IMPACTO CIENTÍFICO EDITORA

ENVIRONMENTAL QUALITY ASSESSMENT OF THE UBERABINHA RIVER-MG USING A RAPID ASSESSMENT PROTOCOL, BIOINDICATORS AND PHYSICOCHEMICAL WATER QUALITY PARAMETERS

AVALIAÇÃO DA QUALIDADE AMBIENTAL DO RIO UBERABINHA-MG UTILIZANDO PROTOCOLO DE AVALIAÇÂO RÀPIDA, BIOINDICADORES E PARÂMETROS FISICO-QUIMICOS DA QUALIDADE DA ÁGUA

EVALUACIÓN DE LA CALIDAD AMBIENTAL DEL RÍO UBERABINHA-MG UTILIZANDO UN PROTOCOLO DE EVALUACIÓN RÁPIDA, BIOINDICADORES Y PARÁMETROS FISICOQUÍMICOS DE LA CALIDAD DEL AGUA

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ABSTRACT

Urbanization processes have been causing various impacts on aquatic ecosystems. The purpose of this research was to assess the environmental quality of the Uberabinha River in the municipality of Uberlândia, Minas Gerais, at three sampling points. The purpose of this research was to assess the environmental quality of the Uberabinha River upstream and downstream of the municipality of Uberlândia, Minas Gerais. The research consisted of applying a rapid assessment protocol for habitat diversity, studying benthic macroinvertebrates using the adapted Biological Monitoring Working Party (BMWP) Index, and assessing the physical and chemical parameters of the water. The water samples collected were evaluated for temperature, pH, color, turbidity, conductivity, and dissolved oxygen. The values of the parameters obtained at the three points and in the two collections remained in accordance with CONAMA Resolution 357/2005, with the exception of color, which was higher than the established value in all samples. Only the point upstream of the municipality presented benthic macroinvertebrates sensitive to pollution. With the results of the rapid assessment protocol applied to the analyzed sections of the river, it was possible to verify that both fell into the altered section category. The results obtained show that the water quality of the river changes from upstream to downstream of the city, leading to the conclusion that the Uberabinha River is suffering significant anthropogenic interference, both in the rural area upstream and in the urban area downstream of the municipality, presenting a situation that requires greater control and investigation to restore the environmental quality of this ecosystem.

Keywords: Lotic Ecosystem. Habitat Diversity. Benthic Macroinvertebrates.

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RESUMO

Os processos de urbanização vêm causando diversos impactos nos ecossistemas aquáticos. A proposta desta pesquisa foi efetuar a avaliação da qualidade ambiental do rio Uberabinha no município de Uberlândia - MG, em três pontos de amostragem. A proposta desta pesquisa foi efetuar a avaliação da qualidade ambiental do Rio Uberabinha a montante e a jusante do município de Uberlândia - MG. A pesquisa constou da aplicação de um protocolo de avaliação rápida da diversidade de habitats, do estudo dos macroinvertebrados bentônicos com o uso do Indice Biological Monitoring Working Party- BMWP adaptado e das avaliações dos parâmetros físico-químicos da água. Foram avaliados para as amostras de água coletadas temperatura, pH, cor, turbidez, condutividade e oxigênio dissolvido. Os valores dos parâmetros obtidos nos três pontos e nas duas coletas realizadas permaneceram de acordo com a Resolução CONAMA 357/2005, com exceção da cor que foi superior ao valor estabelecido em todas as amostragens. Apenas o ponto a montante do município apresentou macroinvertebrados bentônicos sensíveis à poluição. Com o resultado da aplicação do protocolo de avaliação rápida nos trechos analisados do rio foi possível constatar que ambos se enquadraram na categoria de trecho alterado. Observa-se com os resultados obtidos que a qualidade da água do rio altera de montante a jusante da cidade, concluindo-se que o Rio Uberabinha está sofrendo interferências antrópicas significativas, tanto na zona rural a montante, como na zona urbana a jusante do município, apresentando uma situação que requer maior controle e investigações para reestabelecer a qualidade ambiental desse ecossistema.

Palavras-chave: Ecossistema Lótico. Diversidade de Habitats. Macroinvertebrados Bentônicos.

RESUMEN

Los procesos de urbanización han causado diversos impactos en los ecosistemas acuáticos. El propósito de esta investigación fue evaluar la calidad ambiental del río Uberabinha en el municipio de Uberlândia, Minas Gerais, en tres puntos de muestreo. El propósito de esta investigación fue evaluar la calidad ambiental del río Uberabinha aguas arriba y aguas abajo del municipio de Uberlândia, Minas Gerais. La investigación consistió en aplicar un protocolo rápido de evaluación de la diversidad del hábitat, estudiar los macroinvertebrados bentónicos utilizando el Índice adaptado del Grupo de Trabajo de Monitoreo Biológico (BMVP) y evaluar los parámetros físicos y químicos del agua. Se evaluaron la temperatura, el pH, el color, la turbidez, la conductividad y el oxígeno disuelto de las muestras de agua colectadas. Los valores de los parámetros obtenidos en los tres puntos y en las dos recolecciones realizadas se mantuvieron de acuerdo con la Resolución CONAMA 357/2005, con excepción del color, que excedió el valor establecido en todos los muestreos. Solo el punto aguas arriba del municipio presentó macroinvertebrados bentónicos sensibles a la contaminación. El protocolo de evaluación rápida aplicado a los tramos fluviales analizados reveló que ambos tramos se encontraban en la categoría de alteración. Los resultados muestran que la calidad del agua del río cambia aguas arriba y aguas abajo de la ciudad. Se concluye que el río Uberabinha está experimentando una importante interferencia antropogénica, tanto en la zona rural aguas arriba como en la zona urbana aguas abajo del municipio. Esta situación requiere mayor monitoreo e investigación para restaurar la calidad ambiental de este ecosistema.

Palabras clave: Ecosistema Lótico. Diversidad de Hábitat. Macroinvertebrados Bentónicos.

1 INTRODUCTION

Monitoring water quality through the quantification of physical and chemical parameters is of great importance for the environmental management of urban rivers. **However, it has become increasingly common to combine other assessment methods.** Rapid Habitat Assessment Protocols are resources that can be used to establish connections between humans and their surrounding environment, serving as important tools in environmental science. They aggregate environmental quality indicators related to the physical and biological aspects of the river ecosystem, which can be used as instruments for water resource assessment.

Biological monitoring, in turn, has proven to be highly effective, as it uses communities intrinsically linked to the aquatic environment as indicators of pollution levels. These communities are capable of detecting disturbances that occurred long before sample collection, allowing an analysis of the ecosystem's prior condition. The distribution of benthic macroinvertebrates is influenced by the characteristics of the habitat in which they are found. Therefore, these organisms are widely used as bioindicators of water quality, since under specific environmental conditions, such as signs of pollution, the most resistant groups may become dominant while the most sensitive groups may become rare or absent (COSTA et al., 2024). Metrics based on benthic macroinvertebrates, such as the Biological Monitoring Index of the Zio Basin (MMIZB), the Average Score per Taxon (ASPT), and the Biological Monitoring Index (BMWP), are robust for discriminating pressure gradients and sensitive to detecting variations in water quality and human disturbances (ZHANG et al., 2021).

Additionally, the taxonomic and functional diversity of benthic macroinvertebrates in freshwater ecosystems is influenced by environmental factors such as the presence of nutrients, heavy metals, biocides, sewage, and fine sediments. The composition of these communities can vary significantly in response to these factors, reflecting the impact of human activities on urban aquatic ecosystems (LEE et al., 2022).

The objective of this study was to assess the environmental quality of the Uberabinha River, located in the municipality of Uberlândia, Minas Gerais, using the Rapid Habitat Diversity Assessment Protocol proposed by Callisto et al. (2002), the biomonitoring technique using benthic macroinvertebrates as bioindicators, and water physical-chemical parameters.

2 THEORETICAL REFERENCE

Water quality assessment is an essential element for environmental planning and

management of water resources, especially in urban environments subject to intense anthropogenic pressure. According to Costa et al. (2024), monitoring physical-chemical parameters allows for the identification of environmental changes and understanding of the impacts of urbanization on aquatic ecosystems. CONAMA Resolution No. 357/2005 establishes quality standards and the classification of water bodies, guiding comparative analyses and the definition of pollution levels.

Among the main physical-chemical parameters used to characterize water quality are pH, turbidity, electrical conductivity, dissolved oxygen, and apparent color. These indicators allow for the assessment of everything from acidity and available oxygen content to the presence of organic and inorganic compounds that interfere with the environmental quality of the water body (Brazil, 2005). Significant variations in these parameters may reflect the discharge of domestic and industrial effluents, erosion of the banks, and the absence of riparian vegetation, which are common factors in urban watersheds.

In addition to physical-chemical analyses, the use of bioindicators has proven to be an effective tool in environmental diagnosis. Benthic macroinvertebrates are widely used in this type of study because they have different levels of tolerance to pollution and respond to environmental changes in an integrated manner over time. Organisms of the orders Plecoptera, Ephemeroptera, and Trichoptera are considered sensitive to pollution, while Chironomidae and Oligochaeta are more tolerant and may indicate degraded environments (Mugnai et al., 2010; Callisto et al., 2002).

The Biological Monitoring Working Party (BMWP) index, adapted to the Brazilian context, is often applied to assess the diversity and presence of macroinvertebrate families, assigning scores according to their sensitivity to pollution (Costa et al., 2006). This index, combined with physical-chemical analyses, allows for a more comprehensive understanding of the ecological conditions of the water body.

Another widely used complementary method is the Rapid Habitat Diversity Assessment Protocol (PAR), proposed by Callisto et al. (2002). This protocol brings together physical and biological parameters of the river ecosystem and enables a qualitative analysis of the environmental integrity of river sections. The combination of rapid assessment protocols, biomonitoring, and physical-chemical analyses therefore represents an integrated and efficient approach to diagnosing the environmental quality of urban rivers, as evidenced in studies conducted on the Uberabinha River in Uberlândia (MG).

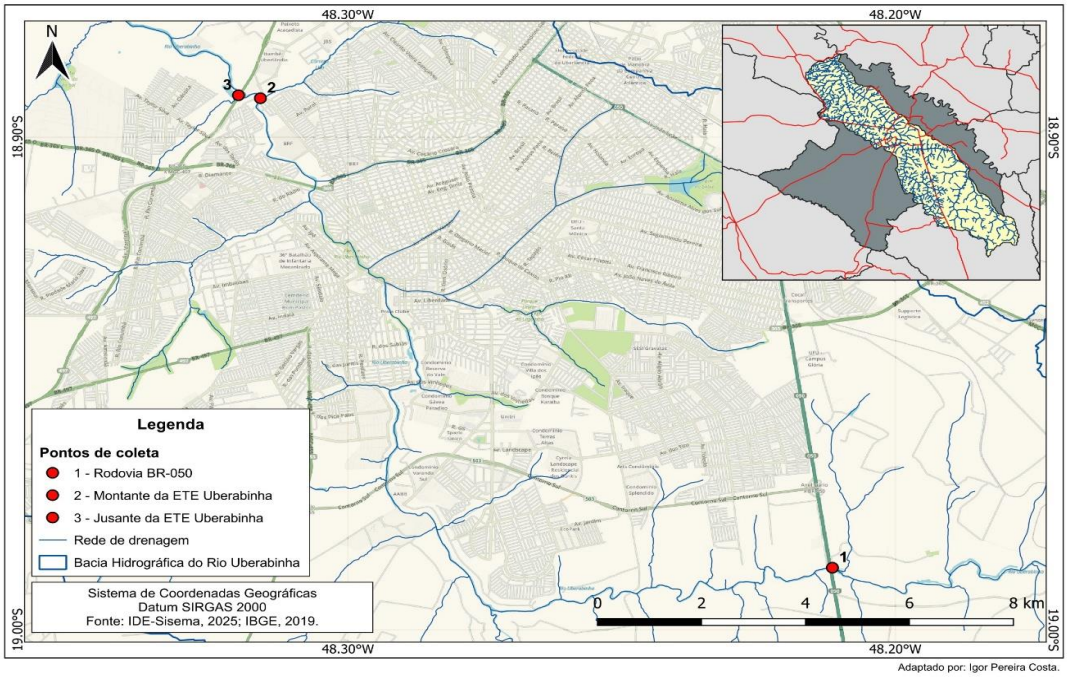
3 METHODOLOGY

In this study, three points were evaluated at different sections of the Uberabinha River, within the municipality of Uberlândia. To select the sampling points, areas showing degradation and anthropic interference were sought, and three points were identified for water collection, obtaining their geographic coordinates using the Global Positioning System (GPS). The location of the points in relation to the city of Uberlândia can be seen in Figure 1. Point 1 has coordinates S 18.987361º and W 48.211511º, point 2 has coordinates S 18.89205º and W 48.31600º, and point 3 has coordinates S 18.89147º and W 48.31996°.

Point 1 is located at a point where the Uberabinha River, despite being within the urban perimeter of the municipality of Uberlândia, is not yet within the city. Point 2 is located on a part of the river that passed through the city, and point 3 is located after the municipality's industrial district.

Figure 1

Location of the three sampling points on the Uberabinha River - MG



Source: Adapted from Costa, I.P., 2025

In assessing the quality of the physical habitat, the Rapid Habitat Diversity Assessment Protocol proposed by Callisto et al. (2002) was applied, adapted from the protocols proposed by the Ohio Environmental Protection Agency (EPA, 1987) and Hannaford et al. (1997). This

protocol consists of two tables, comprising a total of 22 parameters. The first table has 10 parameters that assess the characteristics of the segments and the level of environmental impacts due to anthropogenic activities, with scores ranging from 0 to 4 points. The second table consists of the remaining 12 parameters and seeks to analyze habitat conditions and the level of conservation of the natural conditions of the environment, with scores ranging from 0 to 5 points. Each parameter is scored based on observation of habitat conditions, and the final score is obtained from the sum of the scores assigned to each parameter. According to Callisto et al. (2002), the final score is relative to the level of preservation of the ecological conditions of the segments studied.

The impacted sections have a final score of 0 to 40 points, the altered sections from 41 to 60 points, and those considered natural have a score above 61 points.

In the assessment of benthic macroinvertebrates, a sediment sample was collected at the three points analyzed using a 30x30 cm Surber-type collector with a 250 µm mesh, with agitation of the delimited substrate for one minute. After collection, the sediment retained in the sampler net was stored in plastic bags, preserved in 70º GL alcohol, and transported to the Microbiology Laboratory of the Federal University of Uberlândia, where the samples were processed. The sediment was placed in a system of three metal sieves for washing and then in plastic trays. The separation of the organisms occurred in two stages. First, with the naked eye, where the larger ones were separated, and then using a stereoscopic microscope. The collected organisms were stored in small plastic bottles, labeled, and preserved in alcohol. Subsequently, the macroinvertebrates were identified to the family level using specific identification keys (Costa et al., 2006; Mugnai et al., 2010). To calculate the diversity index of benthic macroinvertebrate families at the water collection points, the BMWP biotic index adapted for the Uberabinha River basin was used (VASCONCELOS, 2015).

For the inorganic parameters, two collections were made, the first in June, considered the dry season, and the second in February, the rainy season. The water samples were collected and stored based on the technical standards of the Brazilian Association of Technical Standards (ABNT) and were evaluated at the Environmental Quality Laboratory of the Federal University of Uberlândia. The physical parameters pH, color, turbidity, conductivity, and dissolved oxygen were measured by the electrometric method, in accordance with the respective ABNT standards. The comparison of the parameters related to fresh water investigated in this study was carried out using CONAMA Resolution No. 357/2005, which provides for the classification of water bodies and environmental guidelines

for their classification, as well as establishing the conditions and standards for the discharge of effluents (Brazil, 2005).

4 RESULTS AND DISCUSSIONS

Table 1 lists the results of the rapid assessment protocol, with the first point being natural and the other two points altered.

Table 1

Results of the application of the Rapid Habitat Diversity Assessment Protocol

Parameters	Point 1	Point 2	Point 3
Type of land use along the riverbanks	4	4	4
Erosion near or along the riverbanks and siltation in the riverbed	2	0	2
Anthropogenic alterations	4	2	
Vegetation cover in the riverbed	4	2	2
Water odor	4	2	2
Water oiliness (presence of oil)	4	2	2
Water transparency	4	2	2
Bottom sediment odor	4	2	2
Bottom oiliness (presence of oil)	4	4	2
Type of riverbed substrate	2	4	4
Habitat diversity	3	2	2
Extent of rapids	3	3	2
Frequency of rapids	2	5	2
Substrate type	3	3	2
Silt deposition	0	2	0
Sediment deposits	2	3	0
Alteration of the river channel	5	3	3

Water flow characteristics	5	5	5
Presence of riparian forest	0	0	0
Bank stability	3	2	5
Riparian vegetation extent	0	0	0
Presence of aquatic plants	0	0	0
SUM	**62**	**51**	**43**

Source: authorial, 2025

Table 2 shows the results for the quantity of macroinvertebrates.

Table 2

Quantity of benthic macroinvertebrates found at the Uberabinha River sampling points during the first collection

Class	Order	Family	Point 1	Point 2	Point 3
	Diptera	Chironomidae	-	42	25
	Trichoptera		15	-	-
Oligochaeta			2	4	15
Gastropoda			-	-	4
Hirudina			-	3	4
Nematomorpha			-	-	2

Source: authorial, 2025

The analysis of benthic macroinvertebrates from the river was conducted at the Microbiology Laboratory of the Federal University of Uberlândia. At sampling station 1, a total of 17 organisms were collected; at station 2, 48 benthic organisms were identified; and at station 3, 50 organisms were collected. Benthic organisms belonging to the order Diptera are known for their high tolerance to pollution. Taxa from the orders Gastropoda, Hirudinea, and Nematomorpha also exhibit resistance to polluted environments. Individuals of the class Oligochaeta represent the main indicator of pollution at station 3, whereas station 1 was the only site presenting pollution-sensitive taxa, specifically from the order Trichoptera. This result was expected, since station 1 is located upstream of the city of Uberlândia, station 2 within the urban area, and station 3 downstream of the industrial district.

Figure 2

Photograph of the first sampling site

Source: Environmental Management and Quality Research Group Collection, 2025.

Figure 3

Photograph of the second sampling site

Source: Environmental Management and Quality Research Group Collection, 2025.

Figure 4

Photograph of the third sampling site

Source: Environmental Management and Quality Research Group Collection, 2025.

During the second sampling campaign, no benthic macroinvertebrates were recorded, which can be attributed to climatic and seasonal factors, as the river was in a flood stage and, in some sections, even overflowing.

Table 3

Results of inorganic parameters evaluated in collection 1 and collection 2 at the three points of the Uberabinha River and values established by CONAMA Resolution 357/2005

SAMPLES/PARAMETERS	Coleta 1			Coleta 2			CONAMA 357/2005
	Point 1	Point 2	Point 3	Point 1	Point 2	Point 3	
pH	6,57	6,82	6,49	6,38	6,65	6,42	6,0 – 9,0
Color (mg Pt/L)	490	464	500	492	430	520	<75,0
Turbidity (UNT)	7,02	7,93	11,24	23,46	25,39	44,5	<100
Conductivity (µS/cm)	92	104,4	110,3	90,9	89,28	96,5	-
OD (mg/L)	5,90	5,88	5,93	5,92	5,89	5,91	>5,0
Water temperature (°C)	20	21	20	21	22	22	<40

Air temperature (°C)	26,5	24	25	25	25,4	26	<40

The pH, turbidity, and temperature parameters are lower than those established by CONAMA Resolution 357/2005 for class 2. The color parameter at all collection points was higher than the maximum established value.

5 CONCLUSION

Benthic organisms can be used as bioindicators, with the least resistant to pollution and most resistant groups being, respectively: Plecoptera, Ephemeroptera, Trichoptera, Chironomida, and Oligochaeta. Point 1, as it is the only one to present benthic organisms sensitive to pollution and to obtain the highest score in the rapid habitat diversity assessment protocol, has the best water quality among the three points. The physical-chemical parameters assessed remained within the values established by CONAMA Resolution 357/2005 for class 2 freshwater, with the exception of color. Based on the various assessment methods used, it is considered that the river is undergoing a process of degradation from point 1 to point 3. The degradation process directly affects the water quality of the river, the local population, and the animals that depend on this aquatic ecosystem. Therefore, it is important to continue monitoring this body of water, and it is hoped that effective actions will be taken by the relevant sectors to halt the degradation process, ensuring the preservation and conservation of the water quality of the Uberabinha River in the region.

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