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The impact of urbanization and domestic waste on a small watercourse in the eastern Amazon basin

O impacto da urbanização e do lixo doméstico em um pequeno curso d'água na bacia amazônica oriental

El impacto de la urbanización y los desechos domésticos en un pequeño curso de agua en la cuenca oriental del Amazonas

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Mário Junior Saviato
ORCID: https://orcid.org/0000-0002-8757-7915
Federal University of Amapá, Brazil
E-mail: msaviato@yahoo.com.br
José Carlos Guimarães Júnior
ORCID: https://orcid.org/0000-0002-8233-2628
University of Amazonas State, Brazil
E-mail: profjc65@gmail.com
Jucivaldo Dias Lima
ORCID: https://orcid.org/0000-0002-2592-7430
Amapá Scientific Research Institute, Brazil
E-mail: jucivaldo@yahoo.com

Abstract
The present study shows the physical and chemical parameters collected in an urban river in the Eastern Amazon, they present the characteristics of the waters in the Neblina stream, which has its basin inserted in an urban center, in the city of Araguaína - TO. Therefore, the present study aims to investigate the water quality parameters of that stream, and thus allow deductions about the causes and effects of these changes. In this stream, sampling points were listed that contemplate environments from the springs to its mouth. Being, the quality of its waters, evaluated in two stages that envision two seasons (dry and rainy), respectively, August 2020 and March 2021. Adding a total of six sampling points, systematically visited in both seasons described, making up 12 samples, for all parameters analyzed here. In this way, the samples were explored in order to find values for the parameters: *In Situ* (Turbidity by turbidimeter; Dissolved oxygen; Electrical conductivity; Water temperature; Air temperature; pH); and *Ex Situ* (BOD; COD; Nitrogen series; Phosphate series; Fecal coliforms; Chlorophyll-α; Heavy metals). The parameters showed similar variations between the sampling points, with a notable data discrepancy between the mouth and head of the Neblina stream. These results show that there are higher concentrations for these parameters, directly related to the length of the route in the urban environment. Indicating a possible impact on the existing fauna and flora, which may conjecture a plausible toxicity and risks to organisms, as an admissible threat to biodiversity.
Keywords: Urban rivers; Aquatic fauna; Environmental contamination.

Resumo
O presente estudo exibe os parâmetros físico químicos coletados em um rio urbano na Amazônia Oriental, estes apresentam as características das águas no ribeirão Neblina, o qual tem sua bacia inserida em um centro urbano, na cidade de Araguaína – TO. De modo que, o presente estudo tem por objetivo investigar os parâmetros de qualidade da água do referido ribeirão, e assim permitir deduções sobre as causas e efeitos dessas alterações. Neste ribeirão, foram elencados pontos amostrais que contemplam ambientes desde as nascentes até sua foz. Sendo, a qualidade de suas águas, avaliada em duas etapas que, vislumbram duas estações (seca e chuvosa), respectivamente, agosto de 2020 e março de 2021. Somando um total de seis pontos amostrais, visitados sistematicamente em ambas as estações descritas, perfazendo 12 amostragens, para todos os parâmetros aqui analisados. Desta forma, as amostras foram exploradas a fim encontrar valores para os parâmetros: *In Situ* (Turbidez por turbidímetro; Oxigênio dissolvido; Condutividade elétrica; Temperatura da água; Temperatura do Ar; pH); e *Ex Situ* (DBO; DQO; Série nitrogenada; Série fosfatada; Coliformes fecais; Clorofila-α; Metais pesados). Os parâmetros apresentaram variações similares entre os pontos amostrai, tendo notável discrepância de dados entre a foz e a cabeceira do ribeirão Neblina. Estes resultados evidenciam que há maiores concentrações para estes parâmetros, diretamente relacionadas com o tamanho do percurso no meio urbano. Indicando possível impacto a fauna e flora ali existentes podendo conjeturar uma plausível toxicidade e riscos aos organismos, como admissível ameaça a biodiversidade.
Palavras-chave: Rios urbanos; Fauna aquática; Contaminação ambiental.

Resumen
El presente estudio muestra los parámetros físicos y químicos recolectados en un río urbano en la Amazonía Oriental, presentan las características de las aguas en el arroyo Neblina, que tiene su cuenca inserta en un centro urbano, en la ciudad de Araguaína - TO. Por lo tanto, el presente estudio tiene como objetivo investigar los parámetros de calidad del agua de esa corriente, y así permitir deducciones sobre las causas y efectos de estos cambios. En este arroyo se enumeraron puntos de muestreo que contemplan ambientes desde los manantiales hasta su desembocadura. Siendo, la calidad de sus aguas, evaluada en dos etapas que contemplan dos temporadas (seca y lluvia), respectivamente, agosto de 2020 y marzo de 2021. Sumando un total de seis puntos de muestreo, visitados sistemáticamente en ambas temporadas descritas, conformando 12 muestreos, para todos los parámetros analizados aquí. De esta forma, las muestras fueron exploradas con el fin de encontrar valores para los parámetros: *In Situ* (Turbidez por turbidímetro; Oxígeno disuelto; Conductividad eléctrica; Temperatura del agua; Temperatura del aire; pH); y *Ex Situ* (DBO; DQO; Serie Nitrógeno; Serie Fosfato; Coliformes fecales; Clorofila-α; Metales pesados). Los parámetros mostraron variaciones similares entre los puntos de muestreo, con una notable discrepancia de datos entre la desembocadura y la cabecera del arroyo Neblina. Estos resultados muestran que existen mayores concentraciones para estos parámetros, directamente relacionados con la longitud del recorrido en el medio urbano. Indicando un posible impacto sobre la fauna y flora existente, lo que puede conjeturar una plausible toxicidad y riesgos para los organismos, como una amenaza admisible para la biodiversidad.
Palabras clave: Ríos urbanos; Fauna acuática; Contaminación ambiental.

1. Introduction

Water resources are common goods and essential to the maintenance of the ecosystem and of life as a whole. It must be available in a way that can reliably support its diverse uses (Dusabe et al. 2019; Chapman & Sullivan 2022).

The state of Tocantins has a vast territorial area, mainly inserted in the Cerrado biome, its variations and ecotones. This biome comprises most of the hydrographic basins that drain the Brazilian Midwest. As Tocantins holds the largest basin fully inserted in the Brazilian territory, the Araguaia-Tocantins basin (Lowe-McConnell 1999; Gomes et al. 2018).

With a territorial area of over 2. 0 million km², the Cerrado *sensu lato* covers the Brazilian states Alagoas, Amapá, Amazonas, Paraná, Pará, Pernambuco, Matogrosso and Matogrosso do Sul, Roraima, São Paulo and Sergipe, in addition to occur, also in other countries, such as: Bolivia and Paraguay. Being located in the drainage area of the three largest hydrographic basins in South America (Klein 2000)

Being the most exploited ecosystem due to the different faces of human demands, such as agriculture, livestock and mining. A fact that makes it one of the areas with the greatest negative anthropogenic pressure, with interventions that degrade and disfigure the environment. Making this one of the most threatened ecosystems on the planet, where the greatest threat to biodiversity in this location is agribusiness and its aspects (Rost et al. 2021).

The hydrographic basins that cut or originate in this biome are, therefore, affected by the impacts described above. Because, rivers reflect the synergies between the environment and anthropic actions or natural relationships, as well as the processes of occupation, urbanization and land use. Resulting in the health of aquatic biodiversity (Barbosa et al. 2021).

Thus, the intense urbanization on the banks of the rivers that touch the urban center of cities in the north of Tocantins, such as Araguaína-TO, also have occupation of the headwaters, for cattle raising and for agriculture and horticulture. These characteristics imply a constant degradation of the quality of the physical chemical parameters of the water in these rivers. In this way, it can lead to a demand for leachates and solutes, higher than the natural demand for Cerrado rivers, contaminating and compromising the relevant ecological services (Trindade & Sieben 2012, Saviato et al. 2017).

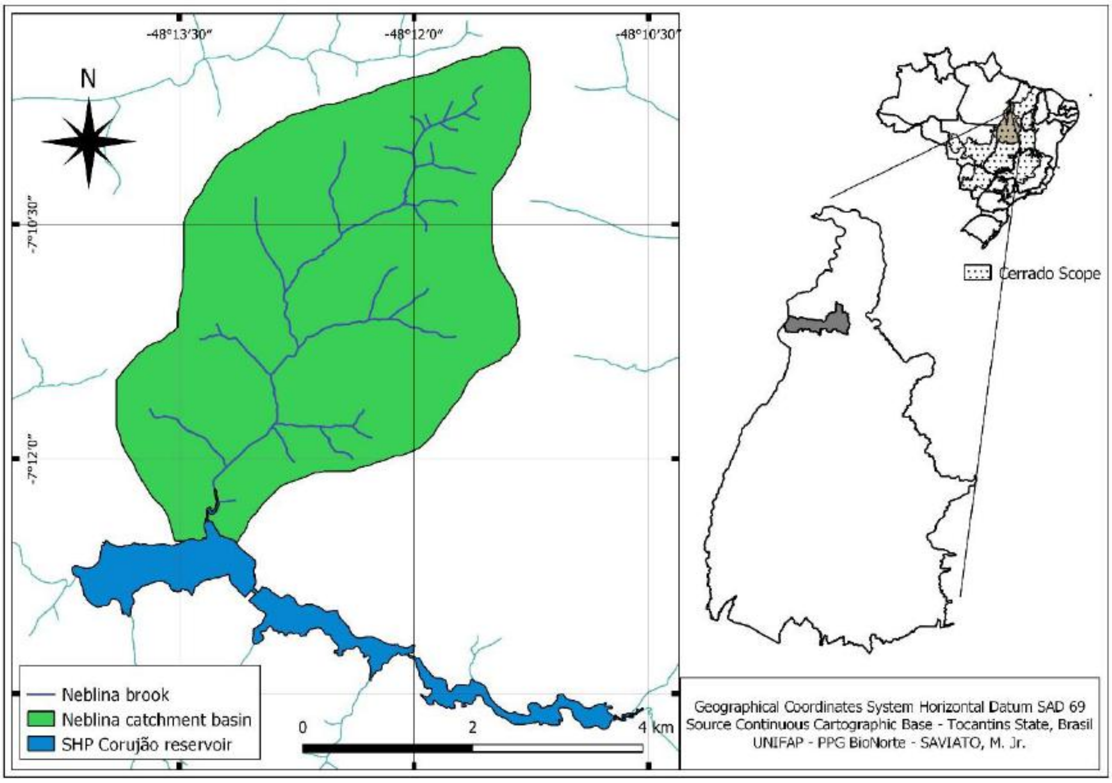
Therefore, within a general framework, there is the possibility of environmental contamination and trophic magnification by urban and agro-industry pollutants in these so-called urban rivers. In this sense, it is imperative to investigate the Neblina River, which cuts through the urban center of the city of Araguaína-TO, and thus enable inferences about the causes and effects of these local contaminations.

2. Methodology

2.1 Description of the study area

The Brook Neblina, object of this study, is an important tributary of the Lontra sub-basin, located in the north of Tocantins, in the Eastern Amazon (Figure 1). Being a typical fluvial environment of the physiognomies of the Cerrado biome, it is present in its characteristics, the riparian forest in the form of galleries, crystal clear waters in its headwaters (Trindade & Sieben 2012; Saviato et al. 2020; Souza 2020). Less than 10 km long, it is considered a small river, but with considerable volume, draining an area of approximately 18 km². However, it is densely populated, as it travels through the central urban area of the city of Araguaína – TO. Where it receives all sorts of effluents and residues, as well as suffering from structural changes, see (Figure 2).

Figure 1 - Neblina brook hydrographic basin, located in the north of the state of Tocantins – BR.



Source: Authors (2022).

Figure 2 - Neblina brook, in an area where it is channeled and receives a large effluent load, before point 06.

Source: Authors (2022).

2.2 Data collect

The water samples were systematically collected in 06 (six) points distributed in the main channel of the Neblina brook, from its head more upstream, to its mouth, close to the lake formed by the SHP Corujão reservoir, Lontra river (Table 1 and Figure 3). The collection and storage of samples was carried out as stipulated in NBR 9898 (Schalenberger et al. 2019), at the sampling points delimited in Table 1. Therefore, such sampling events took place in two seasons, dry and rainy, respectively, October 2020 and March 2021 (Guarda et al. 2021).

Table 1 - UTM geographic coordinates of the collection points within the Neblina brook watershed.

Collection points	Longitude 22M	Latitude
01	808370. 00 m E	9203601. 00 m S
02	808965. 00 m E	9204843. 00 m S
03	809008. 00 m E	9206096. 00 m S
04	809350. 00 m E	9206944. 00 m S
05	807750. 00 m E	9205043. 00 m S
06	806833. 00 m E	9202594. 00 m S

Source: Authors (2022).

Figure 3 - Distribution of collection points within the brook Neblina gutter.

Source: Authors (2022), Google Earth adapter.

For the *Ex Situ* analyses, the water samples directly from the Neblina brook were conditioned and stored in such a way as to remain viable until the moment of analysis in the laboratory. Therefore, the collected material was packed in amber flasks with a capacity between 1000ml and 500ml, depending on the parameter analyzed, and these were then kept at controlled temperature, refrigerated, during transport until preparation in the laboratory (Bega et al. 2020). These analyzes were carried out systematically at the Research Laboratory in Chemistry - Foundation for Scientific and Technological Support of Tocantins - FAPTO - UFT - Palmas - TO. Therefore, the analysis of physical chemical parameters followed the protocols presented in the Standard Methods for the Examination of Water and Wastewater of the American Public Health Association (APHA, 2012) and the International Organization for Standardization (ISO 11905-1, 1997). Therefore, the tests performed were: *In-Situ* (Turbidity by turbidimeter; Dissolved Oxygen; Electrical conductivity; Water temperature; Air temperature; pH); and *Ex Situ* (BOD; COD; Nitrogen series; Phosphate series; Fecal coliforms; Chlorophyll-α; Heavy metals) (Campos et al. 2021).

2.3 Data analysis

The results of the samples were treated and statistically analyzed from the assumption of homoscedasticity with analysis of variance (ANOVA), Spearman's correlation and comparison of means by the Tukey test at 5% significance with the help of the Excel program from Office 2013 for Windows.

3. Results and Discussion

The results refer to 06 (six) sampling points, making a total of 12 samples, in allusion to the two climatic seasons (dry and rainy). From these samples, data on physical and chemical parameters were extracted, resulting in the information tabulated below (Table 2 to Table 5), which are listed by sampling point and by climatic station.

Table 2 - Parameters obtained for the dry season (October 2020) in the Neblina brook.

Parameters	**Temperature**	**Electric conductivity**	**Turbidity**	**Total dissolved solids**	**pH**	**Dissolved oxygen**	**Chlorophyll-α**	**Total coliforms**	***Escherichia coli***
Unit	**ºC**	**µS/cm**	**NTU**	**PPM**	**Scale**	**mg/L**	**µg/L**	**NMP/100 mL**	**NMP/100mL**
Lq(1)	-10	0,01	0,01	0,01	-2	0	0,002	Ausente	Ausente
P1	26,8	162	2,4	105	7,36	7,46	0,48	>2419,6	613,1
P2	29,25	135	7	88	7,72	6,39	0,87	>2419,6	727
P3	27,61	241	2,4	157	7,38	5,35	0,72	>2419,6	>2419,6
P4	31,23	190	12,6	123	7,43	6,24	0,051	>2419,6	>2419,6
P5	29,43	276	12,0	180	4,68	3,63	0,001	>2419,6	>2419,6
P6	31,53	268	15,3	174	8,48	6,97	3,4	>2419,6	488,4
CONAMA 357/2005 VMP(2)	*****	*****	**100**	**500**	**6,0 a 9,0**	**Above of 5,0**	**30**	*****	***(3)**

Source: Authors (2022).

Table 3 - Parameters obtained for the rainy season (March 2021) in the Neblina brook.

Parameters	**Temperature**	**Electric conductivity**	**Turbidity**	**Total dissolved solids**	**pH**	**Dissolved oxygen**	**Chlorophyll-α**	**Total coliforms**	***Escherichia coli***
Unit	**ºC**	**µS/cm**	**NTU**	**PPM**	**Scale**	**mg/L**	**µg/L**	**NMP/100 mL**	**NMP/100mL**
Lq(1)	-10	0,01	0,01	0,01	-2	0	0,002	Ausente	Ausente
P1	26,85	320	2,2	208	7,53	6,63	5,91	>2419,6	>2419,6
P2	29,98	223	2,4	145	7,49	5,77	14,97	>2419,6	93,3
P3	27,35	176	2,8	114	7,48	8,53	1,58	>2419,6	>2419,6
P4	26,28	191	2,6	124	7,26	6,48	<0,002	>2419,6	>2419,6
P5	27,93	260	5,8	169	7,31	4,62	0,20	>2419,6	>2419,6
P6	30,85	187	14,0	187	7,87	5,87	2,17	>2419,6	>2419,6
CONAMA 357/2005 VMP(2)	*****	*****	**100**	**500**	**6,0 a 9,0**	**Above of 5,0**	**30**	*****	***(3)**

Source: Authors (2022).

Table 4 - Parameters obtained for the dry season (October 2020) in the Neblina brook.

Parameters	Orthophosphates	Total Phosphorus	Manganese	Zinc	Copper	Lead	Cadmium	Nickel	Chrome	Ammonia	Nitrite	Nitrate	Organic Nitrogen	Total Nitrogen
Unit	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Lq(1)	**0,02**	**0**	**0,001**	**0,034**	**0,003**	**0,008**	**0,009**	**1,312**	**0,003,**	**0,02**	**0,002**	**0,1**	**0**	**0**
P1	0,21	0,26	0,129625	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,0875	0,0085	3,50	4,09	7,69
P2	0,05	0,13	0,083375	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,050	0,1562	3,75	3,50	7,46
P3	0,08	0,15	0,053875	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,137	0,0587	3,00	4,63	7,83
P4	0,05	0,10	0,072125	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,212	0,0200	3,88	3,50	7,40
P5	0,10	0,16	0,112875	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,075	0,0375	3,50	5,25	8,86
P6	0,11	0,19	0,063875	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,575	0,0088	4,00	3,50	8,09
CONAMA 357/2005	*****	**0,10**	**0,10**	**0,180**	**0,009**	**0,010**	**0,001**	**0,025**	**0,050**	**0,5-3,7**	**0,5-3,8**	**10**	*****	*****

Source: Authors (2022).

Table 5 - Parameters obtained for the rainy season (March 2021) in the Neblina brook.

Parameters	Orthophosphates	Total Phosphorus	Manganese	Zinc	Copper	Lead	Cadmium	Nickel	Chrome	Ammonia	Nitrite	Nitrate	Organic Nitrogen	Total Nitrogen
Unit	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Lq(1)	**0,02**	**0**	**0,001**	**0,034**	**0,003**	**0,008**	**0,009**	**1,312**	**0,003,**	**0,02**	**0,002**	**0,1**	**0**	**0**
P1	0,17	0,21	0,1037	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,070	0,007	2,80	3,27	6,15
P2	0,04	0,10	0,0667	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,040	0,125	3,00	2,80	5,97
P3	0,06	0,12	0,0431	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,110	0,047	2,40	3,70	6,26
P4	0,04	0,08	0,0577	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,170	0,016	3,10	2,80	5,92
P5	0,08	0,13	0,0903	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,060	0,030	2,80	4,20	7,09
P6	0,09	0,15	0,0511	<0,0341	<0,0032	<0,0075	<0,0095	<1,3128	<0,0034	0,460	0,007	3,20	2,80	6,47
CONAMA 357/2005	*****	**0,10**	**0,10**	**0,180**	**0,009**	**0,010**	**0,001**	**0,025**	**0,050**	**0,5-3,7**	**0,5-3,8**	**10**	*****	*****

Source: Authors (2022).

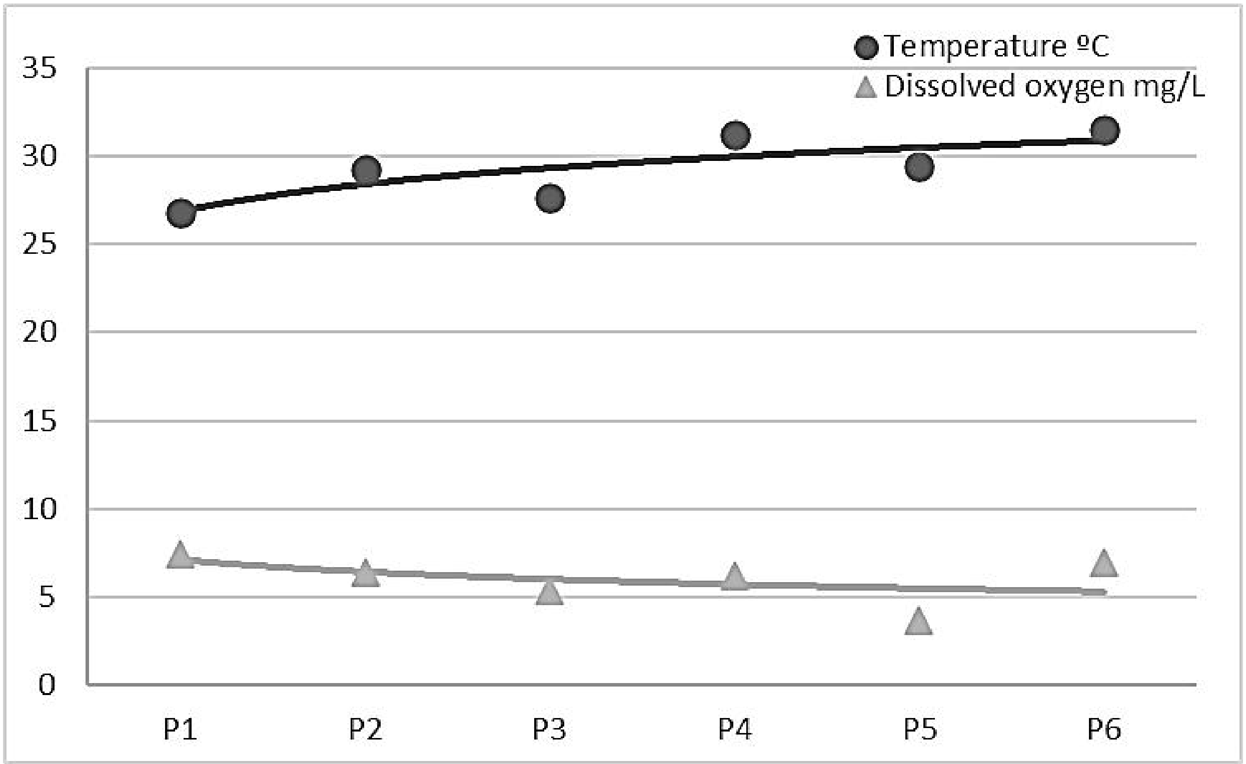
The data presented here emphasize that there is variation in the physical and chemical parameters of the Brook Neblina waters, from the headwaters to its mouth. These values corroborate each other, in some groups, as well as the one presented below. Some of these parameters deserve more attention in terms of their variations, as they strongly influence aquatic life and organisms dependent on this body of water, as well as the human population (Carneiro et al. 2021). In this way, we can verify that the water temperature underwent a slight increase, while the dissolved oxygen decreases inversely proportional to the previous parameter. As expected, as the dissolution of oxygen in the medium in water is inversely proportional to the increase in temperature. Evidencing that the temperature increases as we approach the mouth, decreasing oxygenation in the same direction (Nascimento et al. 2021, Poersch & Sebastien 2021).

It is possible to infer that there are a series of factors that change the temperature parameter, whether direct anthropogenic, such as discharge of effluents at a temperature higher than that of the watercourse, to the then secondary, such as the removal of riparian vegetation cover, which allows direct entry of light and solar heat. So, considering these possibilities and not natural causes, as it is a watercourse with only 7,500 meters in length, which presents a variation of approximately 5ºC, from the headwater to the mouth. In this sense, the indicated DO values ranged between 3. 63 and 8. 53 mg/L, with the lowest value found at point 01, in the dry season. Strong indication of the low concentration of water and low flow, evidencing the non-existence of forced oxygenation by the displacement of water (

Figure **4**). In the same way that there is such a pattern for the rainy season, but with greater variation in the results, due to the volume of rainfall and water in this brook (Source: Authors (2022).

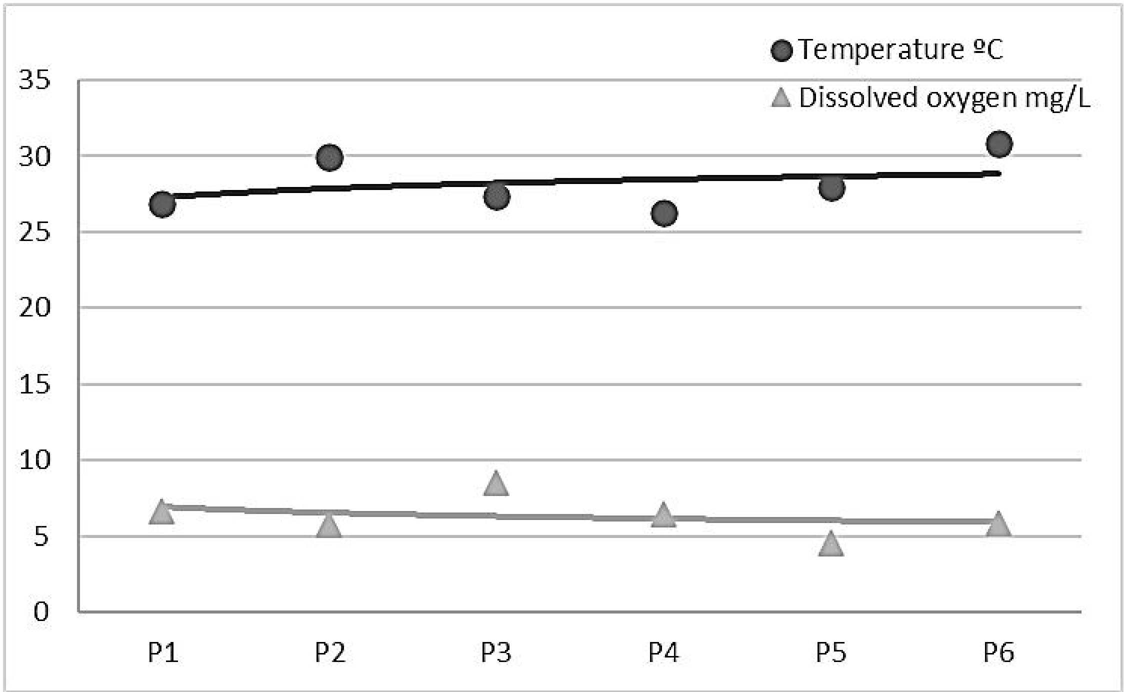
Figure 5).

Figure 4 - Distribution of results for temperature (ºC) and Dissolved Oxygen (DO - mg/L), for the dry season (August/2020).



Source: Authors (2022).

Figure 5 - Distribution of results for temperature (ºC) and Dissolved Oxygen (DO - mg/L), for the rainy season (March/2021).

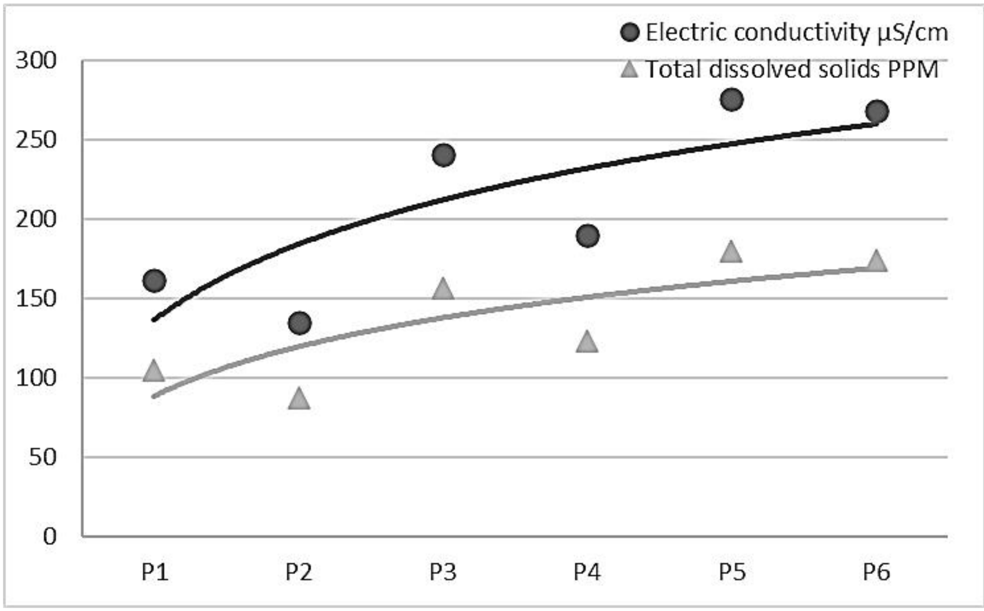


Source: Authors (2022).

The results for dissolved solids and for electrical conductivity point to a direct relationship, which can be explained by the leaching of minerals, which increases the amount of dissolved metallic ions in water, consequently increasing the electrical conductivity (Reginato et al. 2021). However, it is possible to observe that this parameter has higher values in the dry season, which would not be expected since the lack of rain considerably reduces the transport of minerals to the water bodies, consequently the conductivity (Figure 6). It is possible to infer that there is an unidentified source that enables this increase in conductivity during the dry season, showing that, in the rainy season, the high rainfall enables the dilution of these dissolved solids in the sample sections (Source: Authors (2022).

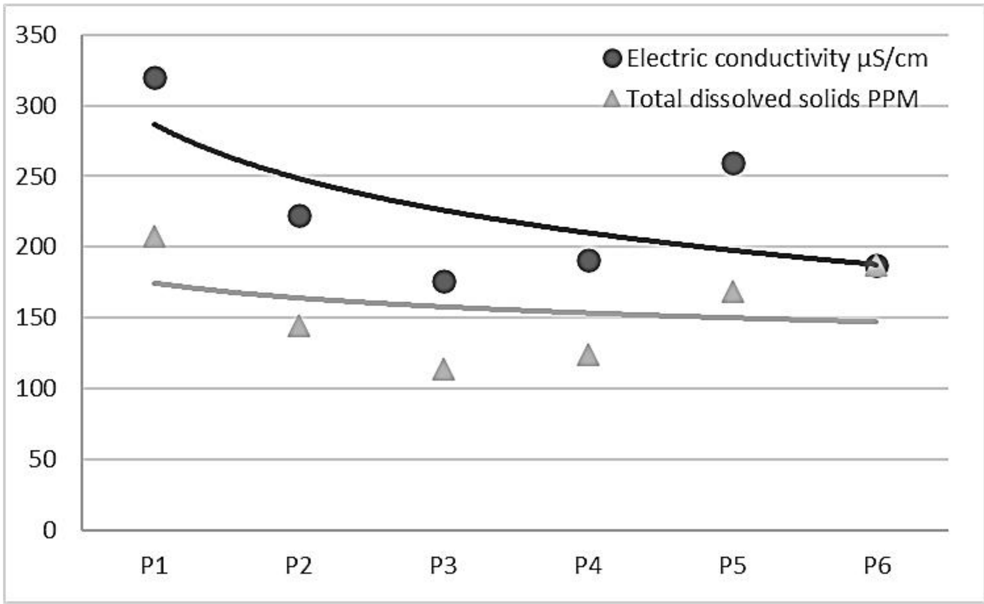
Figure 7).

Figure 6 - Relationship between dissolved solids and electrical conductivity results for the dry season (August/2020).



Source: Authors (2022).

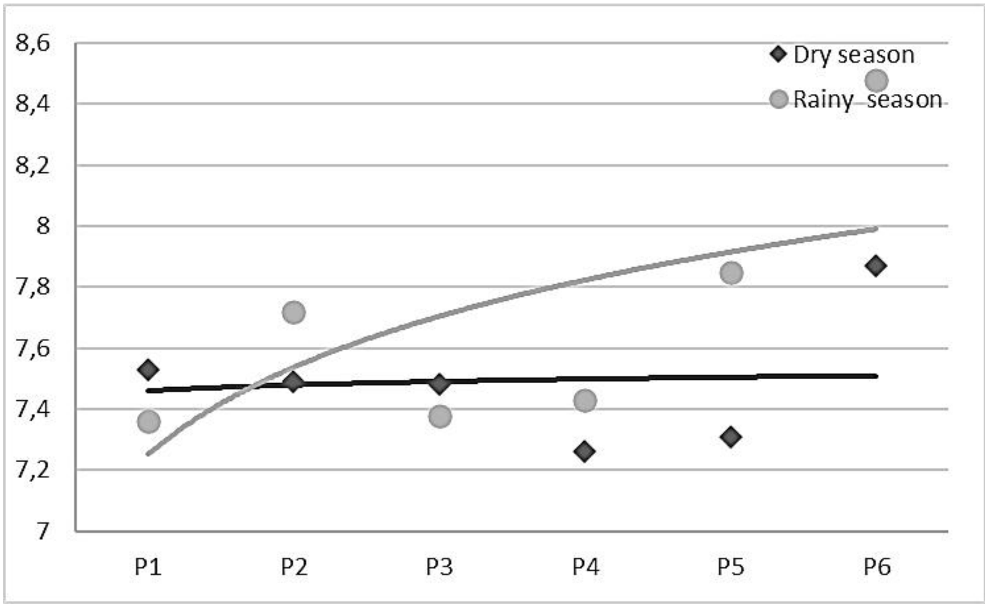
Figure 7 - Relationship between dissolved solids and electrical conductivity results for the rainy season (March/2021).



Source: Authors (2022).

The pH values found in this study ranged from 7. 31 to 8. 48 which, despite the short distance between the sample sites, are quite different values. These values are consistent with the proposed by CONAMA resolution 357, which indicates the range from 6. 0 to 9. 0, as limits for aquatic systems. However, we can identify that the highest values are found at points further downstream in this study, with the highest value being seen at point 6 (mouth). These high pH values may come from the increase of substances composed of hydroxides, phosphates and bicarbonates, these connected to domestic effluents rich in detergent products or even associated with the natural deterioration of rocks. However, as the aforementioned brook is entirely inserted in the urban area, such values must be associated with anthropogenic sources (Poersch & Sebastien 2021) (Figure 8).

Figure 8 - pH values for the two seasons (dry – August/2020 - and rainy – March/2021).

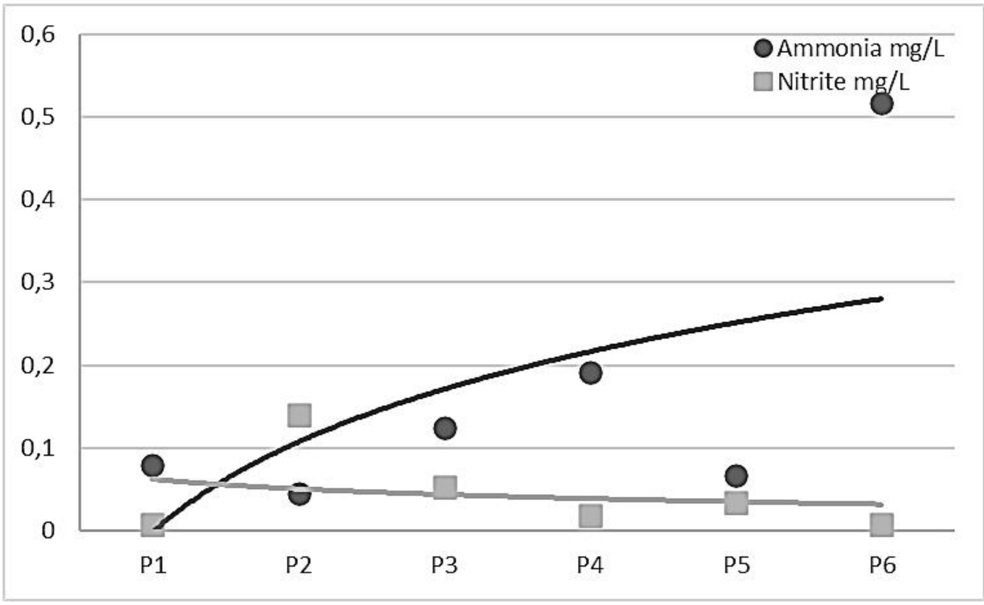


Source: Authors (2022).

The results obtained for Nitrite are between the values of 0. 0 and 0. 125 mg/L, being within the recommended limits established by CONAMA, in resolution 357, which indicates 1. 0 mg/L as the legal limit (Figure 9). However, the shapeless variation between the points, with the highest value indicated for P2, must be linked to a source close to that point and the other smaller results related to the self-purification provided by the flow of this body of water (Araújo et al. 2021). However, it was verified that the values for the other nitrogenous compounds present an increase as the river channel descends. Where the ammonia indices found, denote the increment with organic matter to the brook, also relating to the course from upstream to downstream, with the highest values found in the mouth (Source: Authors (2022).

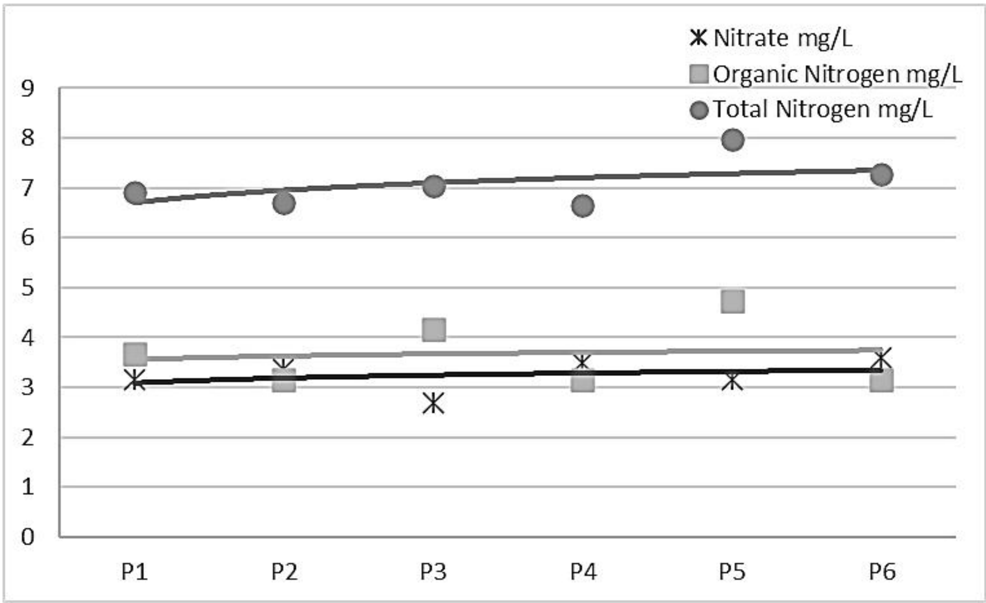
Figure 10).

Figure 9 - Presentation of the mean values of Ammonia and Nitrite in relation to the sampling points.



Source: Authors (2022).

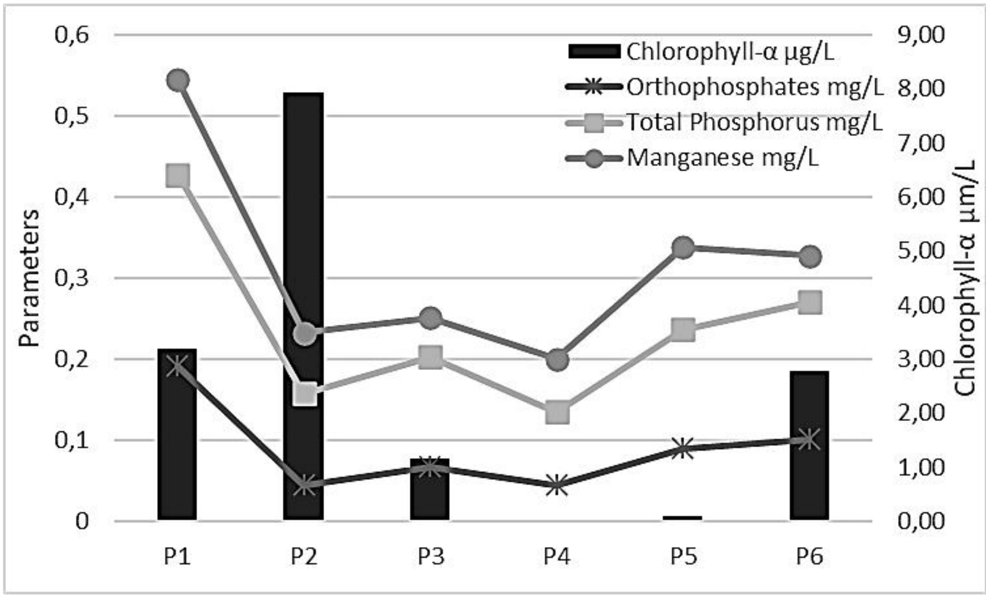
Figure 10 - Presentation of mean values for nitrogen compounds (Nitrate, Organic Nitrogen and Total Nitrogen) in relation to the sampling points.



Source: Authors (2022).

The values for the phosphate compounds varied in order to compose higher values upstream of the study instead of at the mouth as the others already presented. This fact may be related to the presence of rural properties around the brook Neblina basin, as well as areas for growing vegetables and domestic effluents dumped directly into its gutter (Xu et al. 2021). Likewise, there are greater results for Chlorophyll α in the upstream points. Indicative of the eutrophic relationship between phosphate nutrients and photosynthetic organisms participating in phytoplankton (Serbeto et al. 2021) (Figure 11).

Figure 11 - Comparison of the distribution dynamics of phosphate organic compounds and manganese, with α Chlorophyll values.



Source: Authors (2022).

Neblina brook has waters that undergo numerous quality changes, from the headwaters to its mouth, with a great discrepancy in values. However, according to CONAMA resolution 357 regulations, it is classified as unsuitable for recreation and secondary use, as it presents very high coliform rates throughout its entirety. Emphasizing that these waters are unsuitable for irrigation, use in aquaculture and fishing activities. However, the other contaminants, coming from domestic and industrial effluents, form a gradient with their higher levels as they approached the mouth. It is also this gradient of urban occupation, as the river advances, it receives all sorts of urban waste, increasing the levels of these contaminants. Thus, the brook Neblina at its mouth is considered unsuitable for any use, including landscape composition, as it is totally uncharacterized, chemically and physiognomic, with its high levels of contamination, which can cause damage to the human population.

Likewise, the turbidity results were low in the headwaters and increased as the distance from the mouth decreased. This parameter did not directly interfere in the water quality of the Neblina brook, being related, in the rainy season, to the leaching of particles from the soil and in the dry season by urban contamination processes by domestic and industrial effluents (Collares et al. 2021).

Similarly, the results for the analyzed metals were always lower than those established in CONAMA Resolution 357. However, they were always present in the samples collected for both seasons. A subtle indication that there are some contaminating sources, but on a small scale, as measured in other springs in the region (Guarda et al. 2021).

Likewise, monitoring these parameters and, consequently, water quality is an important tool for understanding the impacts of urbanization on the environment (Re et al. 2022). Indicating that the monitoring of water quality in urban rivers is considerable for the creation of pollution control measures, aiming at improving environmental quality and consequently the well-being of human populations (Silva et al. 2022). Noting that the improvement of water quality is of paramount importance so that we can think of a future without scarcity, since drinking water in its natural form has been gradually decreasing in the world, due to incorrect and polluting releases, both by urbanized areas, as well as by agro-industry and other types of exploitation of natural resources (Manoj et al. 2022; Thakur & Devi 2022). Thus, advancing in the creation of subsidies for the establishment of better public policies, aimed at improving environmental quality as a whole (Westerhoff et al. 2022).

4. Conclusion

According to the data obtained, we can infer that, even with evidence of evictions of rural origin in its headwaters, the Neblina brook receives untreated urban effluents along the way, worsening the quality of its waters. Thus, making this unsuitable for the various uses recommended by CONAMA resolution 357, which governs the quality and use of water in Brazilian territory. And so, there is an indication of negative anthropogenic interference, such as the change in river physiognomy and the change in water quality due to the discharge of domestic and industrial effluents. Pointing out that, at the end of the route of this urban brook, the levels of contamination are high and can cause damage and contamination to human populations, as well as to aquatic biota.

It is important that there are more experiments similar to this one, in order to continue monitoring the health of this urban freshwater environment, and of others that suffer the same anthropic pressures. With a view to providing subsidies for the formulation of better public policies, to face the degradation of urban water sources.

5. Final Considerations

This study points out some nuances that reveal the reality of urban rivers and the disregard for the common good. As a drainage gutter fully inserted in the urban area, the brook Neblina is often subject to changes in rainwater runoff, effluent reception, solid waste disposal, among others. Therefore, the waters that in the past would be used to supply secondary uses, at present they cannot do so, as they are harmful to the population. This work highlights the fact that the change in the quality of the water in these drainages promotes impacting environmental and social impacts, reducing the quality of life due to the impacts arising from the unregulated uses of natural resources.

These damages are reflected in the degradation of biodiversity and human quality of life, also contaminating the waters downstream of its mouth. Needing better public policies and public awareness, related to the conservation and use of the waters of the brook Neblina. Enabling future generations to enjoy and maintain this important urban river, in the headwaters of the Eastern Amazon basin.

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