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WATER QUALITY OF THE LIVRAMENTO STREAM IN THE ICOARACI DISTRICT IN THE MUNICIPALITY OF BELÉM IN THE STATE OF PARÁ (BRAZIL)

QUALIDADE DA ÁGUA DO RIACHO DO LIVRAMENTO NO DISTRITO DE ICOARACI NO MUNICIPIO DE BELÉM NO ESTADO DO PARÁ (BRASIL)

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ABSTRACT

Justification: In the Belém Metropolitan Region, water has become a challenge in terms of water resource management due to anthropogenic impacts; therefore, analysing water quality through biophysicochemical parameters is essential for assessing potential impacts resulting from human activities, such as nutrient concentrations and the presence of heavy metals. **General objective:** to analyse the biophysical and chemical quality of the waters of the Livramento Stream. **Specific objective:** to identify the anthropogenic impacts on the Livramento Stream. **Methodology:** a field laboratory study, of exploratory and explanatory nature, with a quantitative-qualitative approach, utilising biophysical-chemical parameters and conducted *in loco*. **Conclusion:** In the year 2026, the Livramento Stream showed biological compromises due to the presence of thermoresistant coliforms and *E. coli*. The trace elements identified were Fe and Pb; the latter is of greater concern for water management, requiring investigation to pinpoint its source and to facilitate the development of projects and public policies aimed at containment. Several anthropogenic impacts were observed, most notably the dumping of construction waste along the banks near the stream's mouth and the discharge of untreated domestic sewage; this highlights the need for environmental education and public policies for domestic sewage management in the studied area.

Keywords: Environmental Chemistry; Water Resources; Limnology; Livramento Stream; Belém; State of Pará (Brazil); Biophysicochemical analyses of water.

RESUMO

Justificativa: Na Região Metropolitana de Belém, a água tornou-se um desafio em termos de gestão de recursos hídricos devido a

impactos antropogênicos; portanto, analisar a qualidade da água por meio de parâmetros biofísico-químicos é essencial para avaliar potenciais impactos decorrentes de atividades humanas, como as concentrações de nutrientes e a presença de metais pesados. **Objetivo geral:** analisar a qualidade biofísico-química das águas do Riacho do Livramento. **Objetivo específico:** identificar os impactos antrópicos no Riacho do livramento. **Metodologia:** pesquisa laboratorial de campo, de caráter exploratório-explicativo e de natureza quanti-qualitativa, que utilizou parâmetros biofísico-químicos e foi realizada *in loco*. **Conclusão:** No ano de 2026, o Riacho do Livramento apresentou comprometimentos biológicos pela presença de coliformes termoressistentes e *E. coli*. Os elementos traços identificados foram Fe e Pb, onde esse último é o mais preocupante para a gestão hídrica necessitando rastreamento para identificar a fonte e promover projetos e políticas públicas de contenção. Foram observados diversos impactos antropogênicos, com destaque para o descarte de resíduos de construção ao longo das margens, próximo à foz do curso d'água, e o lançamento de esgoto doméstico sem tratamento; isso evidencia a necessidade de educação ambiental e de políticas públicas voltadas à gestão de esgoto doméstico na área estudada.

Palavras-chave: Química Ambiental; Recursos Hídricos; Limnologia; Riacho do Livramento; Belém; estado do Pará (Brasil); Análises Biofisioquímicas da água.

1. INTRODUCTION

The aquatic ecosystem possesses unique characteristics that differentiate it from the terrestrial environment, due to the aqueous medium being efficient in accelerating both metabolic and biogeochemical processes. Water’s high capacity for fluidity and

solubilisation reduces barriers to dispersal, facilitating an exchange of nutrients and chemical signals across various habitats through a constant flow. Furthermore, both the locomotion and the vertical distribution of living organisms within an aquatic ecosystem depend on physical factors such as viscosity, specific heat, and light refraction[1].

In this context, Limnology stands out, which is the scientific study of all continental waters across the planet, including lakes, reservoirs, rivers, lagoons, coastal areas, wetlands, saline lakes, estuaries, and wetlands in coastal regions[2].

In addition to its descriptive nature, limnology has important practical applications because its ability to make predictions and prognoses also qualifies it as an important science from an applied perspective. In recent years, the degradation of inland water ecosystems has intensified, driven by the dumping of various types of waste, the effects of deforestation within river basins, and air pollution leading to acid rain. Therefore, containing these deterioration processes and correcting and preventing changes in inland waters can only be done if a solid foundation of scientific knowledge exists[2].

In the application of this knowledge, challenges related to water resource management stand out. Thus, the analysis of water quality through physicochemical and biological parameters becomes essential. These parameters allow for the assessment of potential impacts resulting from human activities, such as nutrient concentrations and the presence of heavy metals.

The use of water for industry, agriculture and livestock, public supply, etc., has revealed serious management problems. In the case of the Amazon region, in many cities sewage is dumped directly into rivers and lakes without any treatment, causing an unbearable load of phosphorus, nitrites, nitrates and various other nutrients, leading to eutrophication, contamination, among other problems, of rivers, streams and lakes, resulting in the death of several endemic species and the proliferation of other exogenous species. The result includes the migration of certain species, environmental health issues, a reduction in the depth of rivers and lakes due to the accumulation of excess sediment, the presence of heavy metals in the chemical composition of water and soil, and the acceleration or retardation of certain biogeochemical cycles, among other effects[3].

According to data from the 2022 Demographic Census, the Administrative District of Icoaraci (DAICO), located in the city of Belém, in the state of Pará (Brazil), has a resident population of 171,524 people[4].

Icoaraci is bordered by several rivers, including the Maguari River, as well as streams such as the Livramento Stream and other smaller watercourses that flow into the Acará River, which is part of the hydrographic system of the Bay of Guajará. Despite the importance of the Livramento Stream for the Icoaraci District's water resources, scientific studies on its waters are scarce in the literature to date, making it necessary to conduct research on the biophysicochemical quality of its water.

Given this, the general objective of this study is to conduct a biophysical-chemical analysis of the waters of the Livramento

Stream, while a specific objective is to identify the anthropogenic impacts on this stream.

2. METHODOLOGY

This research is integrated into the project "Environmental impacts of urbanisation on the limnological resources of the Metropolitan Region of Belém and their effects on human and environmental health: A brief look at environmental chemistry and geomedicine through physicochemical parameters - 2nd Stage", coordinated by Professor Aureliano da Silva Guedes, PhD.

This is a field-based laboratory study of exploratory-explanatory nature, employing a quantitative-qualitative approach and utilising biophysical-chemical parameters, conducted "*in loco*"[5].

The samples were collected at the mouth of the Livramento stream in the Icoaraci District, in the city of Belém, State of Pará (Brazil), specifically at latitude 1°19'20.07"S and longitude 48°29'5.33"W, within the mesolimnion of the thalweg, between April 6, 2026, and October 2, 2026.

The pH was measured using a portable electronic pH meter and compared against test strips for control purposes. Electrical conductivity values were obtained using a portable electronic conductivity meter, expressed in µS/cm (microSiemens per centimetre); the same equipment was used to measure the temperature of the samples and the total dissolved solids content. A portable thermometer was used to measure the ambient temperature. All samples were subjected to three *in situ* tests using multicolourimetric reagents, aimed at determining alkalinity and

analysing for the potential presence of lead, bromine, nitrate, nitrite, iron, chromium (VI), copper, mercury, and fluoride, among other elements [5,6,7].

Dehydrated chromogenic plates on an absorbent membrane were used for the identification of "*Escherichia coli*" colonies, thermotolerant coliforms, and total coliforms; this method is validated by AOAC, MicroVal, and NordVal.



Mouth of the Livramento Stream – Icoaraci District in Belém, Pará, Brazil. On Google Earth[8].



Livramento Stream at high tide. Photo by Aureliano da S. Guedes II.

3. RESULTS AND DISCUSSIONS

The samples were collected and analysed in accordance with the proposed objectives and methodology; the results are presented in the table below, which follows the format proposed by Guedes and Guedes II[5,7].

LIVRAMENTO STREAM					
Parameters	**Sample 1 06/04/2026**	**Sample 2 05/06/2026**	**Sample 3 25/08/2026**	**Sample 4 02/10/2026**	**Tolerability in recreational waters/Source**
Environmental visibility	Cloudy	Normal	Cloudy	Normal	-
Environment	29.9	25.2	26.6	26.0	-

temperature C°					
Wind	Absent	Low	Absent	Low	-
Ciliary forest	Yes	Yes	Yes	Yes	Varies depending on the type and width of the river
Tide	Low	Low	High	High	-
Aquatic macrophyte presence	Yes	No	No	No	Must not present eutrophication
pH	≤6.2	≤6.2	≤6.2	≤6.2	6-9
Temp C° - Sample	22.9	25.1	27.7	26.6	-
Colour	Brown	Brown	Brown	Brown	True colour: natural colour level of the water body in mg Pt/L – CONAMA[9]
Turbidity	Normal	Normal	Normal	Normal	**≤** 40 nephelometric turbidity units (NTU) – CONAMA[9]

Odour	Normal	Normal	Normal	Normal	Absent odour
Electrical conductivity- (mS/cm).	0.156	0.154	0.058	1.568	Depends on ions, geological aspects, pH and others
TDS (Total Dissolved Solids)	0.078	0.082	0.027	0.784	< 500 mg/litre – CONAMA[9]
Carbonate	0	0	0	0	Observe pH, presence of macrophytes and other factors.
Water Hardness	250	250	250	250	500mg/l Review
Lead	0	0	10	5	0.01mg/L – CONAMA[9]
Bromine	0	0	0	0	0.5mg/l (500 µg/l) WHO[10]
Nitrate	0	0	0	0	10.0 mg/L – CONAMA[9]

Nitrite	0	0	0	0	1.0 mg/L – CONAMA[9]
Iron	0	0.5	0.25	5	0.3 mg/L – CONAMA[9]
Chromium (VI)	0	0	0	0	0,1 mg/l
Copper	0	0	0	0	0.009 mg/L – CONAMA[9]
Mercury	0	0	0	0	0.0002 mg/L – CONAMA[9]
Fluoride	0	0	0	0	1.4 mg/L – CONAMA[9]
Thermoresistant coliform colonies	175	425	126	114	There must be an absence of thermotolerant coliforms.
***Escherichia coli* colonies**	14	82	16	13	There must be an absence of *E. coli*
Total coliform colonies	189	507	142	127	There must be an

					absence of total thermotolerant coliforms

Based on determination for freshwater salinity ≥ 0.5 ‰ CONAMA[9]

Defined as a subgroup of the *Enterobacteriaceae* family formed by Gram-negative bacilli, total coliforms are characterised in biochemistry by their ability to ferment lactose, generating gas and/or acid within 24 to 48 hours at a temperature of 35°C. The group comprises more than 20 bacterial species and, due to their mixed origin, they can be found in bodies of water and originate from the gastrointestinal tract of both humans and warm-blooded organisms, as well as soil, vegetation, and surface waters and obligatory habitat[11].

Thermotolerant coliforms were present in all water samples collected from the Livramento Stream in Icoaraci; the highest number of colonies, as determined by the method employed, was recorded during low tide, reaching a count of 425 colony-forming units. Colonies of *Escherichia coli* were identified in all samples collected, with the highest frequency occurring during low tide, the highest frequency being 82 colonies in sample number 2. The sum of *Escherichia coli* colonies and thermotolerant coliforms, which indicates the total coliforms, was higher in the second sampling, reaching 507 colonies, indicating that the water from the Livramento Stream is unfit for consumption.

Trace elements are chemical elements that occur in nature in low concentrations, generally less than 0.1% (≤ 1,000 mg*kg -1), and

include different chemical properties, which can be classified into essential and non-essential[12].

Lead (Pb) is classified as a trace element with high ecotoxicity and has no known biological function in living organisms[12]. From the perspective of public health and epidemiology, the absorption of free lead ions (Pb2+) occurs via the respiratory and/or digestive tracts; the metal is then transported through the bloodstream and accumulates in the body, with approximately 90% of it becoming deposited in the bones and teeth for long periods[13]. This contamination can trigger saturnism (or plumbism), as well as chronic renal failure, toxic encephalopathy, and severe damage to the central and peripheral nervous systems; in 25% to 50% of affected patients, this may result in permanent sequelae, such as intellectual disability, seizures, and blindness PORTO[14].

In the samples collected from the Livramento Stream, the trace element Pb was identified in the last two samples, with decay in the last sampling, requiring the identification of the sources for monitoring, given the risks to human and animal health.

Iron (Fe) is classified as an essential micronutrient and a trace element indispensable to the functioning of continental aquatic ecosystems, acting in the constitution of the respiratory chain in cytochromes and in nitrogen fixation by ferredoxin[12].

However, chronic consumption of water with iron concentrations exceeding the potability limits leads to severe cases of intoxication. Among the pathologies associated with excess iron, notable examples include siderosis, hemochromatosis, cardiomyopathies,

liver cirrhosis, splenomegaly, and Neurodegeneration with Brain Iron Accumulation (NBIA) disorders[3].

The electrical conductivity of the samples reached a minimum of 0.54 and a maximum of 1.568; the latter point coincided with the highest concentration of iron, and lead was also detected in the samples. This peak in electrical conductivity occurred simultaneously with the highest level of Total Dissolved Solids in the water from the Riacho do Livramento stream. The pH remained consistently below 6.2, which is normal for tropical zones. The water hardness remained at 250, half of the alert level of 500 mg/l.

In the samples collected, the analytical method employed did not detect trace elements of mercury, chromium (VI), copper, nitrite, nitrate, bromide, or fluoride. Water hardness 250mg/l in all samples. The pH was under 6.2, normal to tropical zones. Ambient temperatures ranged between 25.2 and 29.9 before 9:00 a.m. The temperatures of the samples ranged between 22.9 and 27.7 at the time of collection. The colour of the water remained brown throughout the observations, and the turbidity and odour of all samples appeared normal.

4. CONCLUSION

The Livramento Stream, located in the Icoaraci District in Belém, Pará State (Brazil), showed biological compromises in its waters in 2026 due to the presence of thermoresistant coliforms and *E. coli*. Regarding trace elements, Fe and Pb were identified, with the latter being the most concerning for water management, requiring tracking to identify the source and promote containment projects and public policies.

A variety of anthropogenic impacts are evident, most notably the dumping of construction waste along the banks near the stream's mouth, as well as the discharge of untreated domestic sewage; this highlights the need for environmental education and public policies focused on domestic sewage management in the study area.

REFERENCES

1. ESTEVES, Francisco de Assis. CALIMAN, Adriano. Águas Continentais: Características do meio, compartimentos e suas comunidades. In: ESTEVES, Francisco de Assis. (Coord.). Fundamentos de limnologia. 3. ed. Rio de Janeiro: Interciência, 2011. cap. 6, p. 113-118.

2. TUNDISI, José Galizia; TUNDISI, Takako Matsumura. Limnologia. São Paulo: Oficina de Textos, 2008.

3. GUEDES, Aureliano da Silva; GUEDES II, Aureliano da Silva; GUEDES, Catarynna Maciel Quaresma da Silva. Meio ambiente e limnologia. Belém : Ed. dos Autores, 2023.

4. INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA (IBGE). Panorama do Censo Demográfico 2022. Rio de Janeiro: IBGE, 2022. Disponível em: https://censo2022.ibge.gov.br/panorama/. Acesso em: 19 abr. 2026.

5. 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.

6. GUEDES, Aureliano da Silva; GUEDES II, Aureliano da Silva. Analysis of the biophysical-chemical parameters of the Benfica river in the municipality of Benevides, State of Pará (Brazil) – 2025. In: Revista Tópicos. 4 (35), 6/07/2026. Disponível em https://revistatopicos.com.br/artigos/analysis-of-the-biophysical-chemical-parameters-of-the-benfica-river-in-the-municipality-of-benevides-state-of-para-brazil-2025. Acesso em 26/10/2026.

7. 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.

8. GOOGLE EARTH. Foz do Igarapé do Livramento- Distrito de Icoaraci em Belém-PA. Acesso em 06/04/2026.

9. BRASIL. CONAMA - Conselho Nacional do Meio Ambiente. Resolução n° 357 de 17/03/2005. Estabelece a classificação das águas doces, salobras e salinas do Território Nacional. Brasília, SEMA, 2005.

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

11. SILVA, Neusely da et al. Manual de Métodos de Análise Microbiológica de Alimentos e Água. 4. ed. São Paulo: Livraria Varela, 2010.

12. ESTEVES, Francisco de Assis; GUARIETO, Rafael Dettogni. Elementos-traço. In: ESTEVES, Francisco de Assis. (Coord.). Fundamentos de limnologia. 3. ed. Rio de Janeiro: Interciência, 2011. cap. 18, p. 321-337.

13. BUSCHINELLI, José Tarcísio Penteado. O Clínico e as Intoxicações Ocupacionais e Ambientais. In. LOPES, Antonio Carlos. Tratado de clínica médica. 2 ed. São Paulo : Rocca, 2009. V.1 p.227-234.

14. PORTO, Celmo Celeno. Saturnismo. In.: _____. Vademecum de Clínica Médica. 2.ed. Rio de Janeiro : Guanabara Koogan, 2009. V2, p.800.