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Evaluation of the Water Quality of the River Basin of São João River in the Municipality of Porto Nacional - Tocantins

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***Abstract* —** *Water is an essential natural resource for the maintenance of the life of man and the numerous ecosystems present on the planet Earth, besides enabling several activities that generate income for civilizations. The main objective of this work is to analyze the water quality of the São João River basin in the city of Porto Nacional - Tocantins, by determining the Water Quality Index (WQI). For the development of this work, it was established three research points, located downstream of the São JoãoRiver. The samples were collected monthly and, for six months, from August 2018 to January 2019. The results obtained demonstrated that the water from São João River can be classified as regular according to NSF, although some parameters compared to environmental legislation were in disagreement with the standards determined by CONAMA resolution 357/2005 for freshwater class two.*

Keyword— WQI; Water Resources; Hydrographic basin.

I. INTRODUCTION

The Earth is known as planet water, this is due to the fact that 70% of its surface is covered by this essential liquid to life, which makes it one of the most abundant resources of the planet. However, most of the water of the planet is not available for use by humans beings. For this reason, it is mistakenly thought that water is an inexhaustible resource, but in fact it constitutes a finite resource that must be used without waste (BARROS; AMIN, 2008).

The authors observe that population and economic growth lead to water degradation and consequently its pollution and contamination. This shows that human actions cause environmental degradation that reflects the misuse of this water resource so important to human life.

One of the main natural resources for the existence of the human being is the water. Any way of life needs water to survive. Water is a natural resource that is closely related to all aspects of human civilization, since the agricultural and industrial development to cultural and religious values rooted in the society.

There are large river basins in the world but, unfortunately, drinking water for human consumption is in small proportion, it does not meanit is becoming scarce, but there is a lack of water to meet certain demands that are associated with a minimum quality, taking into account their local availability. Although public awareness policies are carried out, the society is not aware to future consequences and ends up wasting and polluting unnecessarily (NOGUEIRA, 2017).

The monitoring of the quality of a water body is based on the analysis of parameters established by the water quality indicators that aggregate the variables analyzed in a given numerical value related to the concept of quality, verifying the condition and evolution of water quality in the time and space.

The analysis of the Water Quality Index (WQI) according to the criteria established by standards that are used by the State Company of Basic Sanitation Technology (CETESB), makes use of nine water quality parameters, since these properties must have conditions minimum, because its main purpose is public supply.

For these reasons, the aim of this work is to analyze the water quality of the São João River basin in the city of Porto Nacional - Tocantins, by determining the Water Quality Index -WQI.

II. MATERIAL E METHODS

2.1 – Location of the Experiment

The basin of SãoJoão River has its source in the rural area, within the limits of Pilões Farm (coordinates S 10º46'08 "and W 48º15'57"), with direction to the municipality of Porto Nacional, crossing several rural properties in some representative neighborhoods , such as JardimQuerido, JardimUmuarama, Santa Helena and Vila

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Nova, with its mouth (coordinates S 10º42'10 "and W 48º23'47") in lake Lajeado.

The climate is typically tropical, with an annual average temperature of 26.1ºC and an annual rainfall of 1,667.9 mm, referring to the periods 1961-1990 (MINISTRY OF AGRICULTURE AND AGRARIAN REFORM, 1992).

The monitoring was carried out in August, September, October, November and December of 2018 to January 2019, at three collection points distributed along this water body, which they were marked with a global positioning system (GPS navigation model GARMIN-60CSx).

For the definition of water collection points, bibliographical studies, field visits and interviews with the community were carried out. **The location of the points is shown in Table 1.**

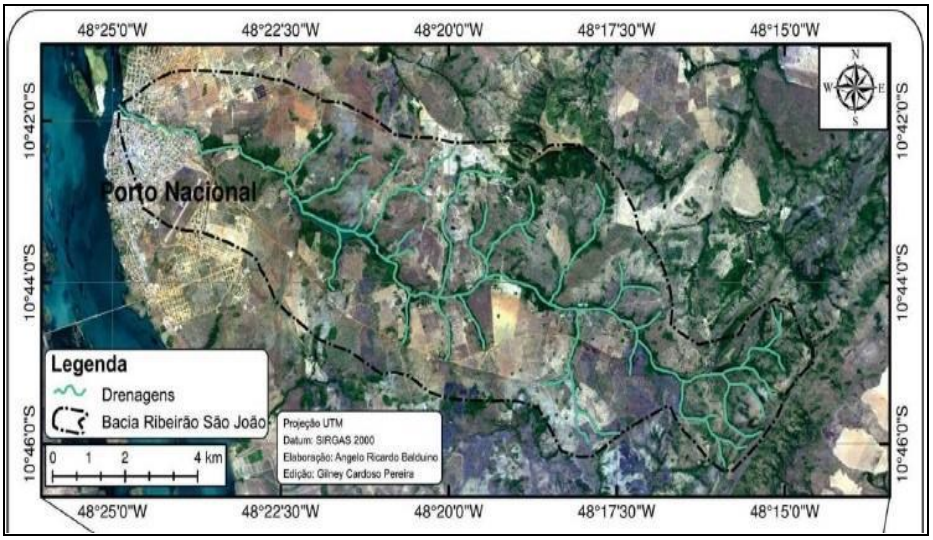

Fig.1 – Map of the location of the São João Rive Basin

Source: Balduíno e Carvalho (2016).

Tradução das palavras da figura:

Legenda - Legend
Drenagens – Drainage
Bacia Ribeirão São João – São João River basin
Datum – Datum
Elaboração- Elaboration
Edição – Edition

Table 1 –Location of the water collection points of São João River in Porto Nacional, Tocantins, in the months of August, September, October, November and December 2018 to January 2019.

Point	Latitude (S)	Longitude (W)	Reference Site
PI	**10°46'08"**	**48°15'57"**	**Next to the source (FazendaPilão);**
PII	**10°43'02"**	**48°22'21"**	**DamofBRK/SANEATINS;**
PIII	**10°42'10"**	**48°23'47"**	**Formigueiro Beach in the Jardim Querido sector.**

2.2 – Water analyses

The water quality parameters studied in this work were: temperature, dissolved oxygen (saturation percentage), pH, total nitrogen, total phosphorus, electrical conductivity, total coliforms, total solids and turbidity.

The samples were collected monthly from August, September, October, November and December 2018 to January 2019. The methodology adopted was divided and exposed in two parts according to the parameters, in the following order: first the field methodology and then the laboratory methodology.

2.2.1 – Field Methodology

conductivity parameter was analyzed with the CD-840 The field collections were made with river collector, and in situ measurements performed with specific portable devices for each parameter. The water temperature and dissolved oxygen were determined in

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locus with YK 22DO oximeter model, and the electrical digital conductivity meter and the pH with the phmeter model TEC-3P, according to the protocols of these devices.

2.2.2 – Laboratory Methodology

The samples were collected in a 1000 ml flask and then packed in ice-containing thermal boxes and then taken to the Laboratory of Environmental Microbiology - Limonology Sector (LAPEQ) Laboratory of Research in Environmental Chemistry, Federal University of Tocantins (UFT) - Campus Palmas - TO.

Fecal coliforms (FC) were analyzed according to the colilert technique according to the methodology described by Standard Methods (APHA, 2005); Total Nitrogen: it was analyzed by the micro Kjeldahl method (APHA, 2005); Total Phosphorus: it was analized by the ascorbic acid method after digestion with ammonium persulfate (APHA, 2005); Total Solids: were analyzed by the porcelain capsule method (APHA, 2005); Turbidity: determined by the nephelometric method (APHA, 2005); Biochemical Oxygen Demand (BDO): was determined by the standard method A (APHA, 2005).

2.3 – Calculation of the Water Quality Index (WQI)

The WQI was calculated by the multiplicative weighted mathematical form of water quality corresponding to the parameters: sample temperature, pH, dissolved oxygen saturation percentage, biochemical oxygen demand (5 days, 20 ° C), fecal coliforms, total nitrogen, phosphorus total solids and turbidity. Being exposed by the equation:

$$IQA = \prod_{i=1}^{n} q_i^{w_i}$$ (Equation 2)

TRADUÇÃO da palavra da equação :

IQA – WQI

At where:

WQI: Water Quality Index, a number between 0 and 100;

qi: quality of the i-th parameter, a number between 0 and 100, obtained from the respective average curve of quality variation for each parameter, depending on its concentration or measure;

wi: correspondingweight to the ith parameter or sub-level, a number between 0 and 1 (Table 2), attributed as a function of its importance to the overall conformation of quality, wherein:

$$\sum_{i=1}^{n} w_i = 1$$

on what:

n: number of parameters that is used theWQI calculation.

Table 2: Parameters and weights for calculation of WQI - NSF.

PARAMETERS	UNIT	WEIGHT (wi)
CF	NMP/100ml	0.15
pH	-	0.12
DBO	Mg/L	0.10
Total Nitrogen	Mgn/L	0.10
Total phosphate	$MgPO_4$/L	0.10
Temperature	°C	0.10
Turbidity	NTU	0.08
Total solids	Mg/L	0.08
OD	%saturation	0.17

Source: Yisaet al. (2012).

The quality of the water is identified as a function of the value of WQI obtained, which can be terrible (WQI<25), bad (26 <WQI<50), regular (51 <WQI<70), good (71 <WQI<90) or excellent quality (91 <WQI ≤ 100) (ANA, 2015).

III. RESULTS AND DISCUSSIONS

3.1 – Water Quality Index (WQI)

The results of the physical, chemical and bacteriological parameters of the surface waters of São JoãoRiver were used in the calculation of the WQI for the period of August, September, October, November and December of 2018 to January 2019. The classification of the quality of the waters of São João River was made from the values recommended by the NSF.

In Table 3, which shows the temporal and spatial behavior of theWQI, there is little variation between the values obtained in the rainy season (November to January) along the water body at points I and III (66.02 in PI and 68.24 in the PIII)in the dry period (August to October) the values obtained greater variations in relation to the rainy season for the same points, but with few variations for the dry season (61.92 in the PI and 62.73 in the PIII), different from point II that is slightly lower in the rainy season (from 65.85 to 68.46) and also in the dry period (from 71 to 71.73). In the dry period, there is little variation between the values obtained in points I and II (average of 70.52 in the PI and 67.86 in the PII), explaining that, according to this index, for the period studied the water quality may to be classified in the regular category (51 <WQI <70), the average of the three points analyzed PI, PII and PII was (68.61), and that despite some variations in specific points, it presents homogeneity among the three collection points.

It is highlightedthat of the nine parameters, four (OD, total phosphorus, total nitrogen and fecal coliforms) were in disagreement with the values established by the

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CONAMA resolutions, however the variations presented showed that they were not significant to reflect in the final results, demonstrating that such variations were absorbed by other parameters.

It is concluded that it is essential to use the WQI for monitoring water resources, due to their low costs, as well as the importance for decision-making. In the case of SãoJoão River, it is observed that the WQI proposed by the NSF does not satisfactorily describe the quality, since in some uses, such as bathing, this index has limitations, since the coliform parameter is absorbed by the other parameters, diluting its effect, which may lead to overestimation of the quality of this water.

Table.3: Water Quality Index (WQI NSF) at the three points of collection.

Points / Month	PI	PII	PIII
August/2018	**74.77**	**71**	**69.01**
September/2018	**74.89**	**71.73**	**70.66**
October/2018	**61.92**	**60.87**	**62.73**
November/2018	**66.02**	**65.85**	**68.24**
December/2018	**72.78**	**68.94**	**68.41**
January/2019	**73.12**	**68.46**	**69.82**

IV. CONCLUSIONS

The results allowed us a better spatial visualization of the water quality of São João River. The temporal analysis of the water quality was extremely important, because it was able to detect small oscillations in the WQI values at the three sampling points.

When analyzing separately the results of the parameters considered in the WQI with the limits established by CONAMA Resolution 357/2005, it was possible to observe that most of them (OD, total phosphorus, total nitrogen and fecal coliforms),were presentedin disagreement with these legal instruments . Therefore, the results obtained indicate that the preventive and preservation measures must be adopted in the management of the water resources of this basin, avoiding that in a short time the WQI, currently classified as "regular", is not classified in another class of inferior quality.

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