

**ANALYSIS BIO-
PHYSICOCHEMICAL
PARAMETERS FROM THE
WATERS OF APEÚ RIVER
FROM DISTRICT OF APEÚ IN
CASTANHAL CITY IN THE
STATE OF PARÁ (BRAZIL)**

**ANÁLISE DOS PARÂMETROS BIOFÍSIOQUÍMICOS DAS ÁGUAS DO RIO
APEÚ NO DISTRITO DE APEÚ, CIDADE DE CASTANHAL, ESTADO DO PARÁ
(BRASIL)**

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ABSTRACT

Justification: River Apeú in the municipality of Castanhal with great importance for leisure, tourism and, in some cases, agriculture and subsistence fishing. Presents itself with endorheic characteristics, with continuous course. It is necessary to identify the impacts and risks of urbanisation and industrialisation on the environment and limnological resources of the Apeú River basin. **Objectives:** To identify the impacts of urban development on the limnological resources of the Apeú district in the city of Castanhal, in the state of Pará (Brazil) and the consequences for human and environmental health. **Methodology:** Analysis of the biophysical-chemical parameters of the Apeú River waters using laboratory and *in situ* observational methods, with samples collected at different times, tidal and meteorological conditions, including pH, electrical conductivity, sample and ambient temperature; determination of Total Dissolved Solids. The samples were subjected to three tests with multiparametric reagents for alkalinity, lead, bromine, nitrate, nitrite, iron, chromium (VI), copper, mercury, fluoride, among others. Turbidity, colour, visibility and odour of the samples were evaluated. The qualitative observational method was used to gather information on anthropogenic environmental pollution and the presence of wild flora and fauna. The biological method using culture plates for *Escherichia coli* and *Thermotolerant coliforms*. **Conclusion:** Analyses revealed the trace element lead, requiring tracking for identification and control. *Escherichia coli* and *Thermotolerant coliforms* were identified in biological parameters, indicating the need for investment in identifying and mitigating these sources of pollution. Industrial and domestic waste should be recycled, ensuring less pollution and the presence of synanthropic animals, among other factors that compromise the river and human and animal health. It is important to use modern urban sanitation

technologies, encourage education for conscious consumption, implement environmental management programs, especially for the proper treatment of effluents, and establish public policies for water use, among others.

Keywords: Environmental chemistry; Chemophysical analysis; Limnology; Apéu River - State of Pará (Brazil); City of Castanhal - State of Pará (Brazil); Amazon Rivers.

RESUMO

Justificativa: O rio Apeú, no município de Castanhal, possui importância para lazer, turismo, agricultura e pesca de subsistência. Apresenta características endorreicas, com curso contínuo. É necessário identificar os impactos, riscos da urbanização e industrialização sobre o meio ambiente e recursos limnológicos.

Objetivos: Identificar impactos do desenvolvimento urbano nos recursos limnológicos do distrito de Apeú em Castanhal, estado do Pará (Brasil), e consequências à saúde humana e ambiental.

Metodologia: Os parâmetros biofísico-químicos das águas do rio Apeú, através de métodos laboratoriais e observacionais *in situ*, com amostras coletadas em diferentes horários, condições de maré e meteorológicas, analisando pH, condutividade elétrica, temperatura da amostra e ambiente, determinação de Sólidos Totais Dissolvidos e, submetidas a três testes com reagentes multiparamétricos para alcalinidade, chumbo, bromo, nitrato, nitrito, ferro, cromo (VI), cobre, mercúrio, fluoreto, entre outros, além de turbidez, cor, visibilidade e odor. O método observacional foi utilizado para informações da poluição ambiental antrópica e presença de flora e fauna silvestres. O método biológico de cultivo em placas para *Escherichia coli* e *Coliformes termotolerantes*. **Conclusão:** Observou-se presença de elemento-traço chumbo, requerendo rastreamento para identificação e controle. Foram identificadas *Escherichia coli* e

Coliformes termotolerantes nos parâmetros biológicos, indicando a necessidade de investimento na identificação e mitigação dessas fontes. Resíduos industriais e domésticos devem ser reciclados, assegurando menor poluição e presença de animais sinantrópicos, entre outros fatores que comprometem o rio e a saúde ambiental. É importante utilizar tecnologias de saneamento urbano, incentivar o consumo consciente, implementar programas de gestão ambiental, especialmente ao tratamento adequado de efluentes, e estabelecer políticas públicas de uso da água, entre outras.

Palavras-chave: Química ambiental; Análise físico-química; Limnologia; Rio Apéu - Estado do Pará (Brasil); Cidade de Castanhal - Estado do Pará (Brasil); Rios da Amazônia.

1. INTRODUCTION

The municipality of Castanhal is located at latitude: 01° 17' 38" S, longitude: 47° 55' 35" W, with altitude: 41m^[1]. Has an area: 1.029,300 km², with an estimated population of 207.603 inhabitants^[2]. The main river in the Apeú district in the municipality of Castanhal, is the Apeú River, which begins in the district de Apeú with great importance for leisure, tourism and, in some cases, agriculture and subsistence fishing. The Apeú River presents itself with endorheic characteristics, with continuous course, flowing into the Inhangapi River, in the city of same name.

For recreational water users, risks associated with chemical hazards will depend on the type and concentration of the chemical contaminants, and the characteristics of the area. River flows, and tidal and wave action can dilute and disperse chemical discharges. Water bodies subject to continuous or intermittent discharges could accumulate contaminated sediments. 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 wastes; naturally occurring chemicals, including algal toxins^[3].

The unplanned growth of cities has caused several impacts on water resources due to population growth, the presence of cemeteries, fairs and markets, the destruction of primary forests for food production, landfills, the construction of canals and barriers in water resources altering the natural flow, industrialisation, clandestine mining of sand, rocks and clay for construction, the introduction of exotic plant and animal species, the deforestation of ciliary forests for the construction of highways, streets, housing complexes and leisure areas, placing water resources at biophysiochemical risk, among others, and consequently causing impacts on the health of the population and environmental spaces^[4].

Given this context, there is a need to identify the impacts and consequent risks to the local population, the environment and limnological resources of the Apeú river basin in the Apeú District in Castanhal, as well as to inform the population involved about the risks, causes and ways of mitigation.

The general objective of this research was to identify the impacts of urban development on the limnological resources of the Apeú district in the city of Castanhal, in the state of Pará (Brazil) and the consequences for human and environmental health. The specific objectives were to identify possible risk agents for local environmental degradation; analyse health and environmental impacts caused by human activities; present data to support control

measures to contain the harmful impacts on water resources; predict possible impacts on human health due to the degradation of limnological resources.



Apeú District of Castanhal. Source: Google Maps^[5]



Apeú River. Source Google Maps^[5]

2. METHODOLOGY

Water samples were collected from the Apeú River at different times, tidal situations (high and low) and meteorological conditions, always in the morning and with *in-situs* analysis, between March and Decembre 2025.

The pH was measured using a portable electronic pH meter and compared with test strips as a control. The electrical conductivity values were measured using a portable electronic conductivity meter, expressed in $\mu\text{S}/\text{cm}^{-1}$ (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 disk was used to evaluate turbidity and 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. Analysers were used to identify *E. coli* and *Thermotolerant coliform* colonies^[4,6]. The biological method used was culture plates for *Escherichia coli* and thermotolerant coliforms.

It is worth mentioning that: The climate in most Amazon areas is hot and humid, with a predominance of rain for six months and occasional rain for the rest of the other months. As it is largely located in the equatorial region, the high temperature and vapours from lakes, rivers, the ocean, etc., will contribute to the great Amazon humidity, which, in addition to the evapotranspiration of the plants that extract moisture from the soil that makes up the forest, will result in high atmospheric humidity and a significant level of annual rainfall^[7]. Logically, this humidity, mainly due to rainfall aspects, will influence the analysis of the samples, in this sense, some data such as winds, environmental visibility, local temperature, tide, among others, were considered in the sample collections^[4,6,7,11].

Several variables must be considered when collecting material for limnologic research, including: temperature; odour; pH; colour; transparency; turbidity; dissolved oxygen; electrical conductivity; chlorophyll; deep current; surface current; total suspended solids; total dissolved solids; current speed; wind speed, among others. For example, in a water column at a certain depth there are certain species of plankton, at another depth this can change due to the luminosity, speed of the current, among other specific aspects^[7].

It is important to note that lotic systems, due to their flow and permanent interaction with their tributaries, their waters can present significant variables between the collection of one sample and another, given their transport capacity, decomposition of organic and inorganic matter, difference in water temperature by area and depth, among others^[4,6,7,11].

3. RESULTS AND DISCUSSIONS

Apeú River					
Parameter s	Sample 1 20/03/202 5	Sample 2 28/06/202 5	Sample 3 30/09/202 5	Sample 4 02/12/2025	Toleran y in recreat al waters urce
Environm ental visibility	Cloudy	Normal	Normal	Normal	-

⚠ Esta tabela possui muitas colunas e foi cortada para impressão. Para visualizá-la completa, acesse o artigo original em: <https://revistatopicos.com.br/artigos/analysis->

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Based on determination for fresh water ≥ 0.5 ‰ CONAMA^[8]. Table model by Dr. Aureliano Guedes^[4,6,7,11]



Apeú River. Photo by Aureliano Guedes, PhD.

The chemical quality of water is measured by identifying the component in the water, using specific laboratory methods. Such chemical components must not be above certain concentrations determined with assistance of epidemiological and toxicological studies. Tolerable limit concentrations mean that the substance, if ingested by an individual with an average physical constitution, in a certain daily amount, during a certain period of life, added to the expected exposure of the same substance through other means (food, air, etc.), subjects this individual to an unacceptable risk of developing a resulting chronic illness. Two important groups of chemical substances, each with specific origins and effects on human health, are inorganic chemicals, such as heavy metals, and organic chemicals, such as solvents^[10].

Turbidity is important to check for suspended particles that, in excess, can hinder the passage of light, damaging phytoplankton, some types of important bacteria, photosynthesis of macrophytes, among others^[4,6,7,11].

In the case of the Apeú river, at the sample collection site in different periods, it presented ≤ 40 nephelometric turbidity units (NTU), as normal, without harming photosynthesis and other important actions.

Secchi disc depth is a qualitative value because it depends on the observer's vision and the solar radiation in the probed environment, in addition to the influence of organic and inorganic materials that make up the water. In the case of this research, when for some reason, for example, the riverbed is visible, due to low tide or other reason, the use of the Secchi disc is not applicable^[4].

In the Apeú River, when possible, the use of the Secchi disk allowed visibility between 97cm and 30 cm, always presenting the water colour brown, both in normal river visibility and in environmental visibility, being normal or cloudy, with normal turbidity. However, in the last two samples the river had very low water levels, making the Secchi disk unnecessary.

The predominant brown colour in the waters of the Apeú River is due to the large contribution of sediments and organic compounds from trees that fall and decay, flowers, fruits, leaves and roots of the ciliary forest^[4,6,11]. During most visits to the research area, the water appeared brown; however, during the visits in June, due to heavy rains that caused leaching of the banks, the water appeared muddy, interfering with visibility using a Secchi disk.

Chemically pure water does not conduct electricity; however, if acids, bases or salts are dissolved in it, the solution will conduct an electric current, and chemical transformations will also occur [12]. In the case of waters of a limnological nature, they will be chemically influenced by sediments, substances transported by leaching, rainwater, aquatic and terrestrial biota, anthropogenic and natural pollution, among others, therefore, presenting in their chemical composition on substances that have a greater or lesser degree of electrical conductivity^[4,11].

The electrical conductivity of water constitutes one of the most important variables in Limnology, as it can provide information both about the metabolism of the aquatic ecosystem and about important phenomena that occur in its drainage basin. Among the information that can be provided by electrical conductivity values includes information on the magnitude of ionic concentration. The ions most directly responsible for electrical conductivity values in inland waters are the so-called macronutrients (calcium, magnesium, potassium, sodium, carbonate, sulphate, chloride, etc.), while nitrate, nitrite and especially reactive soluble phosphorus have little influence. The ammonium ion can only have an influence at high concentrations; the daily assessment of the electrical conductivity of water provides information about important processes in aquatic ecosystems, such as primary production (reduction in values) and decomposition (increase in values); electrical conductivity can help detect sources of pollution in aquatic ecosystems; geochemical differences in the tributaries of the main river or a lake can be easily evaluated with the help of electrical conductivity measurements^[13]. It is important to know that the electrical conductivity of water can also be related to the presence of salts, tide and elements leached into the river by rain^[4,7,14].

The electrical conductivity of the Apeú River varied from 0.016 to 0.022; affecting, in a certain way, by the Total Dissolved Solids, which were between 0.008 and 0.011, and among others, by the rainiest period in the region and the tide, where the data were higher at low tide.

The water temperature in lotic systems varies daily and seasonally, due to factors such as climate, altitude, type and extent of ciliary forest and contribution of groundwater. This temperature sets limits to the geographic distribution and physiology of organisms, influencing reproduction, survival and the life cycle of organisms^[3]. 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^[13].

Temperatures, both environmental and water, are importantly related to water density, preservation of microfauna and microflora, mainly nitrifying bacteria, among others, and are important in measuring pH. In this sense, the variation in the temperature of the water samples and the environment shows the characteristics of the hot humid climate of the studied region, therefore with a strong influence on the characteristics of the flora, fauna, hardness and pH of the samples^[14].

The temperatures of the water samples from the Apeú River varied, during the different collection periods, between 24.5°C and 29,0°C, while the ambient temperature varied between 30.2°C and 32,9°C during the different measurement periods. These temperatures,

among other factors, influence the increase in water acidity, due to the breakdown of some water molecules, generating carbonic acid (H_2CO_3) that mixes with the water.

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 ^[15].

The presence or absence of carbonate ions defines hard water rivers or acidic water rivers with low concentration of carbonate ions^[3]. Carbonate (CO_3^{-2}), considered an inorganic carbon ion, related to the pH of the water, it may be related to minerals leached from the banks of rivers, type of sediment, among others, making the water even more acidic due to carbonic acid; however, the processes of decomposition of plant and animal remains by microorganisms, eutrophication of plants, organic components of domestic sewage, respiration of fish and other shellfish, animal and plant decomposition, among others, in these rivers and their banks will generate organic carbon, also making the water more acidic. Acid rain, resulting, among others, from the burning of fossil fuels, fires, industrial chimneys, among others, also contributes to the acidity of limnic waters^[4].

In the river researched in the Apeú district, the identified carbonate rate was 0.00. The presence of carbonates in the Apeú river at the sample collection sites was insignificant in terms of risks to human and environmental health. However, lotic waters should always be

monitored, especially because there are small and medium-sized industries nearby and agricultural activities, in addition to the urbanisation of the district studied.

The pH is also related to the hardness of the water, in the case of the Apeú, on the perimeter of Apeú district in the municipality of Castanhal, in all sample collections were of pH <6,0 to 6.2 and water hardness from 100 to 250, which is classified in hardness as soft water, in addition to showing homeostasis, even with changes in tide, rainy season, sample collection period, among others, which can also be proven by the absence of carbonates in water samples collected at different period. Therefore, the water hardness in Apeú River presenting no environmental risks and/or risks to human and livestock health.

In limnic waters (rivers, lakes, lagoons, wells, etc.) it may contain barium, bicarbonate, calcium, chlorides, strontium, fluorides, phosphates, magnesium, nitrates, potassium, sodium, sulphates, among others of soil origin through leaching, atmospheric, tributary rivers, anthropogenic influences, among others^[7,11].

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)^[16].

The simple change in metal valence transforms the slightly toxic trivalent chromium into the aggressive and carcinogenic hexavalent chromium^[17]. Hexavalent chromium Cr(VI), among the various ionic forms of Cr, is the most toxic. This is generally industrial, by products 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^[18]. Hexavalent Chromium, which causes dermatitis, contact allergy, kidney disease, intoxications, cancer and other diseases^[7,14]. In the Apeú River in the Apeú district of Castanhal, the transition metal Hexavalent Chromium was not detected in any sample during the different periods.

In general, inorganic lead salts have low solubility in water, except for nitrate, chlorate and, to a lesser extent, lead chloride. Lead forms stable organic compounds, that is, when its atom is bonded to a carbon atom, such as tetraethyl lead and tetramethyl lead. These compounds, both colourless liquids, have low solubility in water and are volatile^[19]. However, a water source that is in contact with

minerals containing lead sulphide, or through natural, industrial or anthropogenic contamination of this metal, where penetration via the gastrointestinal, dermal and/or respiratory tract may have cumulative effects on individuals, which, when reaching a level above the tolerability threshold, may cause pathologies related to the transport of calcium in the body, in the gastrointestinal tract and problems in the central nervous system (CNS) and peripheral nervous system (PNS) in a diffuse manner⁷. Exposure to lead has decreased significantly since the use of leaded gasoline was phased out, but there are still multiple sources of this metal, resulting in adverse health and economic effects, particularly in low-income and middle-income countries^[20].

In samples collected from the Apeu River, in the Apeu district, municipality of Castanhal, state of Pará, traces of lead were identified in concentrations of 10 mg/L, significantly above the maximum limit of 0.01 mg/L recommended by CONAMA (National Council for the Environment) of Brazil, which requires investigation to identify the origin of the contamination.

As for mercury, the ability of organomercurial compounds to efficiently cross cell membranes significantly increase its retention in organisms (high biological half-life) and results in its 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. sulphate-reducing bacteria). However, other abiotic mechanisms (photochemical methylation, transalkylation,

etc.) are also capable of producing methylmercury in the environment^[19].

Mercury toxicity in the body can result in various pathologies, both, acute and chronic, mainly in the central nervous system, respiratory tract, urinary tract, gastrointestinal tract, and haematopoietic system, resulting in dementia, depression, stomatitis, insomnia, among others^[7]. However, in the samples collected and analysed in the Apeú River, the presence of mercury was not identified.

The nitrite concentration is always very low ($< 60 \text{ mg N-NO}_2 \cdot \ell^{-1}$), 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 $1 \text{ mg O}_2 \cdot \ell^{-1}$ and in conditions of low stratification^[3]. 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^[21].

Nitrogen, when oxidised, will result in nitrites and nitrates which, as a nutrient for plants, can cause eutrophication of aquatic plants, resulting in increased oxygen consumption, causing competition with aquatic fauna, resulting in migrations or extinction of certain species of fish, crustaceans, etc, and attracting other species that are tolerant to low amount of dissolved oxygen in the water^[4]. In the Apéu river surveyed, no significant quantities of nitrites and nitrates were detected at the time of sample collection.

In addition to water levels and rainfall, biomass, primary productivity and, consequently, the population dynamics of aquatic macrophytes are affected by several other abiotic factors, among which physical factors (e.g. ecosystem morphometry, water velocity, temperature and underwater radiation), chemical factors (e.g. water and sediment nutrients, and inorganic carbon) and physicochemical factors (e.g. pH) can be highlighted. However, these factors affect each biological type of aquatic macrophyte differently. In addition to the effects of abiotic variables, aquatic macrophyte populations are also affected by biological interactions, especially competition (intra and interspecific), herbivory and facilitation^[22].

Several species of fauna were observed during the collection of water samples, among which stand out: *Berlepschia rikeri*, *Bothrops atrox*, *Bradypus tridactylus*, *Melanosuchus niger*, *Paleosuchus trigonatus*, *Pitangus sulphuratus*, *Ramphastos toco*, *Ramphastos tucanus*, *Saimiri sciureus*, *Turdus rufiventris*, *Tyrannopsis sulphurea* and others; As for flora, several species were observed, including: *Bactris gasipaes*, *Ceiba pentandra*, *Euterpe oleracea*, *Heliconia bihai*, *Mauritia flexuosa*, *Spondias mombin*, among others.



Ciliar forest, with emphasis on *Euterpe oleracea*. Photo by Aureliano da Silva Guedes II.



Mauritia flexuosa. Photo by Aureliano da Silva Guedes, PhD



Heliconia bihai. Photo by Aureliano da Silva Guedes, PhD

Lotic systems are affected by the following modifications: pumping water for irrigation or 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 ciliary 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; construction of canals, 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, contaminated by domestic (sewage) and industrial waste, are the two biggest threats to lotic systems^[21].



Apeú River during the dry season. Photo by Aureliano da Silva Guedes II.

In the case of anthropogenic pollution, the main sources are caused by population growth, in many cases, with disorderly urban growth, therefore, without planning, with the main consequences being: changes in river flows, cemeteries, deforestation of ciliary forests, industrialisation, among others. The growing need for food production will reflect an increase pollution risks in rural areas, through extensive agricultural activities, where chemical products for soil correction, if misused, will generate nutrients that, when falling down the gradient in lakes, rivers, Amazonian wells, among others, causing eutrophication, as well as deforestation and the introduction of exotic species, etc. To generate energy for the consumption of these populations and their industries, there is a need for large-scale energy production, whether through charcoal

and/or mineral coal, burning fossil fuels, construction of hydroelectric plants, among others, resulting in damage to surface and underground water resources; another factor is clandestine mining that, without production criteria, silts up rivers, streams and lakes, as well as contaminating them with heavy metals; among many others^[7].

The establishment of the practice of the four Rs, where the waste management philosophy would be aimed at decreasing the volume of waste through: reducing the amount of materials used (source reduction); reusing materials once formulated; recycling materials to recover components that can be manufactured again; and recovering the energy content of materials if they cannot be used in any other way^[23].

An important technique used in pollution prevention is life cycle analysis (or assessment), which consists of accounting for all inputs and outputs at the different stages of a product's life, from the extraction of raw materials to final disposal. This type of analysis from start to finish of a product (or process) can be used to identify the types of environmental impact and their magnitudes, both the natural resources used, and the pollution produced. The results of a life cycle analysis can be used in two ways: to identify opportunities to minimise the overall environmental burden of a product over its life cycle, and compare two or more alternative products, with the aim of determining which is more beneficial to the environment^[23].

It is increasingly clear that human health is closely linked to the conditions of the natural environment. Chemicals released into an environment far from inhabited areas can pose a health hazard by accumulating in the food chain. Other chemicals can have adverse

effects on crop growth and kill birds or fish of great economic value. Neither a cloud of dangerous gases nor contaminants in river or ocean waters know natural boundaries. The adverse effects of a chemical on wildlife may be the first indication of an early danger to the human organism. The disappearance of non-target species such as bees, birds and butterflies may be the first sign of deteriorating conditions^[24].

4. CONCLUSION

Analyses performed on the samples detected the presence of the trace element lead, requiring it to be traced to identify the source for control. Samples were identified in the biological parameters of *Escherichia coli* and *Thermotolerant coliforms* in the Apeú River, in the city of Castanhal (Brazil). There is a need for investment in identifying and mitigating sources of pollution caused by *Escherichia coli* and *Thermotolerant coliforms* to ensure the health of the population that uses the Apeú River. Since lead is a trace element that can also compromise the health of the local population, it is necessary that intervention measures be taken urgently.

Both industrial and domestic waste must be recycled, ensuring less pollution, including synanthropic animals, among others that compromise river water and human and animal health, avoiding higher costs in the future.

It is important to utilize modern urban sanitation technologies, encourage education for conscious consumption, implement environmental management programs, especially regarding the

proper treatment of wastewater, and establish public policies for water use, among other things.

REFERENCES

[1] COORDENADAS GEOGRÁFICAS DE CASTANHAL, PARÁ - PA. Available in <https://www.geografos.com.br/cidades-para/castanhal.php>. Access in 03/21/2025

[2] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA. Castanhal. Available in <https://www.ibge.gov.br/cidades-e-estados/pa/castanhal.html>. Access in 03/21/2025.

[3] WORLD HEALTH ORGANIZATION. Guidelines on recreational water quality: Coastal and Fresh Waters. Geneva : WHO , 2021. V.1

[4] GUEDES, Aureliano da Silva; GUEDES II, Aureliano da Silva. Analysis Of Physicochemical Parameters From The Waters Of The Hydrographic Basin From District Of Caraparu In Santa Isabel Of Pará (Brazil). In: IOSR Journal of Applied Chemistry (IOSR-JAC). 18 (5, ser. 1): 25-36. Mar., 2025.

[5] GOOGLE EARTH. Apeú – PA – Brazil]. Access in 22/03/2025.

[6] GUEDES, Aureliano da S.; GUEDES II, Aureliano da S. Analysis of Physicochemical Parameters From The Water of Pará River In Mosqueiro Island of Belém - Pará (Brazil) – 2023-2024. In: IOSR Journal of Applied Chemistry (IOSR-JAC). 17 (06): 32-41. June, 2024.

[7] GUEDES, Aureliano da Silva; GUEDES II, Aureliano da Silva; GUEDES, Catarynna Maciel Quaresma da Silva. Meio ambiente e limnologia. Belém: _____, 2023.

[8] BRASIL. CONAMA - Conselho Nacional do Meio Ambiente. Resolução nº 357 de 17/03/2005. Estabelece a classificação das águas doces, salobras e salinas do Território Nacional. Brasília, SEMA, 2005.

[9] WORD HEALTH ORGANIZATION. Guidelines for drinking-water quality: Fourth edition incorporating the first and second addenda. 4 ed. WHO : Geneva, 2022.

[10] BRASIL. Ministério da Saúde. Secretaria de Vigilância em Saúde. Vigilância e controle da qualidade da água para consumo humano. Brasília-DF : Ministério da Saúde, 2006. (Série B. Textos Básicos de Saúde).

[11] GUEDES, Aureliano da Silva; GUEDES II, Aureliano da Silva; GUEDES, Catarynna Maciel Quaresma da Silva; QUARESMA, Rosana do S. Maciel. Pilot Study Of Anthropic Impacts Through Physicochemical Parameters From The Waters Of The Hydrographic Basin From District Of Caraparu In Santa Isabel Of Pará (Brazil). In: IOSR Journal of Applied Chemistry (IOSR-JAC) e-ISSN: 2278-5736. 17 (1 Ser. I): 40-45. Jan., 2024.

[12] VOGEL, A. Química Analítica Qualitativa. 5 ed. São Paulo : Mestre Jou, 1981.

[13] ESTEVES, Francisco de Assis; FIGUEIREDO-BARROS, Marcos Paulo; PETRUCIO,

Maurício Mello. Principais Cátions e Ânions. In: ESTEVES, Francisco de Assis (org.). Fundamentos de Limnologia. 3. ed. Rio de Janeiro: Interciência, 2014.p. 299-321.

[14] GUEDES, Aureliano da Silva; GUEDES II, Aureliano da Silva. Analysis of Physicochemical Parameters From The Water of Pará River In Mosqueiro Island of Belém - Pará (Brazil) – 2023-2024. In: IOSR - Journal of Applied Chemistry. 17 (6 Ser. I): 32-41. Jun., 2024.

[15] ESTEVES, Francisco de Assis; MARINHO, Claudio Cardoso. Carbono Inorgânico. In: ESTEVES, Francisco de Assis (org.). Fundamentos de Limnologia. 3. ed. Rio de Janeiro: Interciência, 2014.p. 209-238.

[16] ESTEVES, Francisco de Assis, GUARIENTO, Rafael Dettogni. Elementos-traço. In: ESTEVES, Francisco de Assis (org.). Fundamentos de Linnologia. 3. ed. Rio de Janeiro: Interciência, 2014. p.323-327.

[17] BUSCHINELLI, José Tarcísio Penteado. O clínico e as intoxicações ocupacionais ambientais. In: LOPES, Antonio Carlos. Tratado de Clínica Médica. 2 ed. São Paulo : Rocca, 2009. V.1. p. 227-234car.

[18] CARVALHO, Ester Viana; et al. Cromo e Cobre: Ações no Organismo Humano. In: Medicina ambulatorial VI: com ênfase em medicina do trabalho. In: KASHIWABARA, Tatiliana Bacelar, et al (orgs) Montes Claros-MG : Dejan, 2019.p.91-98.

[19] BARROCAS, Paulo R.G. Metais. In: SISINNO, Cristina Lúcia Silveira, OLIVEIRA-FILHO, Eduardo C. Princípios de Toxicologia Ambiental. Rio de Janeiro : Interciência, 2013. p. 37-73.

[20] ANDERSON.Pauline A. Lead exposure still represents a major health problem in the world. Medscape. 09/19/2023. Available https://portugues.medscape.com/verartigo/6510097#vp_1. Access 08/04/2025.

[21] TUNDISI, José Galizia; TUNDISI Takako Matsumura, Limnologia. Oficina de textos, 2008

[22] THOMAZ, Sidinei Magela; ESTEVES, Francisco de Assis. Comunidade de Macrófitas Aquáticas. In: ESTEVES, Francisco de Assis (org.). Fundamentos de Limnologia. 3. ed. Rio de Janeiro: Interciência, 2014.p. 461-521.

[23] BAIRD, Colin, CANN, Michael. Química Ambiental. 2 ed. Barcelona : Reverté, 2014.

[24] FERNÍCOLA, N. A.G.G. de. Toxicologia Ambiental: Passado, presente e futuro. In: 3 Encontro Técnico Anual da Associação dos Engenheiros da CETESB. Jun., 2002.

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