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Analysis Of Physicochemical Parameters From The Water Of The Riverbed Of Tracuateua River In Santa Bárbara Of Pará (Brazil)

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Abstract
Justification: *the Tracuateua river supplies and is supplied by many streams in several cities, where its mouth is in the city of Santa Barbara, where it is of great importance for the local economy due to tourism, small agricultural productions, among other activities. However, due to rapid urban growth in the region and the emergence of small and medium-sized industries and large plantations, there is a need for constant monitoring of the quality of this river.* ***objective:*** *the general objective of this research is to carry out a physiochemical analysis of the water of the Tracuateua River, in the part that crosses the city of Santa Barbara do Pará, to identify possible impacts of urban development on limnological resources; and as specific objectives: Identify possible risk agents for local environmental degradation; predict possible impacts on environmental health due to the degradation of limnological resources, among others.*
Methodology: *water samples were collected from the bed of the Tracuateua River at different times and tidal situations (high and low), always in the morning and with in-locus analysis. The pH was measured in the samples using a portable electronic pH meter and compared with test strips as a control. The electrical conductivity values of the water samples were measured using a portable electronic conductivity meter, expressed in µS/cm-1 (micronSiemes per centimetre), as well as the sample temperature and Total Dissolved Solids. For environmental temperature, an environmental thermometer was used. The samples were subjected to multiparameter test strips with 3 tests for each sample to identify: alkalinity, lead, bromine, nitrate, nitrite, iron, chromium (VI), copper, mercury, fluoride, among others. The Secchi disc was used to evaluate turbidity, visibility in centimetres, among others. The qualitative observational method was used to obtain information regarding anthropogenic environmental pollution in the studied river and its surroundings and the presence of wild flora and fauna.* ***Conclusions:*** *Physiochemical and observable data, at the time of analysing the collected samples of the stretch of the Traquateua River do not indicate that the water is polluted, however, in the surrounding area there is the presence of potential sources of pollution, which can in the future, compromise the*

waters of this river, urgently requiring public policies for public waste collection, preservation of the ciliary forest, planned urbanisation, public sewage system with filtration, environmental education, among others. The research carried out reflects the moment in which the research material was collected, since the water of a river reflects and is influenced by several factors, such as: atmospheric, soil, sediments, anthropogenic factors, among others, seasonal or not, that can influence momentarily or permanently. In this sense, it is necessary to establish permanent physiochemical and biological monitoring programs for the water of the Tracuateua River.

Keywords: *Environmental chemistry, Water analysis, Limnology, Hydrographic basin, Tracuateua River - State of Pará (Brazil), Santa Barbara do Pará City (Brazil).*

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I. Introduction

The city of Santa Bárbara of Pará according to the *Instituto Brasileiro de Geografia e Estatística* (IBGE) has a territorial area of 278,154 km², with a population of 21,089 people[1]. (IBGE). Located at latitude 01º13'25" South and longitude 48º17'40 West[2].

Santa Barbara of Pará is in the Metropolitan Region of Belém in the State of Pará, it is also known as the "City of Igarapés", which in the Tupi indigenous language means something like "*path or canoe passage*", given the large number of streams that the city has, which contribute with the local economy due to tourism, where some owners of small areas charge entry to tourists and sell food and drinks to them; water for small agricultural production and, in some cases, domestic use, among others.

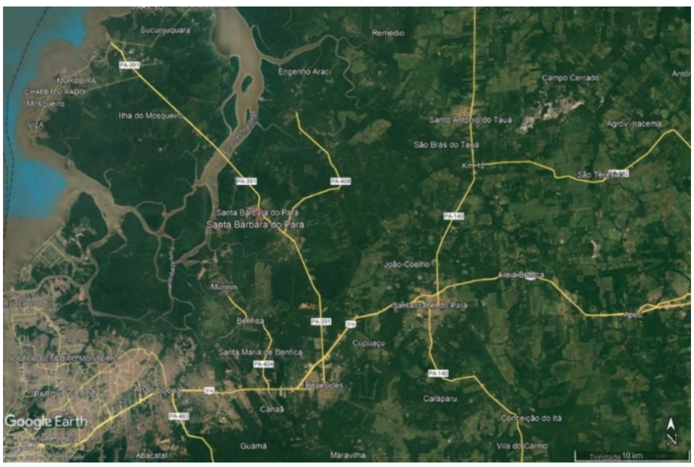
In the hydrographic basin, the main ones stand out as the: Pará River through the part referring to the "Furo das Marinhas", Paricatuba River, Araci River, the source of the Tracuateua River, among others that form the hydrographic basin of the city of Santa Barbara do Pará with its rivers and streams.

In the case of the Tracuateua River, the object of this research, it begins in the city of Santa Barbara, passes through various cities, reaching the city of Quatipurú and Tracuateua (city with same name as the river) where it bifurcates and flows into the Quatipurú bay.

The chemical quality of water must be measured by identifying the component in the water, using specific laboratory methods. Such chemical components must not be present in water above certain concentrations determined with the aid of epidemiological and toxicological studies[3]. It is highlighted that: Potential sources of chemical hazards include onshore and offshore industrial discharges and spills; wastewater discharges; discharges from contaminated sites; local use of motorised crafts; petroleum receiving stations; pesticides; mining waste; naturally occurring chemicals, including algal toxins[4],

In light of this, the general objective of this research is to carry out a physiochemical analysis of the water of the Tracuateua River, in the part that crosses the city of Santa Barbara do Pará, to identify possible impacts of urban development on limnological resources; and as specific objectives: Identify possible risk agents for local environmental degradation; predict possible impacts on environmental health due to the degradation of limnological resources, among others.

It is noteworthy that this research is part of the project "*Environmental impacts of urbanisation on water resources in the Metropolitan Region of Belém and its effects on the health of local populations and the environment: A brief look at geomedicine*" by Professor Doctor Aureliano da Silva Guedes[5] from the Faculty of Chemistry of the Ananindeua Campus of the Federal University of Pará (Brazil) and his team, in the part that refers to the municipality of Santa Barbara of Pará. as part of the research project



Santa Barbara do Pará (Brazil) – Source: Google Earth[6]

II. Methodology

Water samples were collected from the bed of the Tracuateua River at different times and tidal situations (high and low), always in the morning and with *in-locus* analysis.

The pH was measured in the samples using a portable electronic pH meter and compared with test strips as a control. The electrical conductivity values of the water samples were measured using a portable electronic conductivity meter, expressed in µS/cm-1 (micronSiemes per centimetre), as well as the sample temperature and Total Dissolved Solids. For environmental temperature, an environmental thermometer was used[5].

The samples were subjected to multiparameter test strips with 3 tests for each sample to identify: alkalinity, lead, bromine, nitrate, nitrite, iron, chromium (VI), copper, mercury, fluoride, among others. The Secchi disc was used to evaluate turbidity, visibility in centimetres, among others[5].

The qualitative observational method was used to obtain information regarding anthropogenic environmental pollution in the studied river and its surroundings and the presence of wild flora and fauna[5].

III. Results And Discussions

Tracuateua River – Santa Barbara do Pará (Brazil) – Source: Goocle Earth[6]

Parameters	Sample 1 18/10/2023	Sample 2 07/12/2023	Sample 3 13/03/2024	Sample 4 22/05/2024	Tolerability/Source
Environmental visibility	Normal	Normal	Normal	Normal	-
Wind	Absent	Absent	Absent	Low	-
Environment temperature Cº	36.6	27.5	27.5	41.0	-
Ciliary forest	Yes	Yes	Yes	Yes	Varies depending on the type and width of the river
Tide	Low	High	Low	High	-__
Aquatic macrophyte	Yes	Yes	Yes	Yes	Must not present eutrophication
Ph	6.2	6.2	6.2	6.0	5-9
Temp Cº - Sample	25.6	25.0	26.2	29.4	-
Secchi disc depth – Cm	Not applicable	77	Not applicable	65	-
Color	Light brown	Light brown	Light brown	Light brown	-
Turbidity	Normal	Normal	Normal	Normal	-
Odour	Normal	Normal	Normal	Normal	-
Electrical conductivity- (mS/cm).	0.664	0.230	0.032	0,028	Depends on ions and others
TDS (Total Dissolved Solids) - ppm	0.032	0.115	0.016	0.014	500 mg/l CONAMA-BR[7]
Alcalinity	0	0	0	0	-
Carbonate	0	0	0	0	-
Water Hardness	0	50	0	250	<75mg/l Soft 75 at 150 Moderate >150mg/l Hard

					Mol. et al.[8]
Lead	0	0	0	10	0.01 mg/l CONAMA-BR[7]
Bromine	0	0	0	0	0.5mg/l (500 µg/l) WHO[9]
Nitrate	0	0	0	0	0.40 mg/l CONAMA-BR[7]
Nitrite	0	0	0	0	0.07 mg/l CONAMA-BR[7]
Iron	0	0	0	0	0.3 mg/l CONAMA-BR
Chromium (VI)	0	0	1	0	0.05 mg/l – WHO[9] 0,05 mg/l CONAMA-BR[7]
Copper	0	0	0	0	0.005 mg/l CONAMA-BR
Mercury	0	0	0	0	0.0002 mg/l Hg CONAMA-BR[7] 0.006 mg/l (6 µg/l) for inorganic mercury – WHO[9]
Fluoride	0	0	0	0	1.4 mg/l CONAMA-BR[7] 1.5mg/l (1500 µg/l) WHO[9]

(*) Determination for brackish water salinity > 0.5 ‰ and ≤ to 30 ‰ by CONAMA.

At water temperature in tropical regions, conductivity values in aquatic environments are more related to the geochemical characteristics of the region where they are located and the climatic conditions (dry and rainy season), but can also be influenced by the trophic state, mainly in environments under anthropogenic influence[10].

The temperature of the samples showed variations between 25.0 and 29.4 related to the seasons during the sample collection period. The Electrical conductivity- (mS/cm^{-1}) also showed a large change in the rainiest period, including a change in Total Dissolved Solids (TDS).

The pH and plant and animal communities in aquatic ecosystems exhibit close interdependence. Aquatic communities interfere with pH, just as pH interferes in different ways with the metabolism of these communities. In communities, pH acts directly on cell membrane permeability processes, therefore interfering with intra and extracellular ionic transport and between organisms, for example, through the assimilation of CO_2[11].

The pH is also related to the hardness of the water, in the case of the Tracuateua River, on the perimeter of kilometer 32 of Estrada PA 391, in the last sample, it was 6.0 and the others, 6.2, which is classified in hardness as soft water, in addition to showing homeostasis, even with changes in tide, sample collection period, among others. Which can also be proven by the absence of carbonates in water samples collected at different periods.

The main natural sources of trace elements for the continental aquatic environment are the weathering of rocks and the erosion of soils rich in these materials. Recently other sources of trace elements have assumed great importance: industrial activities, through solid tributaries that are released directly into the atmosphere and liquids that are released into small streams or directly into rivers and lakes; Hg in mining activities; domestic effluents and surface water from areas cultivated with chemical fertilisers and mainly from those where agricultural pesticides are used (these contain the most varied trace elements such as: Cd, Hg, Pb, Cu, etc.). The atmosphere is also an important source of trace elements for aquatic ecosystems. There are several sources that enrich the atmosphere with trace elements, which through wet and dry precipitation can reach the aquatic environment. Among these sources, marine and biogenic aerosol stand out, resulting from the disintegration and dispersion of plants and animals, natural fires, particles of volcanic origin, and others carried by the wind (dust) and mainly industrial emissions directly into the atmosphere (anthropogenic source)[12].

In water samples from the Tracuateua River on the perimeter of the highway bridge at PA 391 at kilometer 32, no bromine (Br) or fluoride (F) were identified in the water samples; the presence of heavy metals Cd, Hg, Cu, Fe, were not identified.

Lead (Pb) was only identified in the last sample collection, when the river was at high tide, with great influence from the Atlantic Ocean and could be a one-off, but needs to be tracked, if this data is repeated, public policies for corrections must be developed, as it is in the initial phase.

Hexavalent chromium [Cr (VI)], among the various ionic forms of Cr, is the most toxic. This is generally an industrial byproduct widely used for pigment production, leather tanning, wood processing, chrome plating, metallurgical and chemical industries, stainless steel manufacturing, welding, cement production, ceramics, glass, etc. Cr (VI) levels have increased in soil, water and air, mainly due to increased use by industries and inadequate disposal of these residues in the environment[13].

In the sampling of 13/03/2024, a percentage of the transition metal Cr (VI) was identified, as this had not been identified in previous samples, it could have originated for some eventual reason, perhaps brought by the rains that occurred the night before, a tracking is necessary to locate the source, even if occasional, to guarantee environmental health.

A source of water that is in contact with ores containing lead sulfide, or by another source of natural contamination, or other anthropic sources, with penetration into the human or animal organism via the gastrointestinal, dermal and/or respiratory route, may have effects accumulation in individuals, which at a level above the tolerability threshold, may cause pathologies related to calcium transport in the body, in the gastrointestinal tract and problems in the central nervous system (CNS) and peripheral nervous system (PNS) in a diffuse manner[14].

In risks caused by trace elements of mercury, it is observed that the ability of organomercurial compounds to efficiently cross cell membranes significantly increase their retention in organisms (high biological half-life) and results in their bioaccumulation and biomagnification throughout trophic chains. Thus, most of the mercury present in the tissues of aquatic organisms is in the form of methylmercury, although the levels of inorganic mercury are much higher than the organomercurial forms. It is believed that the formation of methylmercury in the aquatic environment occurs mainly through a reaction mediated by microorganisms (e.g. sulfate-reducing bacteria). However, other abiotic mechanisms (photochemical methylation, transalkylation, etc.) are also capable of producing methylmercury in the environment[15].

In the water samples collected during all research periods, no traces of mercury were found. However, monitoring is always suggested, as urbanization is very accelerated in the city of Santa Barbara do Pará, as well as the presence of agriculture in areas close to the river, in addition to places where the population deposits domestic waste, due to a lack of public policies to raise awareness, and recycling.

Rivers transport nitrogen in the form of nitrate, nitrite or ammonia, and silicate in soluble form[16]. The nitrite concentration is always very low (< 60 mg $N\text{-}NO_{-2}$. ℓ^{-1}), as this chemical substance can be reduced chemically and/or through the activity of bacteria that reduce nitrate or oxidise ammonium. Especially in tropical waters, this concentration is very low and is often below the method's detection limit. Nitrite may occasionally accumulate in pockets with oxygen tensions below 1 mg O_2.ℓ^{-1} and in conditions of low stratification[16]. Inorganic nitrate is highly soluble and abundant in waters that receive high concentrations of nitrogen, resulting from the discharge of domestic sewage or agricultural activities[16]. The presence of nitrite and nitrate was not identified in the samples, indicating that there is no environmental contamination by these nitrogenous substances.

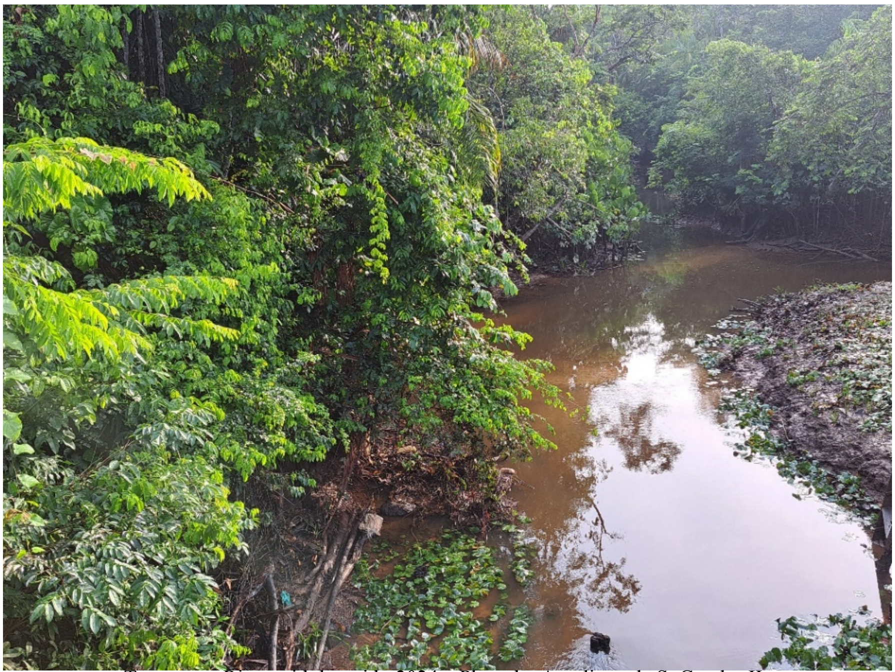
Along the route of the PA 391 road, in the Municipality of Santa Barbara, there are several private properties that have effluents from some watercourse, called "igarapés" by the population, which are generally explored by local tourism bathhouses, where people pay to enjoy of these environments and many offer restaurant services, snack bars, etc. These activities have as a positive point to environmental preservation, including the collection of waste and rejects left by users and tourists, as a way of keeping the environment clean and attracting new visitors. However, many destroy the ciliary forests to establish these projects, divert or alter the natural course of the tributary or effluent, despite many preserving secondary and/or tertiary trees, including trees exogenous to the region[17].

The Traquateua River, being brackish water, receives influence from the Atlantic Ocean, mainly at its high tide, in this sense, a significant increase in water hardness during high tide was observed in the samples, due to the greater influence of the ocean invading its waters, often even reaching its source, altering the chemical composition of the Tracuateua River, which is reversed at the receding tide.

Lotic systems are affected by the following modifications: pumping water for irrigation of public or private supply (farms), which alters the flow and structure of rivers; organic and inorganic pollution from industrial and agricultural sources (point and diffuse sources). Pesticides, herbicides, heavy metals and discharge of untreated sewage are some of the threats to the integrity of rivers; intensive land use, which leads to an increase in suspended material and the discharge of substances and elements in large quantities into lotic systems; introduction of exotic species, which alter the food web and the natural process of community interaction; removal of riparian vegetation, which is extremely important in maintaining buffer conditions for rivers. This removal, in addition to reducing the organic matter available to fish and invertebrates, no longer protects the banks and slopes of rivers, altering their morphometry; construction of dams for hydroelectricity and public supply; alteration of floodplains and flooded areas associated with dams for agriculture, construction of canals or urbanisation; bridges and passages, which interferes with the functioning of rivers, alters the substrate (physical and chemical compositions) and removes and affects organisms; construction of large areas for irrigation, with considerable withdrawals of water for this activity, contamination by domestic (sewage) and industrial waste, are the two biggest threats to lotic systems[16].

It was observed that, in the Tracateua River, in the section that appears on the PA 391 highway bridge at kilometer 32, there is the presence of tailings on the banks of the river, posing a potential risk of pollution for the river basin; There is domestic sewage from some houses, discharged directly into the river. These impacts cause risks to water security, increasing the possibility of hepatitis infection, diarrhea and other water-borne diseases, and eutrophication of aquatic macrophytes due to the presence of nutrients, in some parts of the river, in this case, being a bioindicator of water pollution, indicating the need for the urgent establishment of public policies for selective waste collection, basic sanitation and water and environmental management[17].

It is worth mentioning that, in several activities of our research teams at this location, groups of *Cebus apella* were observed (including with cubs), *Armases benedicti* (Rathbun - 1897), *Vespidea* and other elements of the fauna[17]. In the flora, the following stand out: *Euterpe oleracea*, *Ceiba pentandra*, among others.


Tracuateua River with low tide-2024 – Photo by Aureliano da S. Guedes II

IV. Conclusions

Physiochemical and observable data, at the time of analysing the collected samples from the stretch of the Traquateua River, at kilometer 32 of PA391 highway, the results do not indicate that the water is polluted, however, in the surrounding area there is the presence of potential sources of pollution, which can in the future, compromise the waters of this river, urgently requiring public policies for public waste collection, preservation of the ciliary forest, planned urbanisation, public sewage system with filtration, environmental education, among others.

The research carried out reflects of the moment in which the research material was collected, since the water of a river reflects and is influenced by several factors, such as: atmospheric, soil, sediments, anthropogenic factors, among others, seasonal or not, that can influence momentarily or permanently. In this sense, it is necessary to establish permanent physiochemical and biological monitoring programs for the water of the Tracuateua River.

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