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WATER QUALITY OF THE CAÇADOR RIVER (SC) AND CONTRIBUTIONS TO ACHIEVING SDG 6 TARGETS IN URBAN AREAS

QUALIDADE DA ÁGUA DO RIO CAÇADOR (SC) E CONTRIBUIÇÕES PARA O ALCANCE DE METAS DO ODS 6 EM ÁREA URBANA

CALIDAD DEL AGUA DEL RÍO CAÇADOR (SC) Y CONTRIBUCIONES AL LOGRO DE LAS METAS DEL ODS 6 EN ÁREAS URBANAS

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ABSTRACT
Water quality is strongly influenced by human activities, particularly urbanization and the discharge of untreated effluents. In this context, this study aimed to assess the water quality of the Caçador River, located at Caçador (SC, Brazil). Sampling was conducted at six sites along the river course between February and April 2024. Analyses included physicochemical and biological parameters, as well as the calculation of the National Sanitation Foundation Water Quality Index (NSF-WQI). The results revealed significant spatial variation in parameters such as DO, BOD, TP, turbidity, and thermotolerant coliforms, indicating an increase in organic load and contaminants in areas closer to the urban perimeter. The NSF-WQI values ranged from 85.27 (“excellent”) to 68.95 (“good”), showing a gradual deterioration in water quality from upstream to downstream. Although the results still comply with CONAMA Resolution No. 357/2005 for Class 2 water bodies, evidence of eutrophication and reduced self-purification capacity was observed, associated with intensified anthropogenic pressures.

Keywords: Water Quality. WQI. Water Resource.

RESUMO
A qualidade da água é fortemente influenciada pelas atividades humanas, especialmente pela urbanização e pelo lançamento de efluentes sem tratamento adequado. Nesse contexto, o presente estudo teve como objetivo avaliar a qualidade da água do Rio Caçador,

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localizado no município de Caçador (SC - Brasil). As coletas foram realizadas em seis pontos distribuídos ao longo do curso do rio, entre fevereiro e abril de 2024. As análises foram realizadas por meio da análise de parâmetros físico-químicos e biológicos e do cálculo do Índice de Qualidade da Água (IQANSF). Os resultados indicaram variação espacial significativa em parâmetros como OD, DBO, FT, TU e CTS, evidenciando o aumento da carga orgânica e de contaminantes nas áreas mais próximas ao perímetro urbano. O IQANSF variou entre 85,27 ("ótimo") e 68,95 ("bom"), demonstrando tendência de deterioração gradual da qualidade hídrica no sentido montante–jusante. Conclui-se que, embora os valores ainda atendam à Resolução CONAMA nº 357/2005 para corpos d'água de classe 2, há indícios de eutrofização e redução da capacidade de autodepuração, relacionados à intensificação das pressões antrópicas.

Palavras-chave: Qualidade da Água. IQA. Recurso Hídrico.

RESUMEN
La calidad del agua está fuertemente influenciada por las actividades humanas, especialmente por la urbanización y el vertido de efluentes sin tratamiento adecuado. Por lo tanto, el presente estudio tuvo como objetivo evaluar la calidad del agua del Río Caçador, ubicado en el municipio de Caçador (SC – Brasil). Las muestras se recolectaron en seis puntos distribuidos a lo largo del curso del río, entre febrero y abril de 2024. Los análisis incluyeron parámetros fisicoquímicos y biológicos, así como el cálculo del Índice de Calidad del Agua (IQANSF). Los resultados indicaron una variación espacial significativa en parámetros como OD, DBO, FT, TU y CTS, evidenciando el aumento de la carga orgánica y de contaminantes en las áreas más próximas al perímetro urbano. El IQANSF varió entre 85,27 ("óptima") y 68,95 ("buena"), demostrando una tendencia de deterioro gradual de la calidad del agua en el sentido aguas arriba–aguas abajo. Se concluye que, aunque los valores aún cumplen con la Resolución CONAMA nº 357/2005 para cuerpos de agua de clase 2, existen indicios de eutrofización y reducción de la capacidad de autodepuración, relacionados con la intensificación de las presiones antrópicas.

Palabras clave: Calidad del Agua. ICA. Recurso Hídrico.

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1 INTRODUCTION

Human activities, regardless of their scale, exert negative impacts on the environment, mainly due to inadequate management and conservation practices (Wendling et al., 2018; Campos; Moretto, 2025; Campos; Pavelski, 2025; Campos; Pagioro, 2025a). Land use and occupation, at different intensities, directly affect the quality of water resources, as they alter natural conditions of infiltration, runoff, and recharge within watersheds (Novicki; Campos, 2016; Campos, 2025; Campos; Reichardt, 2025a, 2025b, 2025c, 2025d). This process is closely linked to the depletion of natural resources, highlighting the need for sustainable management measures to ensure the conservation of aquatic and terrestrial ecosystems (Campos; Borga; Vazquez, 2017b).

Water pollution stands out as one of the most pressing contemporary environmental challenges, which has intensified over centuries and is now clearly evident in watersheds around the world (Gardiman Junior, 2015; Ribeiro; Vargas, 2016; Campos et al., 2017; Pereira et al., 2020; Silveira et al., 2022; Alves et al., 2023; Ruckert; Harres, 2025). In South America, particularly in Brazil, transformations in hydrological systems have been accelerated by industrial expansion, unplanned urbanization, and rapid population growth (Barbosa; Araújo, 2013; Viscard Junior; Campos, 2022; Campos; Barcarolli, 2023; Campos et al., 2023; Rodrigues; Minoti; Alves, 2024).

These transformations generate anthropogenic pressures on water bodies through activities such as industrial effluent discharge, inadequate wastewater management, intensive agriculture, and mining (Campos; Oliveira, 2024; Campos; Pagioro, 2025b). Such factors compromise the quality of both surface and groundwater, affecting ecological balance and the availability of water resources for multiple uses (Fraga et al., 2021; Silveira et al., 2022; Campos et al., 2023; Campos et al., 2025a, 2025b). The discharge of untreated domestic and industrial effluents represents one of the main threats to aquatic life and water potability, directly undermining the sustainability of water resources (Campos; Zir, 2024; Borga; Campos; Ribeiro, 2018; Campos Pagioro, 2024).

The preservation of water quality constitutes a global challenge, as contamination affects not only aquatic ecosystems but also public health and water security. In Brazil, deficiencies in sewage collection and treatment systems remain evident in many municipalities (Silva Filho, 2025). In the state of Santa Catarina, a considerable portion of the population still depends on rudimentary cesspits or low-efficiency individual systems, which favor the infiltration and discharge of effluents into water bodies (Wendling et al., 2018; Borga;

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Campos; Ribeiro, 2018). This situation intensifies environmental degradation and increases sanitary risks, highlighting the urgency of implementing integrated policies and actions aimed at the universalization of basic sanitation services (Toledo et al., 2021).

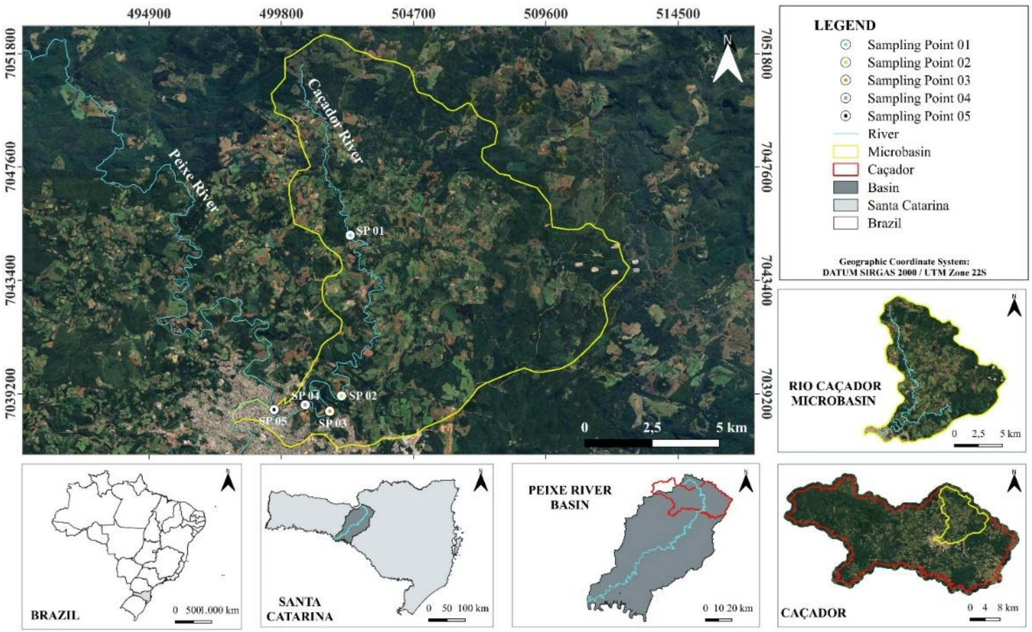
Therefore, the analysis of water quality and the improvement of effluent management are directly aligned with Sustainable Development Goal 6 (SDG 6), which seeks to "ensure availability and sustainable management of water and sanitation for all." Achieving this goal is essential to promoting healthy, resilient, and ecologically balanced urban environments (Lima et al., 2025; Andrade; Carvalho; Branchi, 2025) in accordance with the principles of the One Health approach, a process that depends on the continuous environmental monitoring of water quality (Drose et al., 2020). Accordingly, this study aims at analyzing the water quality of the Caçador River, located at Caçador, Santa Catarina, through physicochemical and biological assessments.

2 MATERIALS AND METHODS

The study was carried out on the Caçador River, one of the main tributaries of the Peixe River, located within the urban area of Caçador town, in the state of Santa Catarina, Brazil (Figure 1; Table 1).

Figure 1

Location of the study area in Caçador, Santa Catarina, Brazil



Source: Elaborated by the authors.

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The Caçador River holds great significance for the municipality under study, as its name inspired that of the city itself. It is an important watercourse within the Peixe River watershed, playing a fundamental role in local drainage and environmental dynamics. The Caçador River Microbasin (MBRC) is located in the northeastern portion of the municipal territory, encompassing nearly the entire area of Caçador (SC) (Zago; Paiva, 2016). Its drainage area covers approximately 119.32 km², making it a key component of the region's hydrographic and ecological framework.

Table 1

Sampling points for water quality analysis

GEOGRAPHIC COORDINATES			
Points	**Longitude (S)**	**Latitude (W)**	**Altitude (m)**
SP 1	26°42'55.91"	50°58'34.84"	1027
SP 2	26°46'9.27"	50°58'46.35"	953
SP 3	26°46'27.91"	50°59'2.16"	933
SP 4	26°46'20.13"	50°59'35.15"	915
SP 5	26°46'25.88"	51° 0'16.84"	893

Source: Elaborated by the authors.

The samples were collected in 1-liter amber bottles during the morning period (between 6:00 a.m. and 8:00 a.m.), following the recommendations of NBR 9898 (Associação Brasileira de Normas Técnicas – [ABNT], 1987).

Three sampling campaigns were carried out in February, March, and April 2024. In situ analyses included pH, temperature (T), and dissolved oxygen (DO), measured using a multiparameter probe (AK88, AKSO), and turbidity (TU), determined with a digital turbidimeter (Mylabor, Tu430).

In the laboratory of the Alto Vale do Rio do Peixe University (UNIARP), the following parameters were analyzed in triplicate: total solids (TS), total coliforms (TC), thermotolerant coliforms (TTC), total phosphorus (TP), biochemical oxygen demand ($BOD_{5,20}$), ammonia ($N\text{-}NH_4^+$), nitrite ($N\text{-}NO_2^-$), and nitrate ($N\text{-}NO_3^-$), according to the methodologies described in Standard Methods for the Examination of Water and Wastewater (APHA, 2017).

For the environmental monitoring, the Water Quality Index established by the National Sanitation Foundation (NSF-WQI) was applied, as expressed in Equation 1 (Brown et al.,

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1970). The index includes the parameters DO, $BOD_{5,20}$, T, TP, $N\text{-}NO_3^-$, TU, TS, and TTC, as shown in Table 2.

$$\mathbf{WQI} = \prod_{i=1}^{n} \mathbf{qi}^{\mathbf{wi}}$$

$$\mathbf{WQI} = (q_{DBO}/100)^{W}DBO^{*}(q_{OD}/100)^{W}OD^{*}q_{N}/100)^{W}N \ldots \quad (1)$$

Where:

WQI: Water Quality Index, a value ranging from 0 to 100;

q_i: quality rating of the i-th parameter, ranging from 0 to 100;

w_i: elative weight assigned to the i-th parameter (ranging from 0 to 1), according to its importance in the overall water quality assessment.

Table 2

Relative weights of parameters used in the calculation of the NSF-WQI

PARAMETERS	RELATIVE WEIGHT (wi)
Dissolved Oxygen	0,17
Thermotolerant Coliforms	0,16
pH	0,11
Biochemical Oxygen Demand	0,11
Total Phosphate	0,10
Temperature	0,10
Nitrate	0,10
Turbidity	0,08
Total Solids	0,07

Source: Brown et al. (1970).

Based on the calculated values, the results were compared with the water quality classification of the receiving water body that receives industrial effluents, as defined by the NSF-WQI and parameterized according to Table 3.

Table 3

Water quality classification according to the NSF-WQI

CATEGORY	RANGE
Excellent	80<WQI≤100

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Good	52< WQI ≤79
Fair	37< WQI ≤51
Poor	26< WQI ≤36
Very Poor	0< WQI ≤25

Source: Brown et al. (1970).

The results were also compared with CONAMA Resolution No. 357/2005 (Brazil, 2005) to determine the classification of the water body. For each analyzed parameter, differences among the experimental group means were assessed using analysis of variance (ANOVA), followed by Duncan's multiple range test at a 5% significance level.

3 RESULTS AND DISCUSSION

Table 4 presents the mean values and standard deviations of the physicochemical and microbiological parameters measured at the five sampling points, along with lettrs indicating significant differences determined by Duncan's multiple range test ($p \leq 0.05$).

Table 4

Statistical analysis of water quality monitoring (n = 3): Biochemical Oxygen Demand (BOD). Mean values followed by the same uppercase letter as a subscript do not differ significantly according to Duncan's multiple range test ($p \leq 0.05$)

PARAMETER	UNIT	POINT 01	POINT 02	POINT 03	POINT 04	POINT 05
pH	-	6,10 ± 0,20 ^{A}	6,53 ± 0,12 ^{A}	6,55 ± 0,20 ^{A}	6,10 ± 0,21 ^{A}	7,70 ± 0,33 ^{B}
Temperature	°C	19,10 ± 0,50 ^{A}	19,91 ± 0,40 ^{A}	19,10 ± 0,32 ^{A}	19,10 ± 0,42 ^{A}	19,10 ± 0,47 ^{A}
Dissolved Oxygen	mg/L	7,30 ± 0,22 ^{A}	7,20 ± 0,21 ^{A}	6,50 ± 0,17 ^{B}	6,30 ± 0,17 ^{A}	6,00 ± 0,20 ^{B}
Total Solids	mg/L	0,90 ± 0,11 ^{A}	1,10 ± 0,40 ^{A}	2,50 ± 0,45 ^{B}	2,90 ± 0,31 ^{A}	2,35 ± 0,59 ^{B}
Total Coliforms	MPN/100mL	60,00 ± 8,00 ^{A}	482,00 ± 10,00 ^{B}	680,00 ± 30,00 ^{B}	980,00 ± 50,00 ^{C}	2481,67 ± 2,89 ^{C}
Thermotolerant Coliforms	MPN/100mL	10,00 ± 2,00 ^{A}	805,00 ± 14,00 ^{B}	950,00 ± 42,00 ^{B}	972,00 ± 0,58 ^{C}	1783,33 ± 115,47 ^{C}
Total Phosphorus	mg/L	0,89 ± 0,20 ^{A}	1,55 ± 0,27 ^{AB}	2,30 ± 0,35 ^{B}	2,89 ± 0,43 ^{C}	3,80 ± 0,57 ^{D}
$BOD_{5,20}$	mg/L	1,65 ± 1,10 ^{A}	2,35 ± 0,50 ^{B}	2,76 ± 0,10 ^{C}	2,65 ± 0,44 ^{C}	3,96 ± 0,60 ^{D}
Ammonia	mg/L	1,10 ± 0,15 ^{A}	1,25 ± 0,29 ^{A}	1,32 ± 0,48 ^{A}	1,10 ± 0,10 ^{A}	2,97 ± 0,74 ^{B}
Nitrite	mg/L	1,52 ± 0,11 ^{A}	1,71 ± 0,42 ^{A}	1,63 ± 0,12 ^{A}	1,52 ± 0,25 ^{A}	1,40 ± 0,63 ^{A}
Nitrate	mg/L	1,01 ± 0,14 ^{A}	1,20 ± 0,10 ^{A}	1,36 ± 0,08 ^{A}	1,01 ± 0,10 ^{A}	1,50 ± 0,20 ^{A}
Turbidity	NTU	7,76 ± 0,59 ^{A}	11,35 ± 0,61 ^{B}	20,53 ± 0,40 ^{B}	26,76 ± 3,00 ^{C}	27,26 ± 1,67 ^{C}
NSF-WQI	Score	85,27 ± 4,27 ^{A}	78,22 ± 0,68 ^{B}	74,03 ± 0,57 ^{B}	71,67 ± 0,68	68,95 ± 0,24 ^{B}

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	Classification	Excellent	Good	Good	Good	Good

Source: Elaborated by the authors.

The pH values remained within the limits established by CONAMA Resolution No. 357/2005 (6.0–9.0), ranging from 6.10 to 7.70, with a significant difference observed only at the downstream point ($p = 0.031$), where an increase in pH was recorded. Temperature remained stable between 19.1 and 19.9 °C, showing no significant difference ($p = 0.814$), indicating thermal homogeneity and the absence of artificial thermal discharges. Similar results were reported by Campos and Pavelski (2025), who recorded mean values of 6.66 ± 0.19 for pH and 11.47 ± 2.24 °C for temperature in the Caçador River during water quality assessments in urban and rural areas. Campos and Barcarolli (2023) reported an average pH of 6.84 and a mean temperature of 18.12 °C in monitoring conducted between March 2016 and April 2017, also in the Caçador Rriver.

Dissolved oxygen (DO) showed a decreasing trend from upstream to downstream, ranging from 7.30 to 6.00 mg/L, with a significant difference ($p = 0.018$). This decline is associated with increased BOD and oxygen consumption during the decomposition of organic matter, which compromises the ecosystem's self-purification capacity. Despite the reduction, the observed values remained above the minimum limit of 5.0 mg/L established for Class 2 water bodies, indicating acceptable oxygenation conditions. Campos and Pavelski (2025) recorded mean DO concentrations of 6.33 ± 0.68 mg/L in the Caçador River, while Campos and Barcarolli (2023) observed 8.29 mg/L in the same river. These findings corroborate the present study, confirming that the water body maintains good oxygenation conditions, although a declining trend is evident in the downstream sections due to increasing organic loads.

Total solids (TS) ranged from 0.90 to 2.90 mg/L, showing a significant difference ($p = 0.027$) and a tendency to increase at points located in more anthropized areas. Campos and Barcarolli (2023) reported an average TS concentration of 1.11 mg/L in the Caçador River, whereas Campos and Pavelski (2025) observed higher values, averaging 47 ± 31.00 mg/L, in the same watercourse.

Microbiological parameters showed a marked increase in total and thermotolerant coliform concentrations, with highly significant differences ($p < 0.001$) among sampling points. This pattern indicates increasing fecal contamination, resulting from domestic effluent discharge and the use of rudimentary septic systems, thereby compromising multiple water uses. According to CONAMA Resolution No. 357/2005, values exceeding 1,000 MPN/100

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mL indicate inadequate sanitary conditions, which were observed in the downstream portions of the river. Previous studies by Campos and Barcarolli (2023) and Campos and Pavelski (2025) also reported high coliform concentrations in the Caçador River, confirming a persistent scenario of microbiological contamination associated with deficiencies in basic sanitation and uncontrolled urban runoff.

Total phosphorus (TP) showed a significant increase, ranging from 0.89 to 3.80 mg/L ($p < 0.001$), indicating inputs of anthropogenic contaminants, possibly linked to domestic effluent discharge and agricultural runoff. In studies conducted within the same watershed, Campos and Moretto (2025) reported average TP concentrations of 0.047 ± 0.101 mg/L in the Caçador River while analyzing the Trophic State Index (TSI) of the Peixe River and its tributaries. Conversely, Campos and Barcarolli (2023) observed higher values, around 1.19 mg/L, in a study on water quality within the urban perimeter of Caçador, indicating signs of nutrient enrichment.

Biochemical oxygen demand ($BOD_{5,20}$) ranged from 1.65 to 3.96 mg/L, with a highly significant difference ($p = 1.42 \times 10^{-12}$). This pattern reflects an increase in biodegradable organic load, evidencing the presence of effluents and organic residues from urban runoff. Campos and Barcarolli (2023) reported an average BOD of 2.43 mg/L during annual monitoring of the Caçador River, while Campos and Pavelski (2025) recorded a mean of 3.15 ± 0.28 mg/L in the same River. Although the values remain below the maximum limit of 5.0 mg/L, the upward trend and the inverse correlation with DO indicate intensified decomposition processes and progressive organic degradation.

Nitrogen compounds exhibited distinct patterns. Ammonia ($N\text{-}NH_4^+$) ranged from 1.10 to 2.97 mg/L, with a significant difference ($p = 0.036$), reflecting the accumulation of nitrogen from organic matter degradation and infiltration of domestic effluents. Nitrite ($N\text{-}NO_2^-$) ranged from 1.40 to 1.72 mg/L ($p = 0.248$) and nitrate ($N\text{-}NO_3^-$) from 1.01 to 1.50 mg/L ($p = 0.312$), with no significant differences, suggesting equilibrium in nitrification and denitrification processes without substantial accumulation of these ions in the water column. Campos and Barcarolli (2023) reported mean concentrations of 0.10 mg/L for ammonia, 0.01 mg/L for nitrite, and 9.58 mg/L for nitrate during water quality monitoring of the Caçador River.

Turbidity increased significantly, from 7.76 to 27.26 NTU ($p = 0.008$), reflecting higher loads of suspended solids and organic matter. Campos and Barcarolli (2023) recorded an average of 22.21 NTU, while Campos and Pavelski (2025) reported 31.01 ± 16.09 NTU in the same river.

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The NSF-WQI demonstrated a significant decline ($p = 0.012$) across sampling points, decreasing from 85.27 ("excellent") upstream to 68.95 ("good") downstream. This reduction corresponds with increasing BOD, TP, and coliform levels, reflecting the cumulative impact of organic and nutrient loads on the aquatic system. Campos and Barcarolli (2023) recorded seasonal WQI values of 54 (autumn), 55.67 (winter), 62.33 (spring), and 58.33 (summer), classifying the Caçador River as fair to good. Similarly, Campos and Pavelski (2025) reported an average WQI of 65.33 ± 12.66, also classified as good. The downward trend of the NSF-WQI aligns with findings from urban watercourses in southern Brazil, where urban expansion and inadequate sanitation contribute to gradual water quality degradation (König et al., 2008; Lopes et al., 2008; Delfes; Parazzoli; Goldbach, 2015; Campos; Borga; Vazquez, 2017a; Gonçalves; Rocha, 2016; Zschornack; Oliveira, 2018; Valentini et al., 2020; Cicilinski; Virgens Filho; Tsukahara, 2021; Taques et al., 2022).

Overall, the results indicate that while most physicochemical parameters remain within the limits established by environmental legislation, microbiological and nutrient indicators reveal a gradual deterioration of water quality downstream. Areas closer to the urban perimeter are directly influenced by diffuse effluent discharges and contaminated surface runoff, which corroborates the study by Oliveira et al. (2023). Consequently, the water body is still predominantly classified as good quality but exhibits signs of environmental degradation that require preventive measures, such as expanding sewage collection and treatment networks, restoring riparian vegetation, and implementing proper stormwater management.

Recent studies highlight that water resources interacting with urban and rural areas of Caçador are significantly impacted by multiple contamination sources from human activities, industrial operations, unplanned urban expansion, and agriculture (Lautert et al., 2019; Campos et al., 2025a, 2025b). Primary vectors of environmental degradation include the discharge of industrial and domestic effluents (Alves et al., 2017; Campos; Borga; Vázquez, 2017; Campos; Borga; Mello, 2017; Tilha et al., 2019; Campos; Barcarolli, 2023; Campos; Moretto, 2025; Campos; Pavelski, 2025; Campos; Oliveira, 2025), fuel station effluents (Campos et al., 2017), inadequate solid waste disposal (Campos, 2025), and the discharge of effluents into stormwater drainage systems (Campos; Kuhn, 2021; Campos; Zir, 2025).

Given this scenario, coordinated action between the public and private sectors in managing urban and rural wastewater is essential. Updating the Municipal Master Plan and

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implementing sustainable land use practices are recommended to mitigate environmental impacts and enhance local water resilience (Borga; Campos; Ribeiro, 2018; Campos; Barcarolli, 2023; Oliveira et al., 2023). Additionally, the development and implementation of the Peixe River Watershed Management Plan, under the coordination of its basin committee, are strategic measures to reduce cumulative and diffuse impacts along the river and its tributaries, including the Caçador River.

As emphasized by Rocha et al. (2025), continuous monitoring of water quality using physicochemical and microbiological indicators is crucial to guide corrective and preventive actions, ensuring the protection of aquatic ecosystems and the sustainable use of water resources. The integration of the present results demonstrates that maintaining water quality depends on the balance between natural self-purification processes and the intensity of anthropogenic pressures. Overall, the findings reinforce the urgency of integrated public policies for environmental management and basic sanitation, aligned with Sustainable Development Goal 6 (SDG 6), which promotes universal access to safe drinking water and sanitation, as well as the protection and restoration of aquatic ecosystems.

4 CONCLUSION

The results of this study indicate that, although most physicochemical and microbiological parameters remain within the limits established by CONAMA Resolution No. 357/2005 for Class 2 water bodies, there are clear signs of gradual deterioration in water quality along the monitored stretch. Observed variations in parameters related to organic load, nutrients, and microbiological contamination highlight the increasing influence of anthropogenic activities in the basin, including the discharge of domestic effluents, urban surface runoff, and irregular land occupation.

The findings point to ongoing eutrophication processes and a reduction in the self-purification capacity of the river, as evidenced by increased BOD, total phosphorus, and coliform concentrations, alongside decreases in dissolved oxygen and NSF-WQI values. Although the water is still classified as “good,” the observed declining trend indicates environmental vulnerability, requiring immediate attention in urban planning, sanitation, and integrated water resources management.

In this context, strengthening continuous environmental monitoring through systematic sampling and analysis of physicochemical and biological parameters is essential to detect early changes in water quality and to evaluate the effectiveness of mitigation measures. Additionally, fostering collaboration among public authorities, research institutions, and civil society is critical for implementing participatory watershed management aimed at reducing pollutant loads, restoring riparian areas, and promoting environmental education. The establishment of an integrated and permanent monitoring and inspection system represents a strategic instrument for improving water quality and ensuring water security, in alignment with the objectives of SDG 6, which advocates universal access to safe drinking water, adequate sanitation, and the protection and restoration of aquatic ecosystems.

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