Assessment of water quality of the Nossa Senhora das Dores-SE reservoir

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ABSTRACT

This study was conducted in the city of Nossa Senhora das Dores-SE, and aims to evaluate the physical, chemical and microbiological characteristics of water quality of the public dam, the main watercourse which crosses the city, through analysis which were done between the years 2014 and 2016. Establishing the grouping of several variables in order to propose a quality index of the primary water, showing the water quality changes in the reservoir under different uses. The variables analyzed were total phosphorus, total nitrogen, Turbidity, Total Dissolved Solids, Dissolved Oxygen, pH, Electrical Conductivity, thermotolerant coliforms and Chlorophyll a. The concentrations of chlorophyll a, total phosphorus, turbidity, electrical conductivity and fecal coliforms are out of the limits set by the relevant environmental legislation, suggesting that dam of Nossa Senhora das Dores has considerable environmental changes, possibly due to domestic wastewater.

Key words – Basic statistics, Nossa Senhora das Dores, Water Resources

INTRODUCTION

Population growth, the search for high economic levels, and water wastage are the main factors of the emerging environmental impacts of society. They are also observed by the large number of dumps, contaminated rivers and social inequality. The management of these socio-environmental disequilibrium vectors is the crucial point for sustainable development.

According to the National Water Agency - ANA (2011), significant amounts of inadequately treated sewage, industrial and agricultural effluents are being dumped daily in the world's waters. Rivers, lakes and ponds absorb the organic load of the entire watershed, in the form of pollution.

As reported by Chin (2013), lentic systems such as lakes, reservoirs and ponds are more vulnerable to pollution, since they retain all discharge of pollutants from the river basin. Thus, it is necessary to monitor the water quality of these environments, since they characterize the anthropic and natural activities of their environment.

Water quality is the basic component for assessing the state of pollution, degradation or conservation of rivers, lakes and dams. It is used as an indicator of the environmental conditions of an aquatic system. Anthropic activities provoke in this very rich ecosystem, significantly altering the reactions and natural physical and chemical interactions present in this ecosystem, according to Vasconcelos (2009).

The physicochemical and biological characteristics of water can provide relevant data for monitoring the water quality of a reservoir. These monitoring systems contribute to the maintenance of aquatic life, essentially assuming the importance of preserving water bodies for the next generations (GARCIA et al, 2014).

In view of this context, the present work was carried out in the municipality of Nossa Senhora da Dores-SE, with the objective of evaluating the physical-chemical and microbiological characteristics of public water, the main water course which cuts the municipality, among 2014 and 2016. Establish the grouping of the various variables in order to propose a preliminary water quality index, demonstrating the changes in water quality in the reservoir for different uses.

METHODOLOGICAL PROCEDURES

Study area

The studied reservoir is located in the municipality of Nossa Senhora das Dores, central region of the State of Sergipe. It belongs to the sub-basin of the Siriri River, integrated to the Basin of the Japaratuba River, Figure 1.

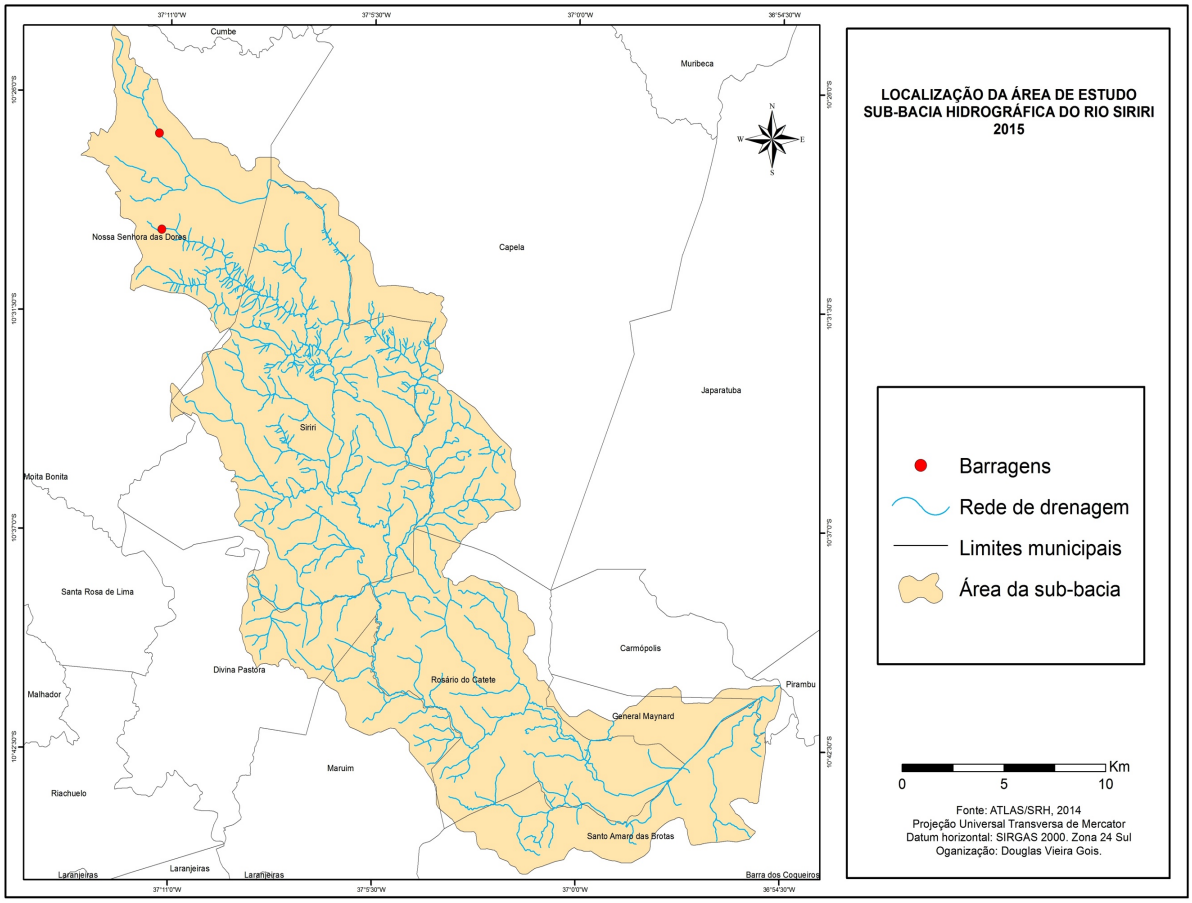

Figure 1. Location of the study area Sub-basin of the Siriri River.

The public dam was built to meet the water supply needs of the municipality, which allowed its development. However, the direct discharge of wastewater and waste in its water body characterize it as inappropriate for this assignment, Figure 2.

Figure 2. Location of sampling, Public dam.
Source: Author, 2015.

The Siriri, Pintado, Cácago and Monteiro rivers make up the main drainage. The relief is of tabular erosive surface, surface planed and dissected in hills and trays, with deepening of drainage from very weak to weak, with vegetation of capoeira, traces of open and closed forests (SERGIPE, SEPLANTEC / SUPES, 1997/2000).

Sampling Period

According to the climatic classification of Köppen, the municipality is partially inserted in the drought polygon, presents dry and sub-humid metamorphic climate, transition to semi-arid, average annual temperature of 24.6 ° C, average annual rainfall of 1,056.4 mm and rainy season from March to August (SERGIPE.SEPLANTEC / SUPES, 1997/2000).

Lemos et al (2010) found that differences in the water quality of the springs as a function of the time of the year are due to the decrease of the water level in the dry season, since the variation in the bacteriological quality of the water is even greater after the rainy season.

Sampling steps

To obtain good results it is necessary that the procedure in the field is well executed. The sample space is extremely important and should be as representative as possible for the area to be studied. Thus, for the reservoir, the samples were collected in three points distributed between the margins and the center. The collections started in January/2014 and completed in October/2016, totaling 10 campaigns.

Table 1 shows the variables analyzed in this study, where they were collected and stored in polyethylene bottles of 500 mL, being stored at constant temperature and measured with thermometer until the analyzes in the LQA of the Chemistry Department of the Federal University of Sergipe.

Table 1. Physical-chemical and biological variables for water quality analysis.

Parameters	Initials	Unit
pH	-	-
Temperature	T	°C
Dissolved Oxygen	DO	$mg.L^{-1}$
Total Phosphorus	P-total	$mg.L^{-1}$
Thermotolerant coliforms	TC	$mg.L^{-1}$
Total nitrogen	N-total	$mg.L^{-1}$
Nitrate	NO_3^-	$mg.L^{-1}$
Electric condutivity	EC	$\mu S.cm^{-1}$
Clorophyll *a*	Clo a	$\mu g.L^{-1}$
Turbidity	Turb	UNF
Total dissolved solids	TDS	$mg.L^{-1}$

The field work included only one sampling point, located at the following coordinates 8833961 and 706432 UTM. The choice of point was made in loco considering the most representative point of the dam, which in turn, has a small surface area. Ten collections were carried out between February 2014 and January 2016, considering the dry and rainy periods of the region. The location of the collection point was obtained through a Global Positioning System (GPS).

The variables measured were Total Phosphorus (P_{total}), Total Nitrogen (N_{total}), Turbidity (Turb), Total Dissolved Solids (STD), Dissolved Oxygen (OD), pH, Electrical Conductivity (Cond), Thermotolerant Coliforms Chlorophyll (Cfila-a). The methodology adopted was the analysis of parameters according to the Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 20th ed. APHA (1998).

Statistical analyzes

For the statistical analysis, the data was worked by the methods of descriptive and bivariate statistics (Matrix of Correlation). The calculations of mean, standard deviation, maximum and minimum value were performed in the Excel^{TM} worksheet. For the analysis of water quality variables, the R software for Windows correlation matrix was used. Through the analysis of basic statistics it is possible to identify the existing discrepancies between the data, for bivariate, the physical, chemical and microbiological variables can be grouped in common data.

RESULTS AND DISCUSSIONS

During the monitoring period of the water quality of the Municipality of Nossa Senhora das Dores, the maximum, minimum and mean values, as well as the standard deviation of the results of the physical and chemical and microbiological analyzes carried out on the samples collected are described in Table 2. In it we can observe that thermotolerant coliforms have the highest average and highest standard deviation, these organisms give an indication of water contamination by fecal material (human or animal), and therefore demonstrate the potentiality of water to transmit diseases.

Table 2 - Basic descriptive statistics of the variables studied during the period from February / 2014 to January / 2016.

Parameters	Mean	Stand. Dev.	Maximum	Minimum
Turbidity (NTU)	96.57	63.46	204.15	31.1
TDS ($mg.L^{-1}$)	170.95	112.82	358.00	48
DO ($mg.L^{-1}$)	7.40	1.19	8.38	4.84
N_{total} ($mg.L^{-1}$)	10.73	15.67	44.24	0.448
P_{total} ($mg.L^{-1}$)	0.071	0.051	0.109	0.003
TC ($NMP.100mL^{-1}$)	28616.67	64368.29	16000000.00	1300.00
EC / $\mu S.cm^{-1}$	462.06	138.26	730.00	312.00
Clo-*a* ($\mu g.L^{-1}$)	98.93	40.39	139.98	25.98
pH	7.78	0.79	8.84	6.91

The electrical conductivity also showed a high average value and standard deviation, according to Cetesb (2014), when the concentrations exceed 100 µS.cm-1, the environment may be impacted by anthropic actions besides that high values of CE may indicate corrosive properties of water. Buzelli (2013) found values above 0.100 mS.cm-1 in the Barra Bonita reservoir, identified in the period of drought and rainfall, assuming that this constant interference would be due to predominant economic activities of the environment, such as cane-of-sugar.

The measured pH varied between 6.91 and 8.84, yet the mean value was 7.78. The pH of water influences several chemical equilibria which occurrs naturally. The pH range restrictions are established for several classes of natural waters. The aquatic life protection criteria set pH between 6 to 9, CETESB (2014).

The turbidity value was within the norm according to the CONAMA Resolution nº 357 of 2005 which establishes value of up to 100 UNT, yet maximum value is equal to 204,15 UNT. Possibly this value is related to the rainy season, due to the absence of ciliary forest in the surroundings of the dam, the great contribution of organic matter is even greater. As reported by Lemos et al. (2010), differences in water quality of water sources due throughout the year are due to the decrease in water level in the dry season, since the variation in the bacteriological quality of the water is higher after the rainy period.

The concentration of phosphorus was above the concentrations established by CONAMA, Brazil (2005), for water courses in class 3, of 0.05 $mg.L^{-1}$ for lentic environments. The nitrogen concentration in the samples was high, with an average value of 10.73 $mg.L^{-1}$. Nitrogen as well as phosphorus is part of the macronutrients and their excess in natural water can cause the eutrophication process, increasing the growth of algae. This process may lead to harmful contamination of aquatic life and public supply, CETESB (2014).

As for Chlorophyll a, a high average value of 98.93 $\mu g.L^{-1}$ is observed, as well as the maximum value of 139.98 $\mu g.L^{-1}$ exceeding the limit established by CONAMA equal to 60 $\mu g.\ L^{-1}$, Brazil (2005). For CHIN (2013), eutrophicated lakes and reservoirs have high concentrations of algae which can cause unpleasant taste and odor for water.

The dissolved oxygen did not recover from Nossa Senhora das Dores was satisfactory, 7.4 $mg.L^{-1}$, for this parameter values were found dissolved oxygen minimum of 4.8 $mg.L^{-1}$ throughout a campaign sampling. According to CONAMA, for water courses in class 3, the OD limit in any model should not be less than 4 $mg.L^{-1}$, so this variable meets the standards established by the legislation.

For the total dissolved solids, the mean value of 170.95 $mg.L^{-1}$ was found, reaching the maximum value of 358 $mg.L^{-1}$, within the established for 500 $mg.L^{-1}$, for water Class 3.

In Table 3, the Pearson Correlation Matrix is described for the water quality variables in the municipality of Nossa Senhora das Dores. This method is used to measure the correlation between two variables through the Pearson Linear Correlation Coefficient, where ρ is the correlation coefficient for the bivariate normal population, and ranges from -1 to +1, Schultz & Schultz (1992).

Table 3 - Correlation matrix of water quality variables in the municipality of Nossa Senhora das Dores.

Variables	Clo-a	TC	EC	Ntotal	DO	pH	Ptot	TDS	Turb
Clo-a	1.000								
TC	-0.378	1.000							
EC	0.091	0.162	1.000						
N_{total}	-0.239	-0.080	0.133	1.000					
DO	-0.598	0.193	0.303	0.685	1.000				
pH	-0.569	-0.313	0.078	-0.200	0.238	1.000			
Ptot	0.921	-0.640	0.197	-0.042	-0.475	-0.352	1.000		
TDS	0.406	0.247	0.910	0.019	0.036	-0.294	0.394	1.000	
Turb	-0.120	0.766	-0.004	0.031	-0.208	-0.564	-0.315	0.193	1.000

In the results obtained by the correlation matrix, the value of ρ equal 0,921 between the total phosphorus and chlorophyll a, showed a strong correlation between the parameters. Specifically, chlorophyll a is an indicator of the presence of macronutrients such as phosphorus and nitrogen, whose growth is directly related to their increase, Aguiar Netto et al. (2013).

The grouping between total dissolved solids and electrical conductivity can also be observed with a considerable value of ρ equal to 0.91. The electrical conductivity is a very significant parameter, regarding the intrusion of ions in the water body.

In contrast, the variables Ptot and TC obtained the lowest value of ρ equal to -0.640, for the parameters of total phosphorus and thermotolerant coliforms.

5 - CONCLUSION

Among the parameters studied here, the concentrations of chlorophyll a, total phosphorus, turbidity, electrical conductivity and thermotolerant coliforms are outside the limits established by the pertinent environmental legislation, suggesting that Nossa Senhora das Dores reservoir possesses considerable environmental changes, possibly originating of domestic effluents.

The grouped variables which presented values of ρ close to 1, such as chlorophyll a and total phosphorus, electrical conductivity and total dissolved solids, evidenced an eutrophic environment, allowing the construction of a water quality indicator for a more detailed analysis.

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