride concentration in Sanhauá river (P1, P2, P3 and P4)

Most of pH values, as shown in the figure 16, remained between 6,5 and 8,5 which is compatible with the standard band for brackish water class 1 and class 2. Only 8% (5 samples) that did not comply with these standard band. Attendance percentage for brackish water class 3 standard band (pH 5 – 9) was 100%.

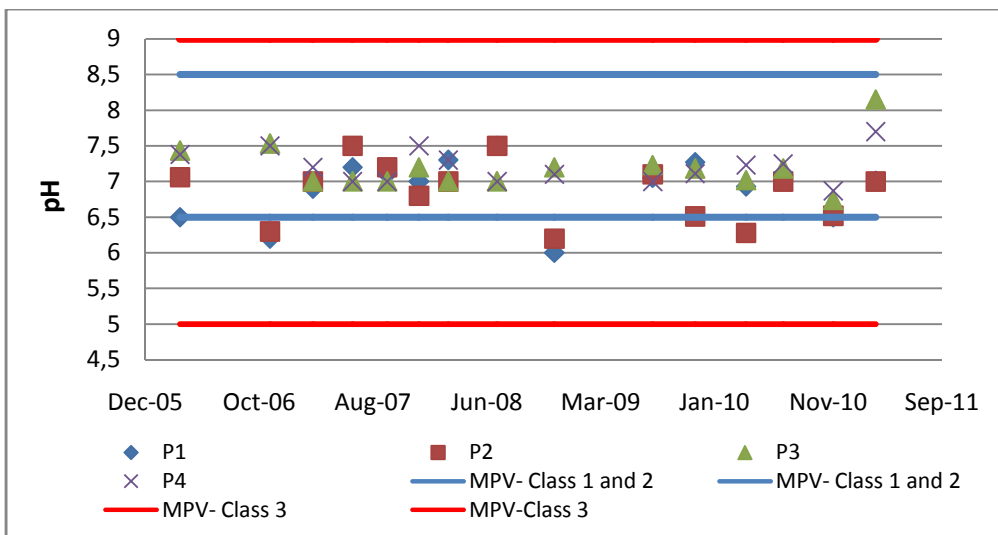


Figure 16. pH in Sanhauá river (P1, P2, P3 and P4)

For oil and grease, CONAMA Resolution 357/2005 states that these pollutants must be absent in water. However, Figure 17 shows that they were found in all the samples, most of them below 10 mg/L. However, in P2, adjacent to the former Roger open dump, it reached 22 mg/L.

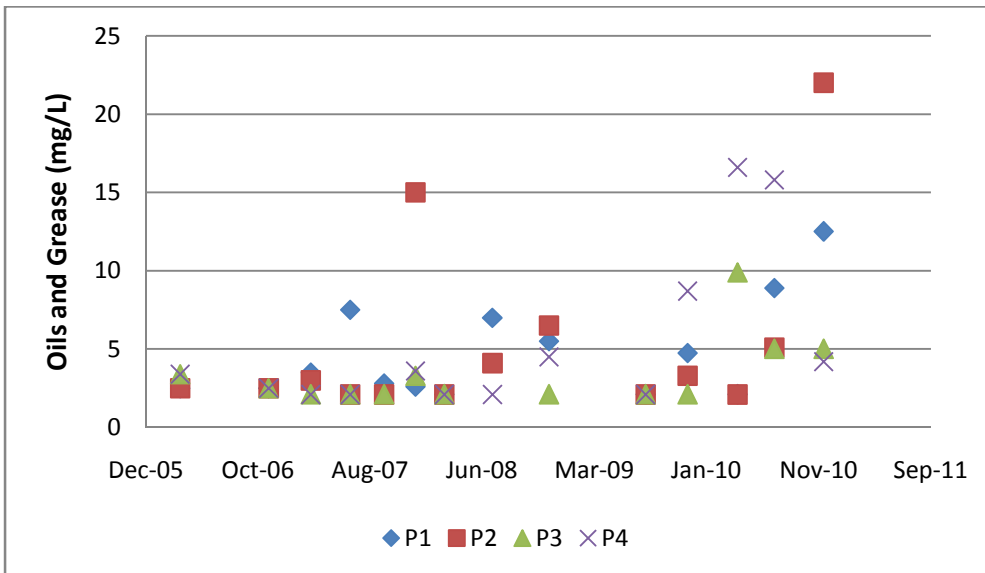


Figure 17. Oils and Grease concentration in Sanhauá river (P1, P2, P3 and P4)

Figure 18 shows nitrite concentration. Most (80,8%) of the values are below water class 1 MPV (0,07mg/L). In comparison to the MPV for class 2, the percentage of attendance was 96,2%. The higher value was found in P2, adjacent to the former Roger open dump.

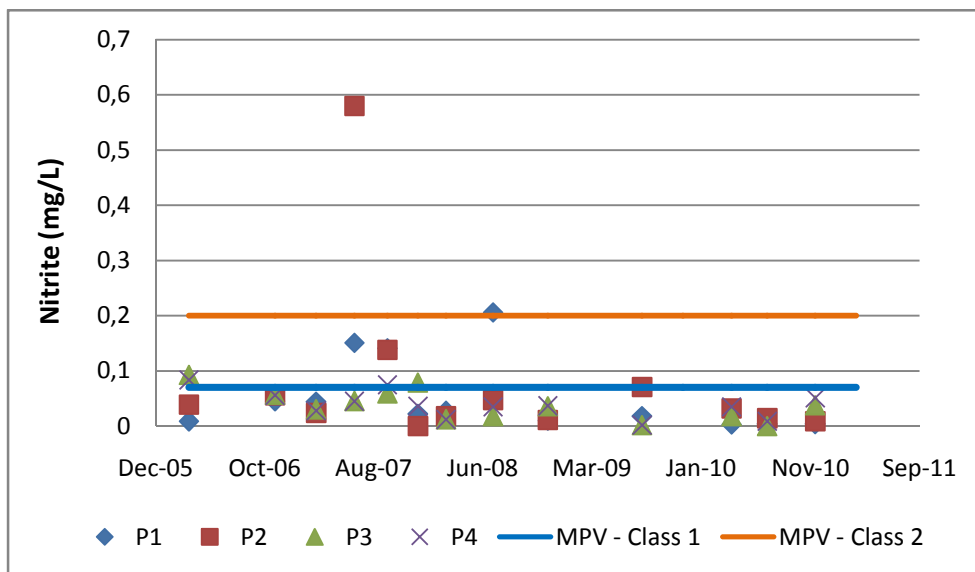


Figure 18. Nitrite concentration in Sanhauá river (P1, P2, P3 and P4)

Figure 19 shows nitrate concentration. The percentage of attendance for brackish water class 1 and class 2 were 88,5% and 94,2%. Concentrations close to 1 mg/L were found in P1 and P2, adjacent to the Roger open dump.

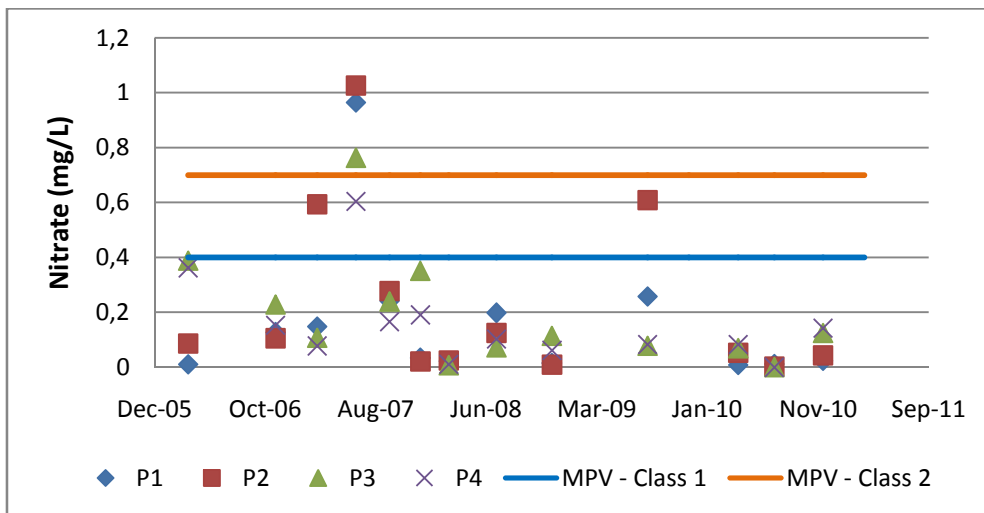


Figure 19. Nitrate concentration in Sanhauá river (P1, P2, P3 and P4)

Although BOD₅ and COD are not mentioned in CONAMA Resolution 357/2005, they are herein presented for better comprehension of Sanhauá River quality (Figs. 20 and 21). For BOD₅, most of values are below 200 mg/L (typical value for raw wastewater). However, it reached about 500 mg/L in P1 and P2 in the sample collected in November 2006. BOD₅ in P1 and P2 were higher than in P3 and P4. COD, most of the values were below 600 mg/L (typical value for raw wastewater) and P1 and P2 again presented the higher values (in comparison to P3 and P4). These numbers suggest that the amount of wastewater discharged in Sanhauá River is high. The large number of houses constructed in the banks of the river may respond for that.

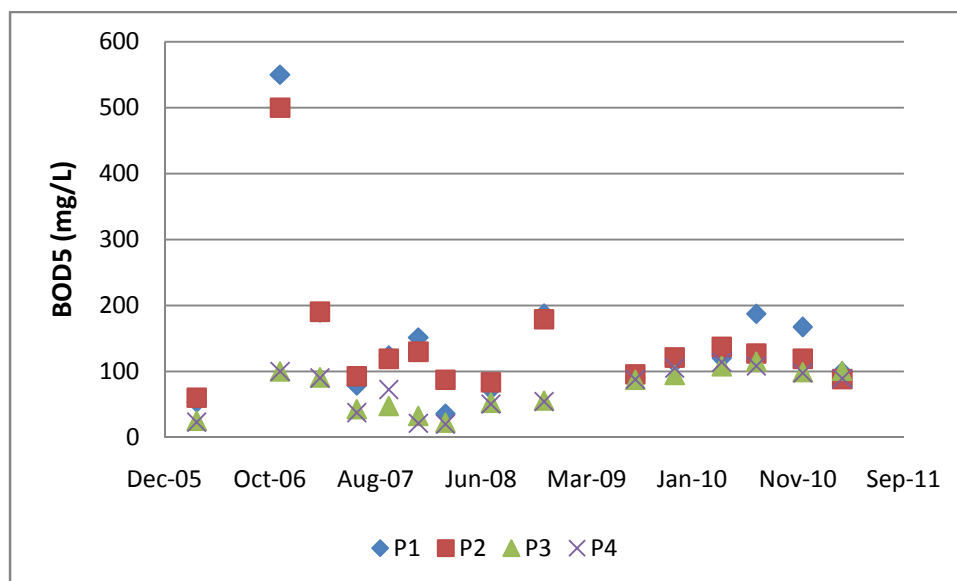


Figure 20. BOD₅ concentration in Sanhauá river (P1, P2, P3 and P4)

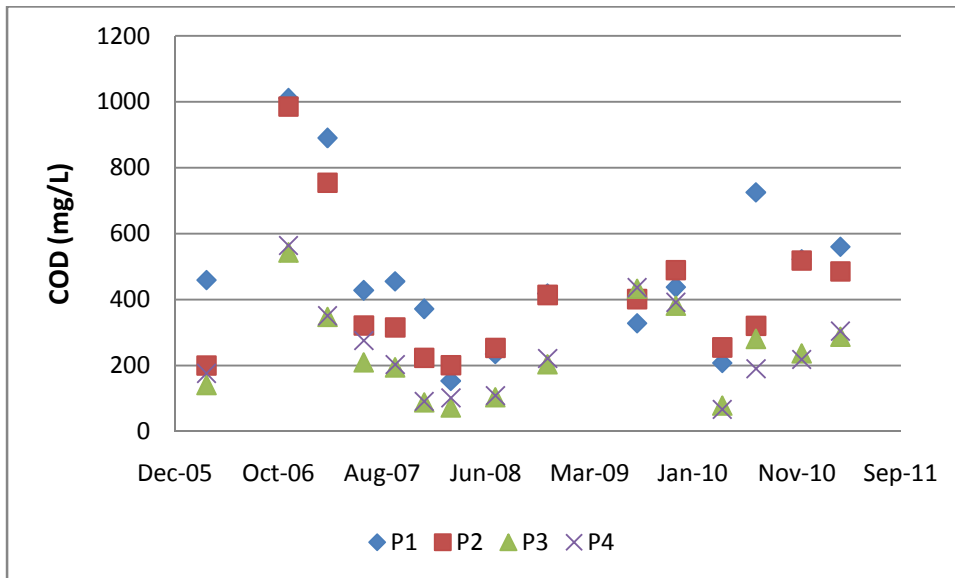


Figure 21. COD concentration in Sanhauá river (P1, P2, P3 and P4)

Aluminium concentration is shown in figure 22. In most cases the MPV for class 1 and 2 (0,1 mg/L) was not attended. This suggests the industrial wastewater and leachate from the former Roger's open dump may be entering the river.

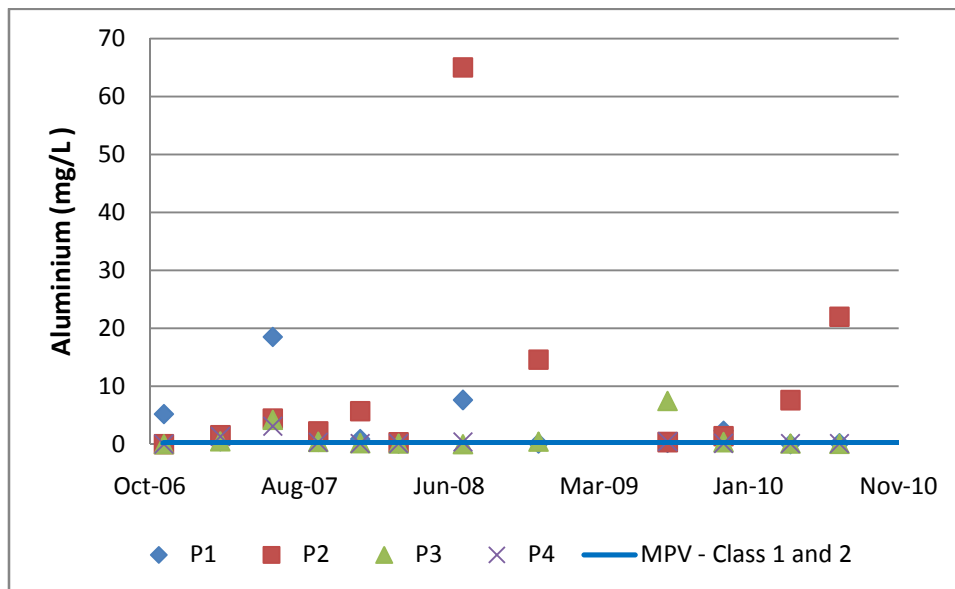


Figure 22. Aluminium concentration in Sanhauá river (P1, P2, P3 and P4)

Lead was also detected in all the monitored points and in most cases was higher the MPV for class 1 (0,01mg/L) and in some cases higher than MPV for class 2 (0,2 mg/L), as shown in figure 23.

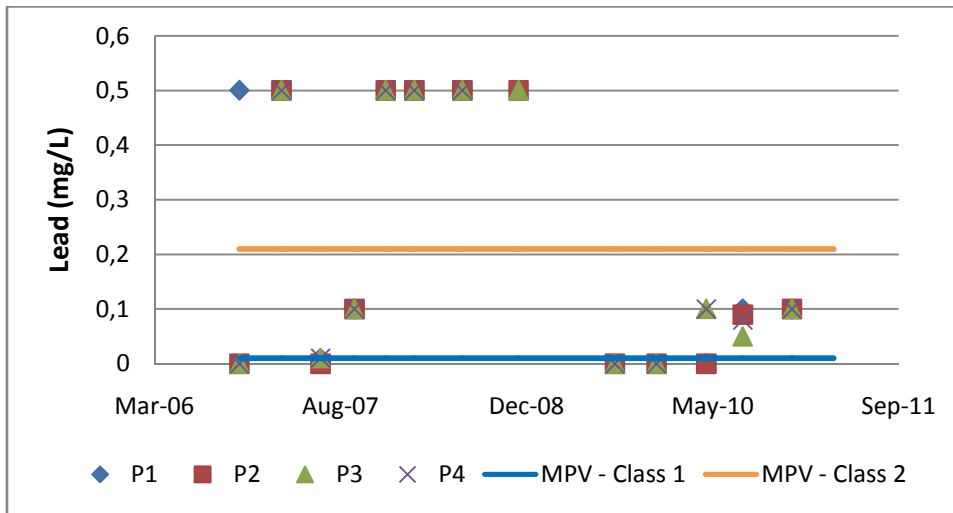


Figure 23. Lead concentration in Sanhauá river (P1, P2, P3 and P4)

Figure 24 shows thermotolerant numbers in Sanhauá river. For bath use standards, CONAMA Resolution 357/2005 refers to its Resolution 274/2000 (Brasil, 2000). According to this Resolution, Sanhauá River water is improper for bathing (MPV of 10^3 thermotolerant coliform/100ml).

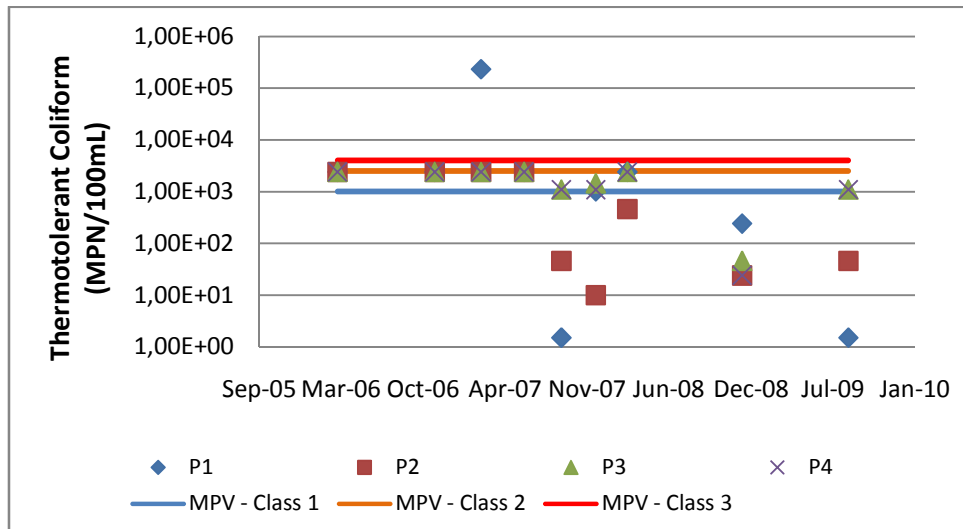


Figure 24. Thermotolerant Coliform numbers in Sanhauá river (P1, P2, P3 and P4)

Table 2 shows percentage of attendance to standards for brackish water class 1, class 2 and class 3.

Table 2. Attendance percentage for brackish water (CONAMA RES 357/2005)

Attendance percentage for brackish water (CONAMA RES 357/2005)			
	Class 1	Class 2	Class 3
DO	50,0	60,0	80,0
pH	91,7	91,7	100
Oils and Grease	0	0	0
Solid waste	0	0	-
Thermotolerant Coliform	30,6	97,2	97,2
Aluminium	11,8	11,8	-
Lead	33,3	60,8	-
Nitrite	80,8	96,2	-
Nitrate	88,5	94,2	-
Ammonia	100	100	-

4. Final remarks and conclusions

The State of Paraíba Environmental Agency (SUDEMA) classifies Sanhauá River water in the part studied herein as class 3 (SUDEMA, 1998). It must be said that this classification was done in 1988, when CONAMA Resolution 357/2005 was not in operation. At that time, CONAMA 20/1986 (Brasil, 1986) was operating and according to it, class 3 was only for freshwater rather than brackish water. This means that SUDEMA classified this part of Sanhauá River as freshwater class 3.

Chloride values (part of salinity) show that estuarine part of Sanhauá River is of brackish band of salinity. If all usages of Sanhauá river water found would be maintained, and considering its salinity, its classification would be class 1 for brackish water. For this classification, water quality is not attended and therefore Governance measures should be taken to make water quality and its uses compatible.

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