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Identification and mapping of potential pollution sources in Lagoa Central, Lagoa Santa (MG, Brazil): contributions to an environmental monitoring plan

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Abstract: This study aimed to identify and map potential sources of pollution in the Lagoa Central, in Lagoa Santa, MG, to support an environmental monitoring plan. The methodology involved on-site environmental surveys, application of an adapted Leopold Matrix, and the use of georeferencing tools and Geographic Information Systems (GIS) to map the impacted areas. The results indicated that, of the 36 points analyzed along the shoreline, 14 presented significant environmental impacts, with 13 classified as critical. Irregular discharges of liquid effluents, inadequate disposal of solid waste, the presence of foam, oily residues, and organoleptic alterations in the water, as well as turbidity and odor, were identified. Specific points, such as P.32 and P.33, stood out due to the severity of the associated impacts. It is concluded that the Central Lagoon presents relevant environmental impairment, requiring continuous monitoring, enforcement, and environmental education actions to mitigate impacts and conserve the ecosystem.
Keywords: Monitoring; Survey of environmental aspects and impacts; Pollution; Leopold Matrix.

Introduction

Water quality monitoring should be tailored to the objectives of the study and to the type of aquatic system (river, lake, estuary, etc.), with the number and spatial distribution of monitoring points, as well as sampling frequency, varying according to the specific situations. The monitoring points must be representative of the system, and the number of parameters should be limited to the minimum required to ensure that no relevant information is lost (Souza, 2015).

In limnic systems located in urban environments, it is essential to map land use within the watershed of the water body, identifying all points of sanitary and industrial effluent discharge, as well as discharges from stormwater drainage networks. This mapping process improves monitoring efficiency and facilitates water quality management, allowing for more targeted field campaigns and promoting environmental education actions aimed at mitigating impacts and enhancing the preservation of water resources.

Lagoa Santa, more commonly known as Lagoa Central, located in the municipality of Lagoa Santa, Minas Gerais, is considered the largest lake within the karst system situated in the northern portion of the metropolitan region of Belo Horizonte. According to Parizzi (1998), as cited in Brighenti (2011), the lake was formed approximately 6,000 years ago as a result of landslides caused by torrential rainfall, which obstructed the flow of water in the valley and led to its impoundment. In addition to being an important geological feature at the national level, the lake also plays a significant role in the development of the city, which expanded around the lake, and stands out for its historical significance and contribution to the development of local culture.

Although studies addressing a variety of topics concerning Lagoa Central exist, there are still few investigations specifically related to the mapping of critical pollution points. In the absence of a municipal plan for continuous water quality monitoring, the capacity to systematically assess variations in pollution levels associated with seasonal hydrological dynamics becomes limited. According to Gadêlha et al. (2025), water quality exhibits high temporal and seasonal variability, requiring continuous monitoring to support understanding and provide a sound basis for proper environmental management aimed at promoting the sustainability of water resources.

Lagoa Central is considered an important urban lentic ecosystem, presenting morphometric features that directly influence its environmental dynamics. According to Brighenti et al. (2011), it is a shallow environment, with a maximum depth of less than 7.5 m, low relative depth, and a concave shape. Its approximate length is 1,960 m, with a maximum width of 1,573 m and a perimeter of around 6,467 m. It has a surface area of 1.7×10^6 m^2 (approximately 1.7 km^2) and an estimated volume of 7.0×10^6 m^3 (about 7 million cubic meters). According to Brighenti et al. (2011), in addition to its ecological relevance, the lake plays a fundamental role in the local social and economic context, being widely used by the population for leisure and recreational activities. Therefore, the conservation of this system is essential for maintaining ecosystem services and the quality of life of the community.

It should be emphasized that lacustrine environments present greater vulnerability to pollution due to their long water renewal periods and limited self-purification capacity (Wang et al., 2023). In some situations, these environments are surrounded by urban drainage structures, which restrict their natural self-cleaning capacity. The increase in water temperature, associated with changes in precipitation patterns and the intensification of extreme climatic events, has contributed to a greater input of nutrients originating from the watersheds, favoring algal proliferation in aquatic environments. In addition, higher temperatures intensify algal metabolism and reduce the solubility of dissolved oxygen, creating conditions conducive to the expansion of these populations, including in deeper layers of the water column (Bolan et al., 2024; Meerhoff et al., 2022). As a consequence, the deterioration of water quality and the ecological status of these environments is observed. Continuous water quality monitoring is essential for detecting temporal and spatial changes in the physicochemical parameters of lentic environments, allowing the identification of trends and seasonal variations and supporting a proactive response to environmental pressures resulting from anthropogenic activities and natural variability (Rock et al., 2025).

This analysis is essential for understanding the physical, chemical, and biological characteristics of Lagoa Central and for relating the possible environmental aspects present in its surroundings, which may directly influence water quality parameters.

In this context, the present study aims to identify and map the potential sources of pollution affecting Lagoa Central, located in Lagoa Santa, Minas Gerais, in order to support the development of an environmental monitoring plan for the lake. The study may therefore contribute to future recommendations for preventive, corrective, and mitigation measures, aimed at improving water quality and promoting its conservation, given its environmental, cultural, and tourism significance.

Methodology

Characterization of the study object

Lagoa Central (Figure 1), located in the municipality of Lagoa Santa, Minas Gerais, is an important water body that performs several ecological, social, and recreational functions. It was formed through geological processes in the karst region, which is characterized by the presence of caves and limestone rocks. The lake is situated within the upper Rio das Velhas watershed, in an urban area. The municipality of Lagoa Santa is part of one of the main lacustrine systems in Brazil: the lake system located in the limestone region of the metropolitan area of Belo Horizonte, Minas Gerais (Brighenti, 2009).

The analysis of the hydrography (Figure 2) and land use and land cover (Figure 3) surrounding Lagoa Central makes it possible to understand how urban occupation and the physical characteristics of the terrain influence surface runoff and the transport of pollutants toward the water body. This approach contributes to the interpretation of the points surveyed in the field and to the identification of the main potential sources of pollution that influence the water quality of the ecosystem.

Land use within the watershed significantly impacts the water quality of a lentic system, and different land use types across seasons have distinct effects on water bodies (Long et al., 2024). Figure 3 shows that the watershed of Lagoa Central is predominantly occupied by urbanized areas.

Strategies adopted for conducting fieldwork

An in situ environmental survey was conducted through three field campaigns carried out between October and November 2024, during the beginning of the rainy season in the Lagoa Santa region, a condition considered relevant for observing the transport of waste materials and potential diffuse sources of pollution. The first visit had an exploratory nature, allowing a general survey of the area and the preliminary identification of possible pollution sources. During the second campaign, strategic control and monitoring points were defined along the lake shoreline, considering aspects related to land use and occupation, urban drainage, and visual evidence of environmental degradation. The third visit was dedicated to a detailed environmental diagnosis, including the identification and assessment of environmental aspects and impacts through the application of the adapted Leopold Matrix. This approach guided the identification and classification of interactions between anthropogenic actions and environmental components.

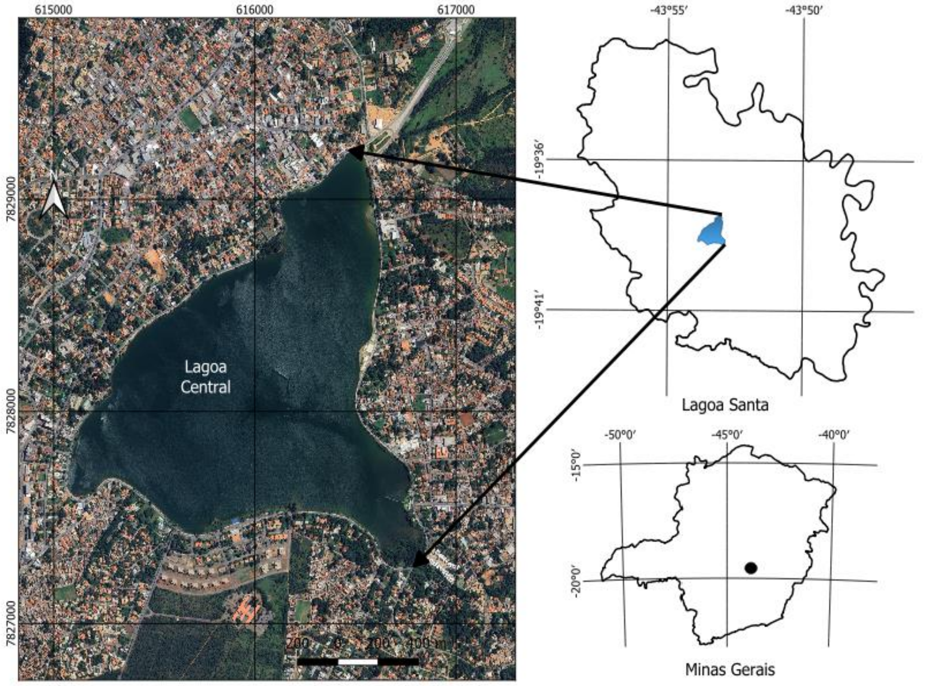

Figure 1. Location map of Lagoa Central in the municipality of Lagoa Santa – MG (19°38'17.83"S; 43°53'33.39"W)

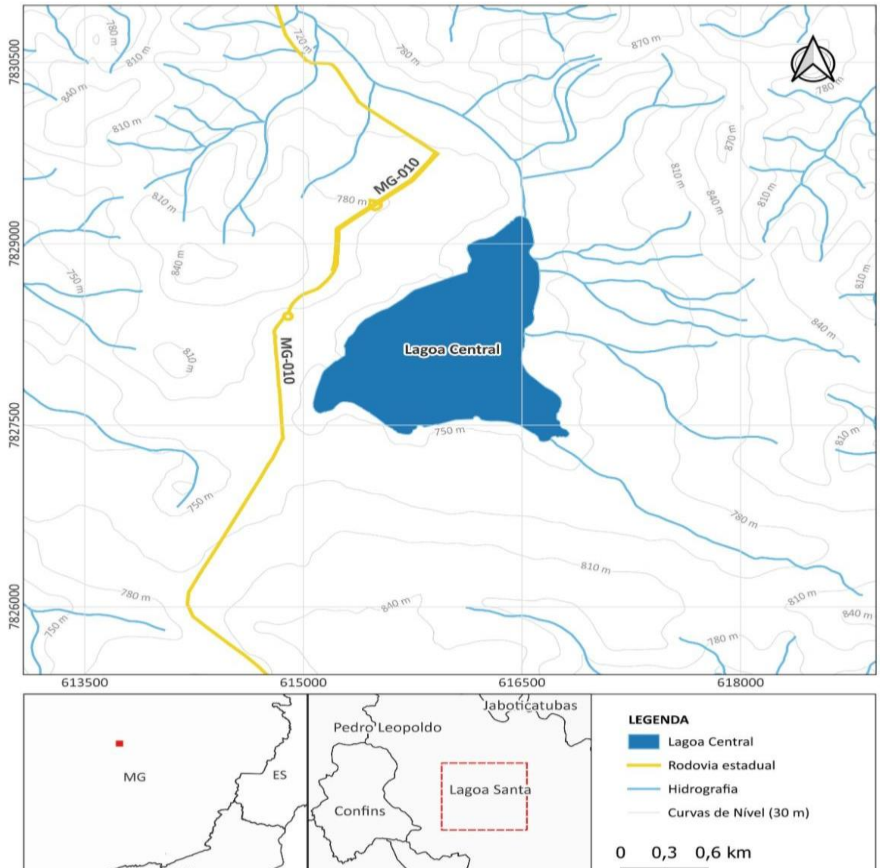

Figure 2. Hydrographic network and main tributary drainage channels of Lagoa Central, Lagoa Santa - MG.

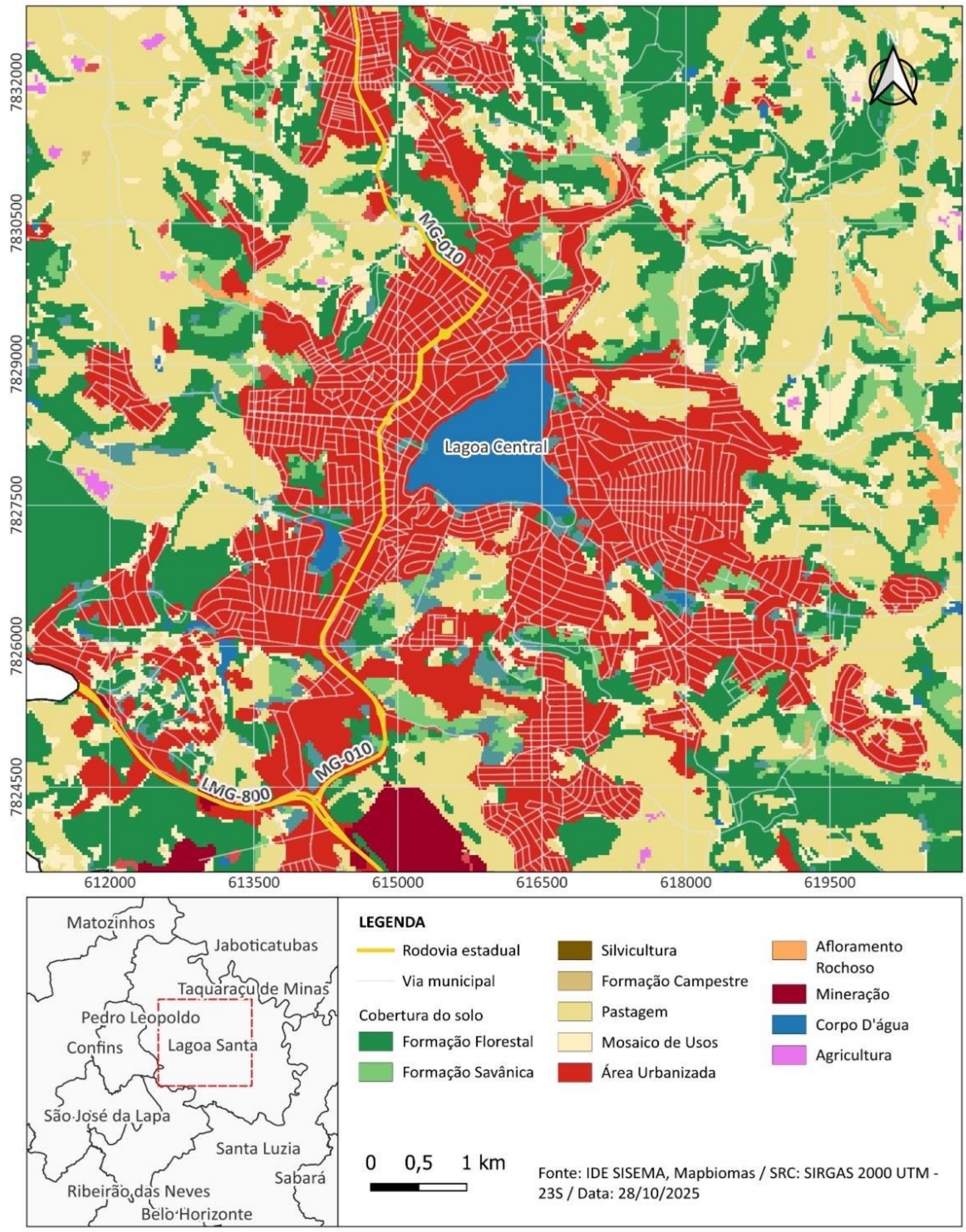

Figure 3*.* Land Use and Land Cover – Lagoa Central.

The original Leopold Matrix corresponds to a two-dimensional listing composed of indicators versus impact factors, allowing the attribution of magnitude and significance values for each analyzed item (Almeida and Bastos, 2004 apud Gebler and Longhi, 2018). Developed as a qualitative tool for the analysis of significant environmental impacts (both positive and negative), it was modified to incorporate the survey of the main environmental aspects and the most common impact-generating activities in the study area through systematic field-based visual assessment. According to Larocca, Cardoso, and De Angelis (2017), the Leopold Matrix, often referred to as interaction matrices, is one of the most recognized tools in Environmental Impact Assessment. This method makes it possible to identify environmental factors and activities related to transformation processes, providing a detailed analysis of the magnitude and intensity of the impacts that these actions may cause to the environment.

To support the field survey and the preparation of cartographic outputs, Geographic Information System (GIS) tools were employed using QGIS software version 3.34. Spatial data were organized according to the SIRGAS 2000 geodetic reference system, Universal Transverse Mercator (UTM) projection, zone 23S, allowing greater standardization and reliability in the spatial representation of information .

The evaluated points were georeferenced using a portable Global Positioning System (GPS) device (Garmin GPSMAP 64sx), with an estimated average accuracy ranging from 3 to 5 meters, identifying not only the locations where impacting activities were observed, but also those considered strategic for future effective and continuous monitoring of the lake's water quality.

During the field campaigns, observations were recorded in digital spreadsheets using a tablet device (Redmi Pad 2) and complemented by photographic records captured using a smartphone (Xiaomi 14T Pro), documenting each relevant point identified in the field.

Survey of Environmental Aspects and Impacts (SEAI)

The matrix used for the classification of environmental impacts was established based on the correlation between importance and severity levels, resulting in the determination of the final category (Figure 4). In accordance with their direct relevance to environmental quality, certain environmental factors critical to the impact analysis were previously defined and considered, namely: sanitary sewage, solid waste, industrial activities, urban occupation, soil sealing, and leisure and tourism activities. The selection of these aspects was based on their recognized potential contribution to environmental pollution, as they are particularly relevant in urban and industrialized areas, where their impacts were identified as significant. The methodology employed assigned quantitative values of 1 (low), 3 (medium), or 5 (high) to each criterion. The relevance assessment was determined by summing these values, allowing each aspect to be classified as negligible for totals between 3 and 5 points, or critical for totals ranging from 7 to 15 points.

According to the adapted matrix, the following characteristics were considered for the characterization of the environmental aspects, as shown in table 1.

<table>
<tr><td colspan="13" rowspan="3">matrix for the identification and assessment of environmental aspects and impacts</td><td>Document's number</td></tr>
<tr><td>REVISION</td></tr>
<tr><td></td></tr>
<tr><td colspan="13"></td><td>Area: Lagoa Central</td></tr>
<tr><td rowspan="2">Reference / Point</td><td rowspan="2">Environmental Aspect</td><td rowspan="2">Environmental Impact</td><td rowspan="2">Sit</td><td rowspan="2">ReSp</td><td rowspan="2">Nat</td><td colspan="3">Relevance</td><td colspan="2">Filtre</td><td rowspan="2">Significance</td><td rowspan="2">Site Characterization</td></tr>
<tr><td>Abr</td><td>Grav</td><td>Prob</td><td>N</td><td>N</td></tr>
</table>

Figure 4. Matrix for the Survey of Environmental Aspects and Impacts (SEAI). **Legend:** situation (Sit), responsibility (Resp), nature of the impact (Nat), scope (Abr), severity (Grav), probability (Prob).
Source: Adapted from Almeida and Bastos (2004) apud Gebler and Longhi (2018)

Table 1. Characterization of the aspects.

Situation (SIT)	Normal (N): routine operation.
	Sporadic (Sp): the operation is not routine, but its execution is necessary at some point during the activity (maintenance, refueling, etc.).
	Emergency (Em): undesirable situations, such as incidents and accidents.
Responsibility (RESP):	Direct (D): aspect that can be controlled.
	Indirect (I): an aspect not subject to control. For example, a company that contracts a waste disposal service cannot directly control the aspects, but still retains responsibility for them.;
Nature of the impact (NAT):	Beneficial (B): brings benefits to the environment.
	Adverse (A): causes harm to the environment.
Relevance. This factor is subdivided into:	Scope (SCO): extent of the damage.
	Severity (SEV): intensity of the damage.
	Probability (PROB): likelihood of the impact occurring.
Filters	Aspects related to applicable environmental legislation are automatically classified as significant.

Definition of land use and land occupation and monitoring sites

After the detailed assessment of the study area, the second phase focused on developing a land use and land cover map of the surroundings of Lagoa Central. For this purpose, high-resolution satellite imagery and available cartographic data were used, enabling geospatial data processing. The geospatial analysis was carried out with the support of Geographic Information System (GIS) tools, allowing the integration and overlay of pollution-related information previously identified in the field. As highlighted by Machado (2019), the application of GIS plays a fundamental role in the efficient and timely processing of environmental data, given its robust capacity to analyze, overlay, and efficiently handle large volumes of spatial information, which proved essential for the mapping process.

Additionally, we declare that artificial intelligence tools were used exclusively to support the linguistic revision and textual organization of the manuscript and were not employed in data analysis, interpretation, or generation of results.

Results and discussion

During the shoreline survey, visually and sensorially perceptible changes in the physical and chemical parameters of the water were observed, including turbidity, suspended solids, occurrences of fish mortality, odors, and foam accumulation along the margins, potentially associated with pollutant discharges. This stage is extremely relevant, as it aims to assess, verify, and complement the analysis performed through geoprocessing techniques.

Currently, there are no recent technical reports that provide a systematic assessment of the impacts arising from sanitation conditions in the lake. However, the observed conditions indicate a significant potential for water quality impairment, which may pose risks to the local fauna and recreational users, manifesting, for example, as discomfort and potential illnesses in the population. In such cases, Souza (2015) highlights the importance of independently determining physical, chemical, and biological water quality parameters, as these allow for an individual assessment of the elements affecting water quality.

Although the discharge of effluents into the lake is legally prohibited, visual alterations in water quality can be observed at certain points, characterized by increased turbidity and a more opaque appearance, suggesting a possible rise in the concentration of suspended solids and dissolved pollutants. Additionally, these observed aspects raise concerns regarding the environmental quality of the water body and reinforce the need for preventive and mitigation measures. The main potential sources of pollution are associated with the direct discharge of effluents and solid waste from adjacent properties, as well as indirect inputs through stormwater drainage networks receiving irregular sewage release.

The identification and assessment of environmental aspects and impacts in Lagoa Central were systematically conducted through the application of the Leopold Matrix. This field survey included a total of thirty-six monitoring points, which were strategically distributed at intervals of 150 to 200 meters, with the study focused exclusively on the lake margins, as shown in Figure 5.

Although the study considered 36 evaluated points, only 14 were classified within the negligible (values between 3 and 5) and critical (values between 7 and 15) categories according to the Leopold Matrix. The remaining points presented values below 3 and were therefore omitted from the chart for the sake of simplicity, in order to improve the visualization of the preliminary results.

The spatial distribution of these significant points allowed the development of an environmental hotspot map (Figure 6), highlighting priority impact areas along Lagoa Central. The use of spatial hotspot analysis has been widely applied in environmental studies to identify critical zones under anthropogenic influence, guiding monitoring and territorial management actions (Esmail et al., 2025). In this context, a greater concentration of high-priority hotspots was observed in the southwestern and northeastern sectors of the lake, indicating regions with greater potential for environmental degradation and requiring intervention.

Figure 5. Sketch map showing the monitoring points surveyed during the shoreline walk around Lagoa Central, Lagoa Santa.

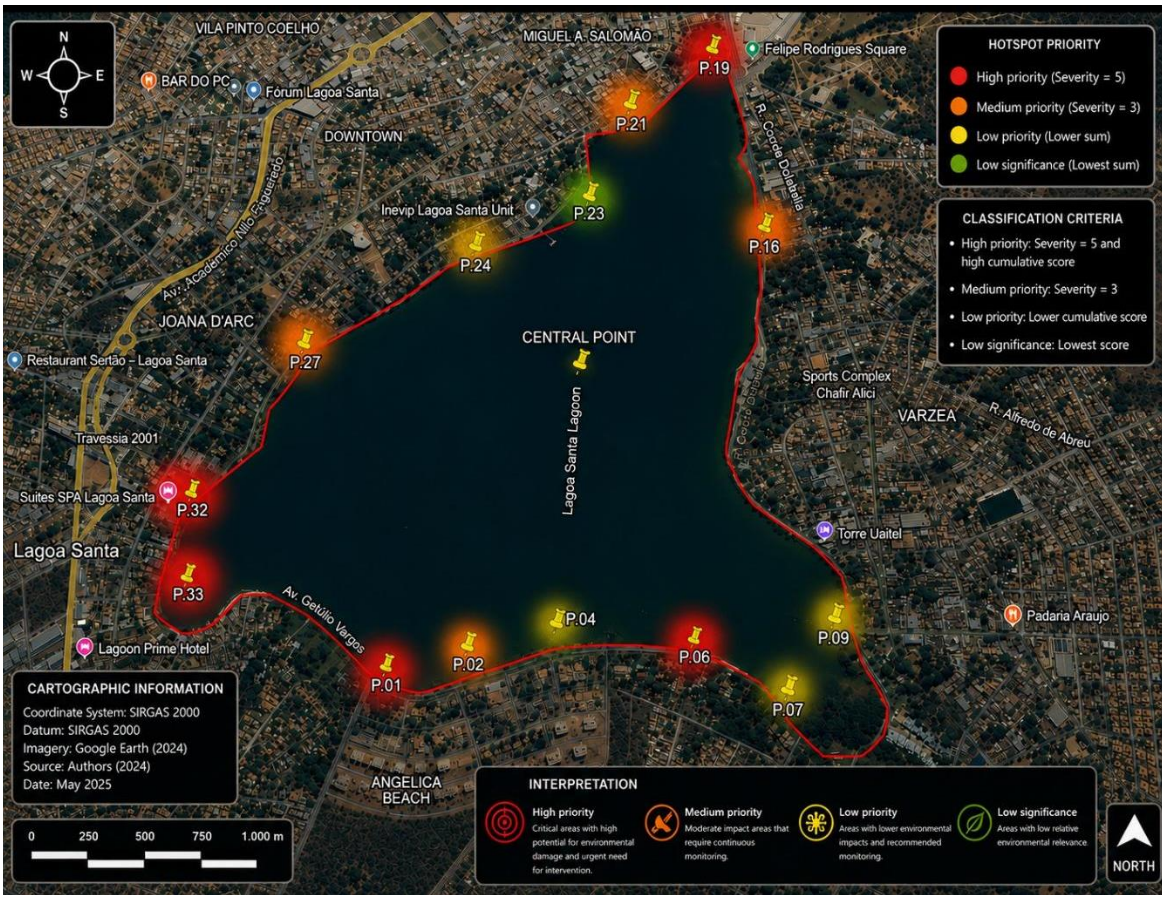

Figure 6. Priority environmental hotspots for monitoring in Lagoa Central.

The predominant category was the non-significant class, accounting for 61.11% of the total and corresponding to 22 monitoring points (Figure 7). These points refer to locations whose scores did not meet the minimum environmental relevance criteria established in the methodology. The negligible and critical categories comprised 1 (2.80%) and 13 (36.10%) points, respectively. It should be noted that Point 23 did not receive a relevance score; however, due to its association with specific environmental legislation, it was automatically classified as significant.

Excluding the non-significant points, the distribution of the variables scope (Sco), severity (Sev), and probability (Prob), in terms of quantity and frequency, is presented in Table 2.

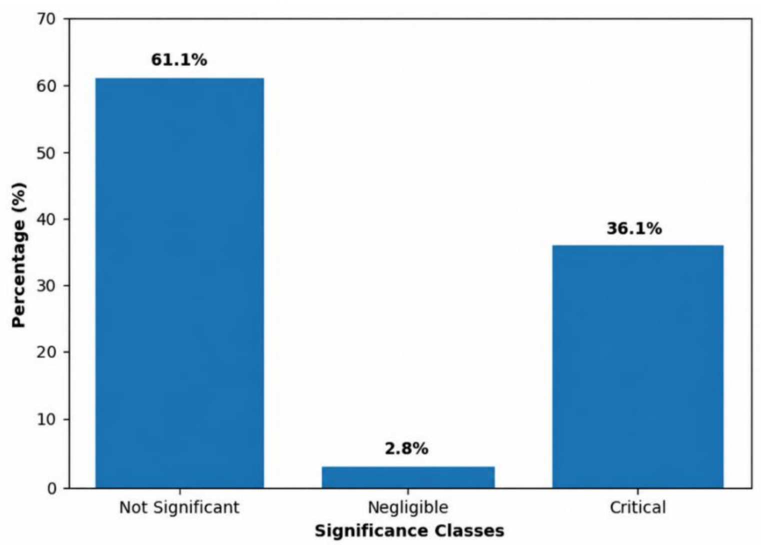

Figure 7. Distribution of significance classes – Non-Significant and Significant (Negligible and Critical).

Table 2. Quantity and percentage frequency for each class of scope (Scop), severity (Sev), and probability (Prob).

Valor	Abr	Grav	Prob	Abr (%)	Grav (%)	Prob (%)
1	1	1	5	7,1%	7,1%	35,7%
3	11	9	6	78,6%	64,3%	42,9%
5	2	4	3	14,3%	28,6%	21,4%
Total	14	14	14	100%	100%	100%

Considering the 14 points classified as significant, there was a predominance of the intermediate value (3) for the variables scope (78.6%), severity (64.3%), and probability (42.9%). The probability variable showed a greater distribution among the classes, with value 1 (35.7%) being particularly frequent, indicating greater variability in the likelihood of impact occurrence. In contrast, the severity variable presented a relevant proportion of high values (28.6%), highlighting the presence of impacts with greater potential for environmental damage (Figure 8).

The aquatic ecosystem has been significantly affected by multiple impacts, possibly resulting from the discharge of domestic and non-domestic effluents, as well as from the irregular disposal of large amounts of solid waste (Pereira et al., 2012).

Figure 9 exemplifies recurring negative environmental changes observed along the shoreline, characterized by the formation of surface foam in specific areas of the lake, the occurrence of dead ichthyofauna in some stretches, and the presence of packaging and waste materials of different types. These aspects may be associated with distinct environmental impacts, indicating environmental degradation processes in the lake, possibly related to the presence of toxic pollutants.

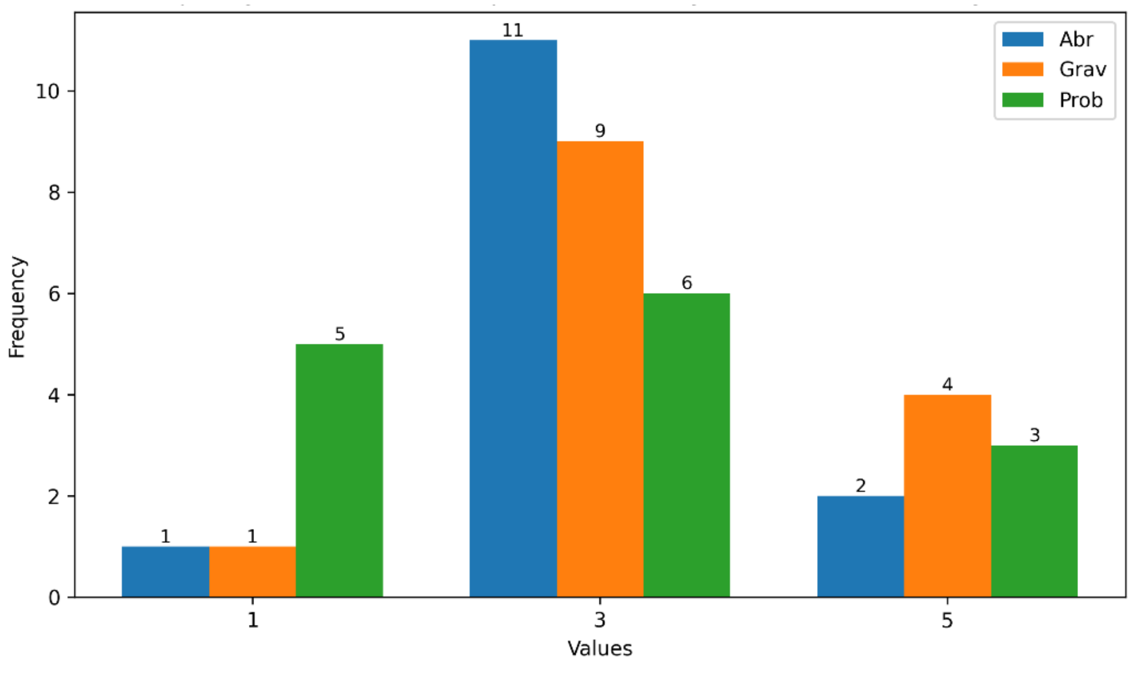

Figure 8. Frequency of values related to relevance (scope, severity, and probability).

Figure 9. Some of the aspects observed in the surroundings of Lagoa Central, Lagoa Santa.

Lagoa Central, in Lagoa Santa, is a relevant tourist, cultural, and natural landmark at both the local and international levels due to its formation history and the development of the city, which began when the *bandeirante* (colonial explorer) Felipe Rodrigues settled in its surroundings (Mendonça, 2006). However, despite the efforts of public authorities to maintain the environmental quality of the site, the ecosystem still receives pollutants, such as effluents of unknown origin, capable of causing damage to the organisms that depend on it.

Among the main problems identified were physical alterations in the water, the presence of oily residues, inadequate disposal of solid waste, and irregular discharges to stormwater drainage channels. Among the significant points, P.01, P.06, P.24, and P.33 stood out the most and may therefore be considered priority locations for the continuous monitoring of physical, chemical, and microbiological parameters. It is worth noting that these points are visually associated with areas of greater human circulation, concentration of bars and restaurants, and residential occupation. In particular, at P.33, contributions of effluents consisting of fats and grease originating from the kitchens of nearby bars and restaurants were observed, as well as a location where vehicle washing activities were taking place and the resulting effluent was being discharged into the stormwater drainage system, the latter occurring exclusively at P.32, near P.33.

To enable management actions aimed at improving environmental quality, it is essential to understand the physical, chemical, and biological parameters interacting within these ecosystems (Farias et al., 2024). According to Simeonov et al. (2003), an environmental monitoring program generally includes frequent sampling at the same monitoring points and laboratory analysis of a large number of variables, resulting in large and complex data matrices. The definition of these monitoring points is justified by the large quantity of waste found along the lake margins, such as cookie wrappers, coconut husks, plastic bags, PET and glass bottles, beverage cans, cups, and disposable packaging. In addition, these locations present areas with intense human activity, concentration of bars and restaurants, and strategic positioning, as they are situated near other significant points.

Upon analysis of the collected data, it was observed that the aspect with the highest negative score was the discharge of effluents, occurring at two specific points: P.32 and P.33. In Figure 10, it is possible to clearly observe the irregular discharge of effluent into the lake through the drainage channel, with an odor characteristic of domestic sewage, influencing the coloration of the water along its margins. Color is a visual characteristic related to the absorption and dispersion of light by substances present in the liquid. Normally, this parameter is associated with the presence of humic acids and tannins originating from the decomposition of vegetation, as well as with anthropogenic sources derived from industrial waste (Alves et al., 2008).

Figure 10. Effluent discharge identified at reference point P.32 (E615,085; N7,827,635; 23S).

At sampling point P.33, the in situ assessment identified the discharge of liquid effluent into the drainage channel, which may negatively affect water quality. As shown in Figure 11, an oily film was observed on the water surface, contributing to increased turbidity. Turbidity refers to the scattering of light as it passes through water and is directly related to the concentration of suspended particles. Elevated turbidity levels may indicate anthropogenic impacts, including the discharge of domestic and industrial wastewater (Calvo, 2018).

Figure 11. Effluent discharge identified at reference point P.33 (E615,078; N7,827,810; 23S)

Oils and grease may form surface films and accumulate along water margins, leading to a range of environmental impacts (Pereira, 2004). According to Berti (2009), these substances reduce the exchange of gases between the water surface and the atmosphere, limiting the transfer of oxygen into the water, which is one of the primary mechanisms of oxygenation in aquatic systems. Their presence and subsequent degradation can decrease dissolved oxygen concentrations while increasing biochemical oxygen demand (BOD) and chemical oxygen demand (COD). As a result, they may contribute to water pollution, oxygen depletion, and eutrophication.

Recent studies on Brazilian urban lakes have demonstrated that the lack of systematic monitoring hinders the early detection of environmental degradation, highlighting the importance of continuous water quality assessment programs (Farias et al., 2024). In this context, the present study provides an initial assessment of the environmental conditions and associated impacts at Lagoa Central, serving as a basis for future laboratory investigations and the development of a long-term environmental monitoring program. The selection of analytical parameters should be guided by both environmental relevance and economic feasibility, prioritizing key indicators that provide reliable diagnostic information while avoiding unnecessary costs associated with analyses of limited applicability to local conditions.

Conclusion

The study conducted at Lagoa Central, in Lagoa Santa, made it possible to identify significant environmental aspects and impacts capable of compromising the quality of the local ecosystem, as well as negatively affecting public health and biodiversity. The application of the Leopold Matrix, combined with mapping, enabled a detailed analysis of the critical and non-significant points along the lake shoreline.

Although the majority of the monitoring points were classified as having non-significant impacts, 13 points presented critical values, highlighting the importance of identifying and mapping these areas in order to propose effective corrective and preventive actions. The main impact factors identified include the irregular discharge of domestic effluents, and possibly those originating from small commercial establishments, the improper disposal of solid waste along the shoreline, and the presence of substances capable of altering the physical and chemical parameters of the water, such as turbidity and odor.

The observed evidence reinforces the need for integrated measures to mitigate environmental impacts, ranging from inspection and enforcement actions to the environmental regularization of the polluting activities. In addition, specific points, such as P.32 and P.33, presented concerning conditions due to the discharge of effluents, making them priority areas for continuous monitoring and intervention.

Long-term environmental sustainability and compliance with the Sustainable Development Goals (SDGs), especially SDGs 6 and 11, directly depend on the monitoring and effective management of water quality in urban lakes (Dawn et al., 2025). Therefore, the development of a continuous environmental monitoring program, with strategic planning of physicochemical and microbiological analyses, is essential to assess the effectiveness of the implemented actions. In this context, the present study contributes to the maintenance of environmental quality, the protection of fauna and flora, and the promotion of the health and well-being of the population that uses the lake for recreational and cultural purposes.

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References

Alves, E. C., da Silva, C. F., Cossich, E. S., Tavares, C. R. G., de Souza Filho, E. E., & Carniel, A.. Avaliação da qualidade da água da bacia do rio Pirapó–Maringá, Estado do Paraná, por meio de parâmetros físicos, químicos e microbiológicos. Acta Scientiarum. Technology, 30(1), 39-48, 2008.

BERTI, Alessandra Paim; DÜSMAN, Elisângela; SOARES, Lilian Capelari; GRASSI, Luiz Eduardo Aparecido. Efeitos da contaminação do ambiente aquático por óleos e agrotóxicos. SaBios: Revista de Saúde e Biologia, v. 4, n. 1, p. 45-51, jan./jun. 2009. ISSN 1980-0002.

BOLAN, S. et al. Impacts of climate change on the fate of contaminants through extreme weather events. Science of the Total Environment, v. 909, p. 168388, 2024. DOI: https://doi.org/10.1016/j.scitotenv.2023.168388.

BOURSCHEIDT, M. L. B. et al. Estratégias de fornecimento de nitrogênio em pastagens: fertilizante mineral, inoculante bacteriano e consórcio com amendoim forrageiro. Scientific Electronic Archives, v. 12, n. 3, p. 137-147, 2019.

BRIGHENTI, Ludmila Silva et al. Parâmetros morfométricos da Lagoa Central (Lagoa Santa, Estado de Minas Gerais): comparação de duas metodologias. Acta Scientiarum. Biological Sciences, Maringá, v. 33, n. 3, p. 281–287, 2011. DOI: https://doi.org/10.4025/actascibiolsci.v33i3.5545.

BRIGHENTI, Ludmila Silva. Avaliação Limnológica da Lagoa Central (Município de Lagoa Santa – MG): Uma Abordagem Espacial. Dissertação (Mestrado em Ciências Ambientais) – Universidade Federal de Minas Gerais, Belo Horizonte, p 92. 2009.

Calvo, B. D. R. Avaliação da Influência Antrópica na drenagem do igarapé do Quarenta e orla de Manaus. Dissertação (Mestrado), Programa de Pós-Graduação em Química, Universidade Federal do Amazonas, Manaus. 107. 2018.

DAWN, A.; et al. Assessment of Water Quality in Urban Lakes Using Multi-Source Data and Modeling Techniques. Sustainability, v. 17, p. 7258, 2025. DOI: https://doi.org/10.3390/su17167258.

DE OLIVEIRA DINIZ, Tamiris; DE LIMA, Mateus Xavier. Biotecnologia ambiental como ferramenta de gestão ambiental–Breve revisão. Scientific Electronic Archives, v. 14, n. 9, 2021.

ESMAIL, B. A. et al. Mapping and analyzing ecosystem services hotspots and coldspots for sustainable spatial planning in the Greater Asmara Area, Eritrea. Environmental Management, v. 75, p. 551–567, 2025. DOI: 10.1007/s00267-024-02078-x.

FAGUNDES, O. S. et al. A crise hídrica e suas implicações no agronegócio brasileiro: Uma revisão bibliográfica The water crisis and its implications in Brazilian agribusiness: A bibliographic. Revista Scientific Electronic Archives, v. 13, n. 1, p. 42-50, 2020.

FARIAS, Luana Marques Souza; SILVA, Maria Cristina Basílio Crispim da; ADLOFF, Clarisse Teixeira; MARINHO, Randolpho Sávio de Araújo. Análise da qualidade da água em uma lagoa urbana na cidade de João Pessoa (PB): diagnóstico e propostas de melhoria. OKARA: Geografia em Debate, João Pessoa, v. 18, n. 3, p. 903–928, 2024. ISSN 1982-3878.

FONSECA, T. L. et al. Qualidade físico-química e microbiológica de nascentes do perímetro urbano de Divinópolis-MG. Scientific Electronic Archives, v. 11, n. 1, p. 62-68, 2018.

GADÊLHA, José Eduardo Ferreira da Silva, et al. Diagnóstico temporal e sazonal da paisagem e impactos antropogênicos: avaliação ambiental de uma bacia hidrográfica utilizando protocolo de avaliação rápida (PAR). Desenvolvimento em Questão, v. 23, n. 62, 2025. DOI: http://dx.doi.org/10.21527/2237-6453.2025.62.16186.

GEBLER, Luciano; LONGHI, Alinise. Aplicação da matriz de Leopold para avaliação expedita de impacto ambiental na produção de morangos: um estudo de caso em Ipê (RS). Ambiência, Guarapuava, v. 14, n. 3, p. 709-727, set./dez. 2018.

GOTARDO, Rafael; MANTOVANI, Analu. Utilização de biofertilizante obtido em um biodigestor anaeróbico alimentado pela mistura de resíduos agroindustriais em área agrícola. Scientific Electronic Archives, v. 14, n. 11, 2021.

Guedes, H. A., Silva, D. D. D., Elesbon, A. A., Ribeiro, C., Matos, A. T. D., & Soares, J. H. (2012). Aplicação da análise estatística multivariada no estudo da qualidade da água do Rio Pomba, MG. Revista Brasileira de Engenharia Agrícola e Ambiental, v. 16, n. 5, p. 558-563.

LAROCCA, Alexandro Gasparini; CARDOSO, Carolina; DE ANGELIS, Bruno Luiz Domingos. O impacto da ocupação de fundo de vales em áreas urbanas – estudo de caso Lago Igapó Londrina – PR. Revista Brasileira de Meio Ambiente, v. 5, n. 30, 2017.

LONG, Mingkai; WU, Xiaodong; GE, Xuguang; YANG, Xiao Qing; HUANG, Zhi; LIU, Haoran; ZHU, Jiali; LI, Jinge; GONG, Mengting; LI, Zhepeng; LI, Zi Xiang. Evaluation of Water Quality and Eutrophication of Typical Lakes in Southeast Hubei, China. Sustainability, v. 16, n. 20, p. 8964, 2024. DOI: https://doi.org/10.3390/su16208964

LUZ, Verônica Silveira Vasconcelos et al. Avaliação da densidade populacional de perfilhos dos capins Marandu e Piatã submetidos à adubação com cama de frango e esterco de bovinos confinados. Scientific Electronic Archives, v. 14, n. 8, 2021.

MACHADO, Jaílson Silva; SILVA, Gabriela Mateus de Fontes; SILVA, João Batista Lopes da. Áreas potencialmente propícias à acumulação de agroquímicos na bacia do riacho Corrente-PI. Gaia Scientia, v. 13, n. 1, p. 103-115, 2019.

Mazzeo, N.; Paerl, H.; Scheffer, M.; et al. MEERHOFF, M. et al. Climate change and eutrophication feedbacks: revisiting the allied attack concept and how to strike back. *Inland Waters*, v. 12, n. 2, p. 187-204, 2022.

MENDONÇA, Paulo C.Lagoa Santa, sua história e sua gente. Lagoa Santa, MG: Edições Garimpo, 2006.

PEREIRA, P. S.; FERNANDES, L. A. C.; OLIVEIRA, J. L. M.; BAPTISTA, D. F. Avaliação da integridade ecológica de rios em áreas do zoneamento ecológico econômico do complexo hidrográfico Guapiaçu-Macacu, RJ, Brasil. Ambi-Agua, Taubaté, v. 7, n. 1, p. 157-168, 2012.

PEREIRA, R.S. Identificação e caracterização das fontes de poluição em sistemas hídricos. Revista Eletrônica de Recursos Hídricos, Porto Alegre, v. 1, n. 1, p. 20-36, jul./dez. 2004

Prefeitura de Lagoa Santa. Disponível em <https://www.lagoasanta.mg.gov.br/turismo-cultura-o-queconhecer/orla-da-lagoa-central?showall=1> Acesso em 27 de setembro de 2024.

PROUS, A.; FOGAÇA, E. & RIBEIRO, L. 1998. Patrimônio arqueológico. In: APA Carste de Lagoa Santa – Patrimônio Espeleológico, Histórico e Cultural. Belo Horizonte, CPRM/IBAMA. 22 p., anexos e mapas. (Série APA Carste de Lagoa Santa, volume III).Prous et al, 1998.

RAJOVIĆ, Goran; BULATOVIĆ, Jelisavka. Eco Tourism with Special Review on Eco-Village" Štavna. Scientific Electronic Archives, v. 8, n. 1, p. 56-65, 2015.

ROCK, T.; et al. Spatiotemporal drivers of water quality and phytoplankton in an aquatic system. Environmental Monitoring and Assessment, 2025. DOI: https://doi.org/10.1007/s10661-025-14258-1.

RODRIGUES, Alessa Fernanda de O. et al. Ocorrências registradas pela Polícia Militar de Meio Ambiente em uma região do Centro-oeste de Minas Gerais-Brasil. Scientific Electronic Archives, v. 15, n. 5, 2022.

SILVA, Eduardo Gomes da Silva Gomes et al. Invertebrados marinhos como biomarcadores de fármacos. Scientific Electronic Archives, v. 14, n. 5, p. 79-84, 2021.

Simeonov, V., Stratis, J. A., Samara, C., Zachariadis, G., Voutsa, D., Anthemidis, A., & Kouimtzis, T. (2003). Assessment of the surface water quality in Northern Greece. Water research, v. 37, n. 17, p. 4119-4124.

SOUSA, Ana Luiza; RIZZATTO, Márcia Luzia. Produção de biogás a partir de resíduos orgânicos: uma revisão. Scientific Electronic Archives, v. 15, n. 2, 2022.

Souza, Mariana Farias de. Qualidade da água do Canal São Gonçalo-RS/Brasil – uma avaliação hidroquímica considerando seus usos múltiplos. 2015. 104f. Dissertação (Mestrado em Recursos Hídricos) – Programa de Pós-Graduação em Recursos Hídricos, Centro de Desenvolvimento Tecnológico, Universidade Federal de Pelotas, Pelotas, 2015.

TATAGIBA, Sandro Dan et al. Inventário quali-quantitativo da arborização na avenida Perimetral de acesso viário ao centro urbano do município de Tucuruí, Pará. Scientific Electronic Archives, v. 15, n. 7, 2022.

TATAGIBA, Sandro Dan et al. Qualidade limnológica da água em ambiente de criação de tambaqui em tanques-rede no reservatório da Usina Hidrelétrica de Tucuruí. Scientific Electronic Archives, v. 15, n. 2, 2022.

VAZ, Mafalda Mendes Nunes. Remoção de fosfatos e reutilização de água: atividades para o ensino e aprendizagem de Ciências numa perspetiva de Educação Ambiental. Scientific Electronic Archives, v. 15, n. 4, 2022.

Wang XY, Pan BZ, Wang LX, Liu TJ, Liao ZL, Han X, Yang ZJ. [Water Environment Characteristics and Water Quality Assessment of Typical Lakes in Inner Mongolia]. Huan Jing Ke Xue. 2023 Dec 8;44(12):6744-6753. Chinese. doi: 10.13227/j.hjkx.202212207. PMID: 38098400.