GC Revista Nacional de Gerenciamento de Cidades
National Journal of City Management

ISSN 2318-8472, v. 13, n. 90, 2025

Simplified environmental assessment in an urban stream in the Veado Stream Watershed in the municipality of Presidente Prudente - SP

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Submissão: 20/05/2025
Aceite 30/09/2025
BARBOSA, Eliane Baptista; TAMAGNO, Gabriel Itada; ROMERO, Danielli Cristina Granado; OKIMOTO, Fernando Sérgio. Avaliação ambiental simplificada em um córrego urbano na bacia hidrográfica do Córrego do Veado no município de Presidente Prudente - SP. **Revista Nacional de Gerenciamento de Cidades**, *[S. l.]*, v. 13, n. 90, 2025. DOI: 10.17271/23188472139020256198. Disponível em: https://publicacoes.amigosdanatureza.org.br/index.php/gerenciamento_de_cidades/article/view/6198

GC Revista Nacional de Gerenciamento de Cidades
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ISSN 2318-8472, v. 13, n. 90, 2025

Avaliação ambiental simplificada em um córrego urbano na bacia hidrográfica do Córrego do Veado no município de Presidente Prudente - SP

RESUMO

Objetivo - analisar a integridade ambiental do Córrego Vale do Sol em uma única visita, no município de Presidente Prudente/SP.

Metodologia - aplicação de um protocolo de avaliação rápida e da análise de alguns parâmetros limnológicos. O PAR foi aplicado em três estações ao longo do córrego e foram avaliados os seguintes parâmetros: tipo de ocupação das margens; assoreamento no leito; presença de resíduos; odor da água; presença de substâncias na água; transparência da água; tipo de fundo; diversidade de habitats de fundo; tipos de substrato; condição da lâmina d'água; alterações no canal do rio; estabilidade das margens; presença de vegetação ripária; extensão da APP e presença de plantas aquáticas. Para a avaliação da qualidade da água foram analisados os parâmetros de condutividade elétrica, oxigênio dissolvido, pH, temperatura e turbidez.

Originalidade/relevância - o Protocolo de Análise Rápida (PAR), apesar de metodologia consolidada no meio acadêmico e científico tem sido pouco explorado e sua facilidade, baixo custo tecnológico e precisão permitem análises ambientais contundentes. Além disso, o uso de análise limnológicas para corroborar o PAR fortalece a relevância e a inovação científica do trabalho.

Resultados - o ambiente está antropizado, mas a presença da vegetação no entorno contribui para que a água apresente condições em conformidade com os limites estabelecidos pela Resolução CONAMA N. 357/2005, para os parâmetros estudados.

Contribuições teóricas/metodológicas - o estudo reflete as condições do córrego analoisado, mas reflete a grande maioria, se não a totalidade dos corpos hídricos urbanos e as análises realizadas, como são simples, facilitam a utilização pelos órgãos gestores dos municípios e das águas.

Contribuições sociais e ambientais - a metodologia em si, permite entender as variáveis importantes para manter ou restaurar o ambiente vizinho dos corpos hídricos promovendo a sensibilização e a consciência necessárias para ações proativas e reflexos positivos no ambiente.

PALAVRAS-CHAVE: Análise ambiental. Protocolo de Avaliação Rápida. Córregos Urbanos

Simplified environmental assessment in an urban stream in the Veado Stream Waterbasin in Presidente Prudente - SP

ABSTRACT

Objective - To analyze the environmental integrity of the Vale do Sol Stream in a single visit, in the municipality of Presidente Prudente/SP.

Methodology - Application of a rapid assessment protocol and the analysis of some limnological parameters. The RAP was applied at three stations along the stream, and the following parameters were evaluated: type of bank occupation; streambed siltation; presence of waste; water odor; presence of substances in the water; water transparency; bottom type; diversity of bottom habitats; substrate types; water surface condition; alterations in the river channel; bank stability; presence of riparian vegetation; extent of the Permanent Preservation Area (PPA); and presence of aquatic plants. For water quality assessment, the parameters of electrical conductivity, dissolved oxygen, pH, temperature, and turbidity were analyzed.

Originality/Relevance - The Rapid Assessment Protocol (RAP), despite being a consolidated methodology in the academic and scientific community, has been explored little. Its ease of use, low technological cost, and precision allow for robust environmental analyses. Furthermore, the use of limnological analysis to corroborate the RAP strengthens the relevance and scientific innovation of the work.

Results - The environment is anthropized, but the presence of surrounding vegetation contributes to the water meeting conditions in compliance with the limits established by CONAMA Resolution No. 357/2005 for the parameters studied.

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Theoretical/Methodological Contributions - The study reflects the conditions of the analyzed stream, but it also reflects the vast majority, if not all, of urban water bodies. The analyses performed, being simple, facilitate their use by municipal and water management agencies.
Social and Environmental Contributions - The methodology itself allows for an understanding of the important variables for maintaining or restoring the environment adjacent to water bodies, promoting the awareness and consciousness necessary for proactive actions and positive environmental impacts.

KEYWORDS: Environmental Analysis. Rapid Assessment Protocol. Urban Streams.

Evaluación ambiental simplificada en un arroyo urbano de la cuenca del Córrego do Veado en Presidente Prudente - SP

RESUMEN
Objetivo - Analizar la integridad ambiental del arroyo Vale do Sol en una única visita, en el municipio de Presidente Prudente/SP.
Metodología - Aplicación de un protocolo de evaluación rápida y el análisis de algunos parámetros limnológicos. El PER se aplicó en tres estaciones a lo largo del arroyo y se evaluaron los siguientes parámetros: tipo de ocupación de las márgenes; sedimentación en el lecho; presencia de residuos; olor del agua; presencia de sustancias en el agua; transparencia del agua; tipo de fondo; diversidad de hábitats de fondo; tipos de sustrato; condición de la lámina de agua; alteraciones en el cauce del río; estabilidad de las márgenes; presencia de vegetación ribereña; extensión del Área de Preservación Permanente (APP) y presencia de plantas acuáticas. Para la evaluación de la calidad del agua se analizaron los parámetros de conductividad eléctrica, oxígeno disuelto, pH, temperatura y turbidez.
Originalidad/relevancia - El Protocolo de Análisis Rápido (PER), a pesar de ser una metodología consolidada en el medio académico y científico, ha sido poco explorado. Su facilidad, bajo costo tecnológico y precisión permiten análisis ambientales contundentes. Además, el uso de análisis limnológicos para corroborar el PER fortalece la relevancia y la innovación científica del trabajo.
Resultados - El ambiente está antropizado, pero la presencia de vegetación en el entorno contribuye a que el agua presente condiciones conformes con los límites establecidos por la Resolución CONAMA N. 357/2005 para los parámetros estudiados.
Contribuciones teóricas/metodológicas - El estudio refleja las condiciones del arroyo analizado, pero también refleja a la gran mayoría, si no a la totalidad, de los cuerpos hídricos urbanos. Los análisis realizados, al ser simples, facilitan su utilización por los órganos gestores de los municipios y de las aguas.
Contribuciones sociales y ambientales - La metodología en sí misma permite entender las variables importantes para mantener o restaurar el ambiente vecino a los cuerpos hídricos, promoviendo la sensibilización y la conciencia necesarias para acciones proactivas y reflejos positivos en el ambiente.

PALABRAS CLAVE: Análisis Ambiental. Protocolo de Evaluación Rápida. Arroyos Urbanos.

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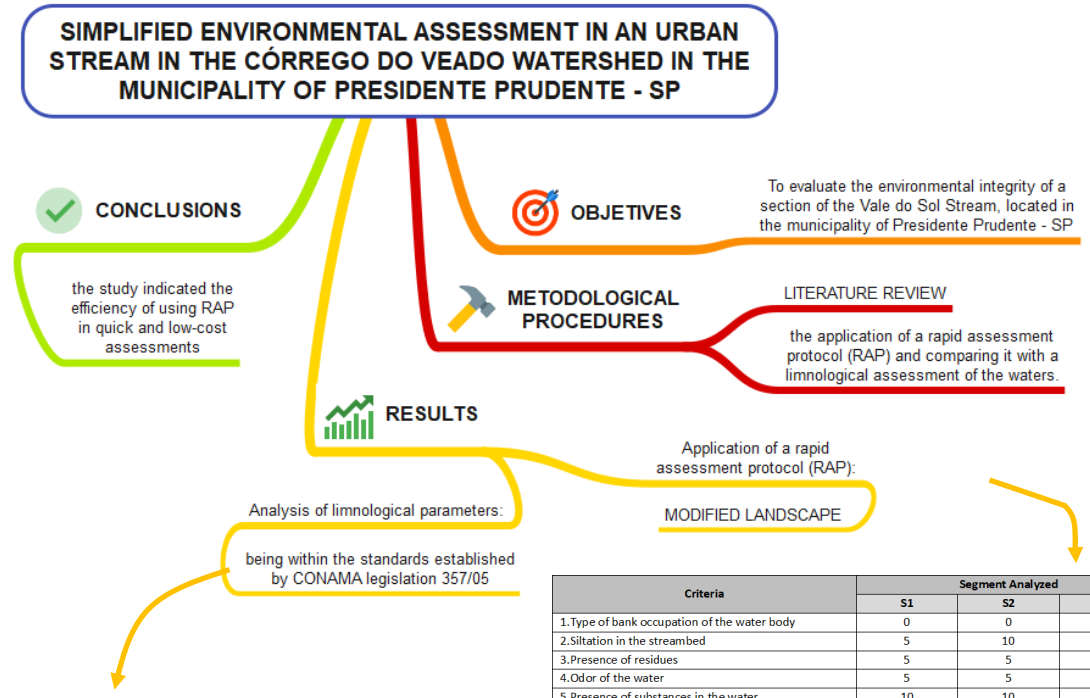
ISSN 2318-8472, v. 13, n. 90, 2025

GRAPHIC SUMMARY



Variables	Stations		
	S1	S2	S3
Conductivity (µS.cm^{-1})	421	364	509
DO (mg/L)	7.07	7.43	6,76
pH (non-dimensional)	7.66	7.54	7,16
Temperature (°C)	18.15	20.50	21.77
Turbidity (NTU)	7.71	2.48	5.24

Criteria	Segment Analyzed		
	S1	S2	S3
1.Type of bank occupation of the water body	0	0	0
2.Siltation in the streambed	5	10	5
3.Presence of residues	5	5	0
4.Odor of the water	5	5	10
5.Presence of substances in the water	10	10	10
6.Water transparency	5	10	5
7.Type of bottom	5	10	10
8.Diversity of bottom habitats	10	5	10
9.Types of substrate (for biota)	0	10	5
10.Condition of the water depth	0	5	0
11.Alterations in the river channel	5	5	0
12.Stability of the banks - erosion	5	0	0
13.Presence of riparian vegetation	5	5	5
14.Extent of the permanent preservation area (PPA)	5	0	0
15.Presence of aquatic plants	5	5	5
Total	**70**	**85**	**65**
Classification of the segment	**Altered Segment**	**Altered Segment**	**Altered Segment**

SCORE		
0 – 60	61 – 90	>91
Impacted Segment	Altered Segment	Natural Segment

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1 INTRODUCTION

Considering the increasing degradation of aquatic ecosystems, the need to assess (Cardoso; Novaes, 2013) and monitor environmental changes and their effects on water resources is evident. For an integrated analysis of the quality of aquatic ecosystems, river monitoring should be based on systemic methods that enable the understanding of all components and processes involved in the environment, including not only the measurement of water quality parameters, but also the assessment of the conditions of the physical environment (Rodrigues, 2008).

Junior et al. (2013) point out several problems derived from urban occupation on the banks of urban streams in the municipality of Cáceres (in the state of Mato Grosso), such as sewage discharges causing bad odors in the area, the presence of foam and various types of waste in the water (plastic cups and bottles, cardboard, bottle caps and plastic bags) and the loss of riparian forests in some areas. Pradella and Bueno (2017) highlight the conflicts of urban occupation in water resources.

According to Callisto et al. (2002), assessment methods that encompass aspects of environmental integrity of water resources and knowledge of the physical characteristics of aquatic systems are of great importance for defining the general characteristics of river ecosystems. In this context, rapid assessment protocols (RAP) become instruments with high potential. With an easy and simple methodology, the results obtained through the application of these protocols combined with the results of water quality analyses allow for a holistic assessment (Rodrigues, 2008), allowing these instruments to be used in plans and/or programs for the management and conservation of aquatic ecosystems (Callisto et al. 2002).

The evaluation of rivers through these protocols enables the qualitative characterization of the area through the observation of several parameters pre-defined by the evaluator. Scores are assigned to each of the parameters evaluated, according to the visual classification of the conservation status of the environment, where higher values indicate a better conservation status, while lower values represent greater changes to the environment, and greater degradation of it (Rodrigues, 2008).

To complement the analysis, analyses of limnological parameters, such as temperature, turbidity, dissolved oxygen, electrical conductivity and pH, are necessary. Temperature influences several physical and chemical parameters of water, such as surface tension and viscosity. Aquatic organisms are affected by temperatures outside their thermal tolerance limits, which impacts their growth and reproduction. All bodies of water experience temperature variations throughout the day and seasons. However, the rise in temperature in a body of water is usually caused by industrial waste (CETESB, 2021).

Turbidity represents the degree of interference with the passage of light through water, giving it a turbid appearance (Von Sperling, 2005) and it is caused by the presence of suspended solids, such as inorganic particles and organic debris (CETESB, 2021). The main source of turbidity is soil and riverbank erosion. During rainy seasons, rainwater brings a significant amount of solid material to water bodies. Increased water turbidity causes changes in coagulant dosages in water treatment plants, causing a greater amount of chemicals to be used, significantly increasing treatment costs. The discharge of domestic sewage and industrial

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effluents also causes increases in water turbidity, as do mining activities. High turbidity reduces photosynthesis, altering the aquatic food chain and influencing biological communities in the water, which can lead to fish deaths. Furthermore, it adversely affects domestic, industrial and recreational uses of water (CESTEB, 2021).

Dissolved oxygen is a limiting factor for self-purification processes and vital for aerobic aquatic beings. Its consumption occurs through oxidation processes, involving the availability of organic matter and nutrients present in the water and the Biochemical Oxygen Demand (BOD) of organisms in their metabolic processes. During the degradation of organic matter, DO consumption increases, reducing its concentration in the environment (Von Sperling, 2005).

Electrical conductivity expresses the ability to conduct electrical current and indicates the quantity of salt in the water. As more dissolved solids are added to the water, its conductivity increases. Therefore, this parameter represents an indirect measure of the concentration of pollutants (CETESB, 2021).

The pH factor represents the concentration of hydrogen ions H+, indicating the acidity, neutrality or alkalinity of the water. It is an important parameter in several stages of water treatment, and it often needs to be corrected to avoid possible corrosion or incrustation in the treatment networks. In water bodies, aquatic life can be affected by the acidity or alkalinity of the water; high pH values may be associated with the proliferation of algae (Von Sperling, 2005).

The application of RAP associated with limnological analyses has proved to be an important tool in the assessment of water bodies. Morais et al. (2015) highlights that when the aim is to assess the integrity of the aquatic environment, this method proves to be quite efficient. Silva et al. (2023) points out, in their study, that RAP has proven to be a robust tool in assessing the environmental integrity of the river basin.

For Rodrigues, França and Duarte (2023), the RAP stands out as a methodological instrument in the evaluation of rivers due to its ease of obtaining and applying it, the possibility of the information obtained contributing to issues related to the preservation of water resources and, above all, the possibility of adapting the protocol to different areas, considering the reality of the location under study.

In view of the above, the present work aims to evaluate the environmental integrity of an urban stream belonging to the Veado Stream Basin in Presidente Prudente (SP), through the application of a rapid assessment protocol adapted to the characteristics of this hydrographic basin, together with the evaluation of some limnological parameters.

2 CHARACTERIZATION OF THE AREA UNDER STUDY

The municipality, in which the Vale do Sol Stream is located, is in the west of the state of São Paulo and is the result of the emancipation of Conceição de Monte Alegre (today Paraguaçu Paulista) in the 1910s. The name of the city is a possible reference to the former Brazilian president Prudente de Morais (1841-1902), first governor of São Paulo (Presidente Prudente, 2024).

The Vale do Sol Stream is in the southwest portion of the city of Presidente Prudente/SP (figure 1), with geographic coordinates 22°7'52.46" South and 51°26'30.28" West (source) and 22°6'46.83" South and 51°26'42.65" West (mouth), and it is approximately 2.10 km

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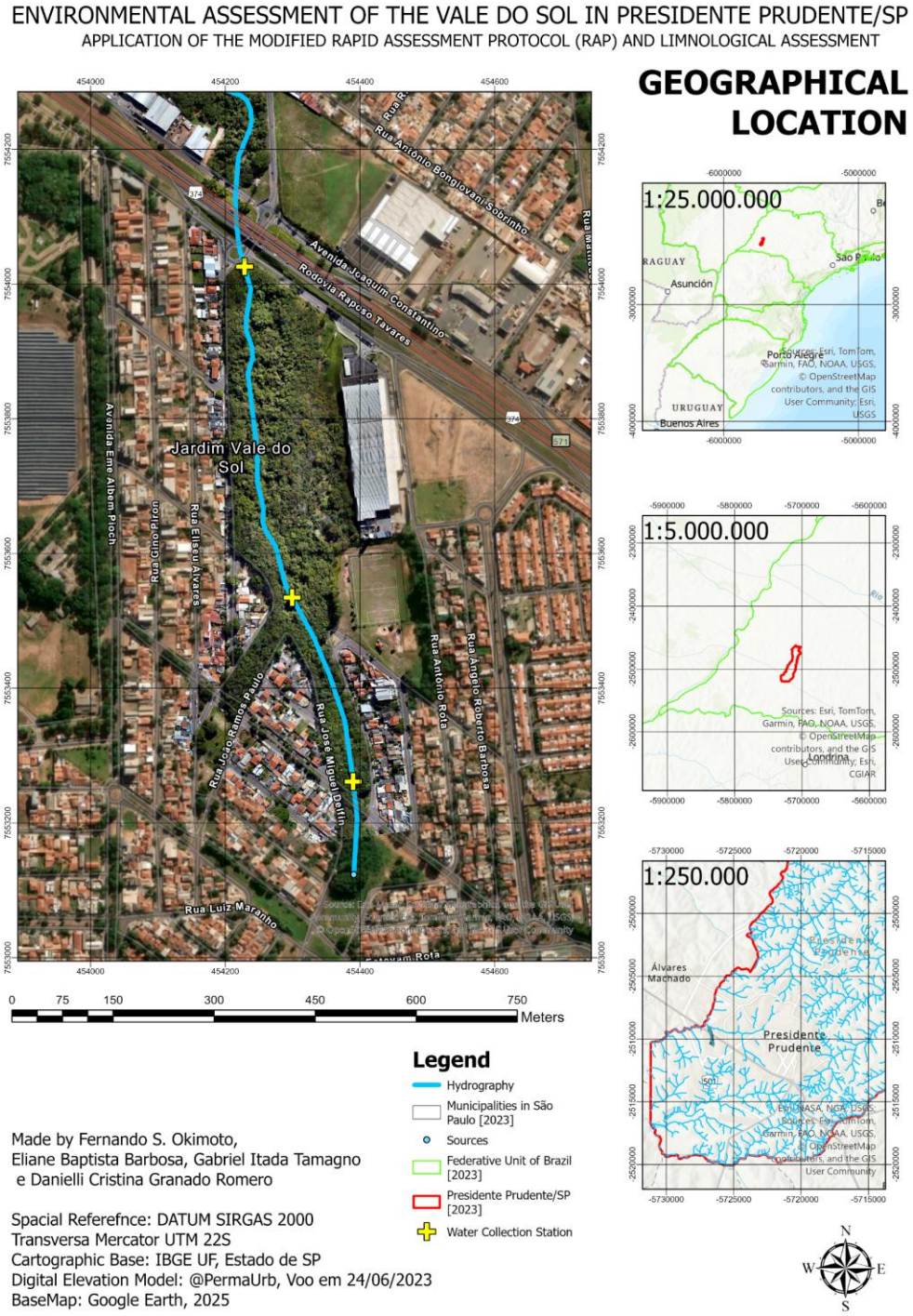
long. Its source is channelized, but a large part of the stream is open and remains so until its mouth. The stream is inserted in the Veado Stream Hydrographic Basin, which is part of the Santo Anastácio River Basin, and belongs to the Pontal do Paranapanema Water Resources Management Hydrographic Unit (UGRHI-22).

Image 1 – Location of the Vale do Sol stream



Source: authors' own elaboration (2024)

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To understand the environment in which the stream is located, it is necessary to understand the basin of which it is part. The Veado Stream hydrographic basin, and consequently the Vale do Sol Stream, are in the morphostructure called the Paraná Sedimentary Basin and in the morphostructure called the Western Paulista Plateau, where it is characterized by reliefs generated from erosion processes, such as hills with tabular tops and smaller hills with convex tops (Nunes; Gouveia; Gouveia, 2024).

The city of Presidente Prudente is in the Hydrographic Region of the Paraná River Basin. A significant part of the city's territory is inside the UGRHI 21 – Rio do Peixe, which includes the Peixe River, Pereira Stream and Mandaguari River hydrographic sub-basins. The southern portion of the municipality belongs to UGRHI 22 - Pontal do Paranapanema, comprising the Peixe River, Cedro Stream and Limoeiro Stream hydrographic sub-basins, with emphasis on the Veado Stream sub-basin. The urban perimeter of the municipality is home to the watershed of the two hydrographic units, where the sources of the Mandaguari River and Santo Anastácio River hydrographic sub-basins are located. In total, Presidente Prudente has 2,125.21 linear km of drainage channels, including rivers, creeks and streams, with 365.05 km of these channels located within the city's urban perimeter (Nunes; Gouveia; Gouveia, 2024).

The region where Presidente Prudente is located is characterized by a sub-warm and humid tropical climate, with dry periods that vary from 1 to 2 months, according to the official climate classification of the Brazilian Institute of Geography and Statistics (the *Instituto Brasileiro de Geografia e Estatística*, IBGE). The average annual temperature of Presidente Prudente is 23.4ºC, with averages of 26ºC in summer and 20ºC in winter. Annual rainfall in Presidente Prudente is around 1300 mm, with a strong seasonal distribution. Most of the rainfall is concentrated from October to March, representing around 70% of the annual total, with January being the rainiest month, with an average of approximately 200 mm. From April to September, there is a significant reduction in rainfall, representing around 30% of the annual total, with July being the driest month, with an average rainfall not exceeding 50 mm (Nunes; Gouveia; Gouveia, 2024).

Still according to the same authors, Presidente Prudente has a diversity of soil types, including Latosols (developed soils), Argisols (shallow to developed soils), Neosols (shallow soils) and Planosols and Gleysols (hydromorphic soils). In the region of the municipality of Presidente Prudente, a large part of the cultivated land is used for sugarcane production, especially in the northern part of the municipality. However, compared to other land uses, areas with shrubby herbaceous cover, which correspond to pasture areas, predominate. On the other hand, tree cover, represented by fragments of riparian forests, occupies the same area of land as the areas where sugarcane is grown.

3 MATERIALS AND METHODS

A literature review was carried out on the main concepts to be investigated, such as limnological parameters, as well as on the methodology of Rapid Assessment Protocol (RAP) and its applications in scientific investigations about the environmental and limnological quality of water bodies.

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The Rapid Assessment Protocol (PAR) used in the present study is being developed by the study group coordinated by Professor Danielli Cristina Granado Romero, one of the authors of this work, for streams in the Veado Hydrographic Basin, in the urban area of Presidente Prudente (São Paulo), based on the protocol proposed by Callisto et al. (2002). The RAP consists of fifteen parameters that are used to assign a value from 0 to 10, which correspond to the situation of each section verified, namely: I) Type of bank occupation; II) Siltation in the streambed; III) Presence of residues; IV) Odor of the water; V) Presence of substances in the water; VI) Water transparency; VII) Type of bottom; VIII) Diversity of bottom habitats; IX) Types of substrate (for biota); X) Condition of the water depth; XI) Alterations in the river channel; XII) Stability of the banks - erosion; XIII) Presence of riparian vegetation; XIV) Extent of the permanent preservation area (PPA) and XV) Presence of aquatic plants.

The PAR was applied only once for each section by the first two authors of the work, during the month of June 2023, characterizing the dry season. For data analysis, an average of each value attributed was calculated, according to each of the fifteen parameters. The three chosen sections were evaluated by the PAR, considering the two banks of the channel as a single section. The selection of the sections for application of the protocol was based on accessibility to the site and the distance between the sections, seeking a more equidistant distribution between the stations and a diversity of surroundings, as follows: 1) at the beginning of the tributary, right after the stream is no longer channeled on R. José Miguel Delfim; 2) in the middle of the route, where Ruas João Guilherme Marconi and R. José Miguel Delfim meet; and; 3) the last point is close to the roundabout on R. José Palácio, as shown in Figure 1.

At the end of the RAP application, the values were added up and the segments of the stream were classified according to the score obtained as follows: “Impacted Segment” (0 – 60 pts.); “Altered Segment” (61 – 90 pts.) or “Natural Segment” (>91 pts.). According to Callisto et al. (2002, p. 93) “the final scores reflect the level of preservation of the ecological conditions of the sections of the basins studied.”

In addition, to contribute with the assessment of the environmental conditions of the area, five limnological parameters were analyzed: electrical conductivity, dissolved oxygen (DO), pH, temperature and turbidity. The parameters were measured on site using a HANNA multiparameter probe, model HI9525, and turbidity was assessed in the laboratory using a HANNA turbidity meter, model 98703.

For the turbidity analysis, samples were collected and stored in sterilized plastic bottles. During collection, water was collected close to the surface of the river, since the water depth in some segments of the stream were not deep and sediments could influence the results. After collection, the samples were taken to the laboratory and refrigerated until the time of turbidity analysis.

4 RESULTS AND DISCUSSION

4.1 RAP application

The RAP application enabled a practical and low-cost environmental diagnostic, which brought relevant information about the environmental integrity of Stream studied in the city of

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Presidente Prudente - SP. The results of RAP showed anthropogenic changes in all the segments studied, as expected.

The stream segments were classified as “altered section” (Table 1). The classification was based on the final score, resulting from the sum of the scores given to each criterion, with the possible scores being 0, 5 and 10, in which score 10 indicates the ideal condition of the parameter, 5 indicates an altered condition and 0 indicates the presence of impacts. At the end of the evaluation, the numbers were added together to subsequently obtain the classification of the section, based on the final number of the sum of the points.

Table 1 – Evaluation of the Vale do Sol Stream segments through Rapid Assessment Protocol – RAP

Criteria	Segment Analyzed		
	S1	S2	S3
1.Type of bank occupation of the water body	0	0	0
2.Siltation in the streambed	5	10	5
3.Presence of residues	5	5	0
4.Odor of the water	5	5	10
5.Presence of substances in the water	10	10	10
6.Water transparency	5	10	5
7.Type of bottom	5	10	10
8.Diversity of bottom habitats	10	5	10
9.Types of substrate (for biota)	0	10	5
10.Condition of the water depth	0	5	0
11.Alterations in the river channel	5	5	0
12.Stability of the banks - erosion	5	0	0
13.Presence of riparian vegetation	5	5	5
14.Extent of the permanent preservation area (PPA)	5	0	0
15.Presence of aquatic plants	5	5	5
Total	**70**	**85**	**65**
Classification of the segment	**Altered Segment**	**Altered Segment**	**Altered Segment**

SCORE		
0 – 60	61 – 90	>91
Impacted Segment	Altered Segment	Natural Segment

Source: Adapted by the authors (2024)

In segment 1, the main parameters that contributed to its classification as “altered” were: the type of bank occupation, type of substrate and condition of the water depth. For these parameters, the score assigned was 0, indicating the existence of some impact related to these criteria. In segment 2, the criteria that received a zero mark were: type of bank occupation, stability of the banks and extent of the PPA. Segment 3 was the one which received the most zero marks for the criteria assessed: type of bank occupation, presence of residues, condition of the water depth, alterations in the river channel, stability of the banks, and extent of the PPA.

Regarding the type of bank occupation, since the stream is in an urban area, the existence of residences and businesses close to the banks was observed in all three segments. The presence of solid waste was observed in all segments; in segments 1 and 2 there was little

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waste, while in segment 3 a greater accumulation of waste was observed. Regarding the odor of the water, in sections 1 and 2 a characteristic odor of sewage was noted, and in section 3 no odor. Regarding the alterations in the channel and the stability of the banks, the watercourse does not present natural conditions due to its channelization. The delimitation of the permanent preservation area in the three segments is smaller than that established by Law 12651/2012 and the existing riparian vegetation is predominantly composed of invasive exotic species.

4.2 Analysis of limnological parameters

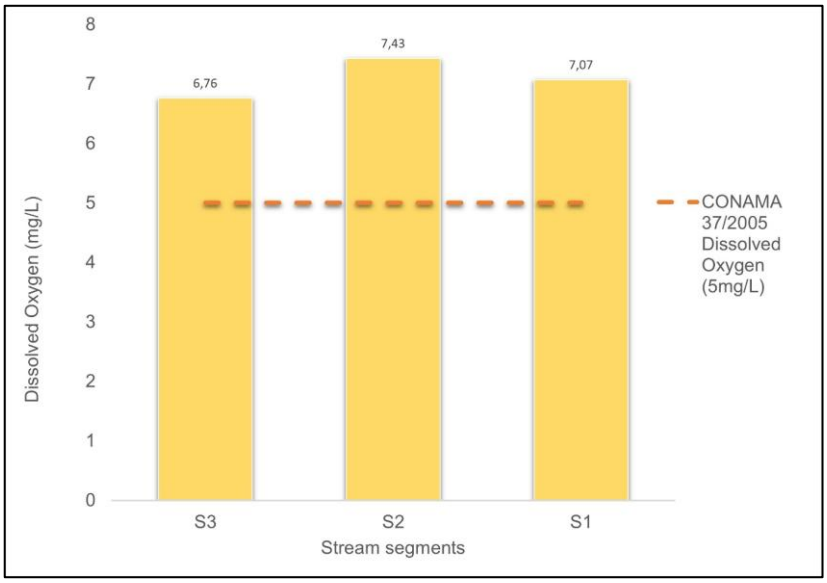
The results of conductivity, dissolved oxygen, pH, temperature and turbidity of the studied stream are presented in Figures 2 to 6.

For the analysis of the results of the limnological parameters, CONAMA Resolution 357, of March 17, 2005, was adopted as a reference for comparison[1]. This resolution establishes limits for the parameters of dissolved oxygen, pH, temperature and turbidity, among other variables, which vary according to the classification of the water body.

To classify the stream, the classification made in 1977 by State Decree 10.755/77 of the State of São Paulo was used as a reference, which designated the section under study as being class 2.

The variation in dissolved oxygen concentration between the studied sections is presented in Figure 2.

Image 2 – Levels of dissolved oxygen



Source: authors' own elaboration (2024)

The dissolved oxygen concentration varied little along the stream, with a minimum of 6.76 mg/L in segment S3 and a maximum of 7.43 mg/L in segment S2. These numbers are within the limits established by CONAMA Resolution 357/2005, with 5 mg/L being the minimum dissolved oxygen amount for the preservation of aquatic life (Image 2). This concentration of

[1] CONAMA is an acronym standing for *Conselho Nacional do Meio Ambiente* [National Council for the Environment]

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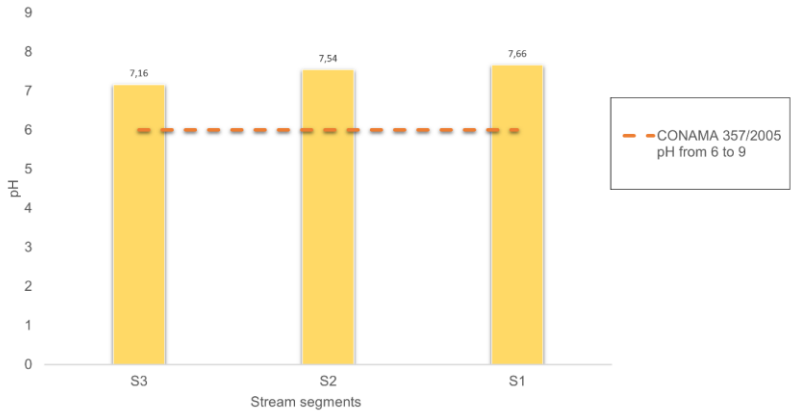
dissolved oxygen along the stream can be attributed to the physical characteristics of the environment studied. The stream has several waterfalls along its course, which should increase the entry of oxygen from the atmosphere into the water body. This phenomenon helps to maintain dissolved oxygen levels at concentrations suitable for aquatic life, even in segments of the stream with different flow conditions and water quality (Esteves, 2011).

The pH values are shown in image 3.

Image 3 – Levels of pH

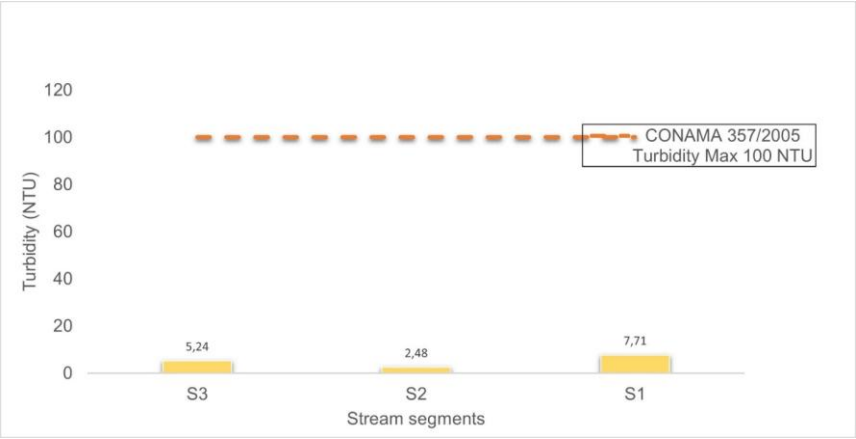


Source: authors' own elaboration (2024)

Regarding the pH factor, the minimum level of 7,16 was recorded in segment S3 of the stream and the maximum of 7,66 in segment S1, indicating that the water body is alkaline. Both levels are within the ranges recommended by CONAMA Resolution 357/2005, which is pH 6 to 9 (Image 3). However, it is worth noting that days before the analysis the site had experienced heavy rains, which consequently may have influenced the pH of the water body, making it more basic.

Upon analyzing the turbidity of the sections, it can be observed that all values are within the maximum limit allowed by CONAMA Resolution 357/2005, which establishes a concentration of up to 100 NTU of turbidity for water bodies classified as class 2, as is the case of the tributary studied (image 4).

Image 4 – Turbidity values



Source: authors' own elaboration (2024)

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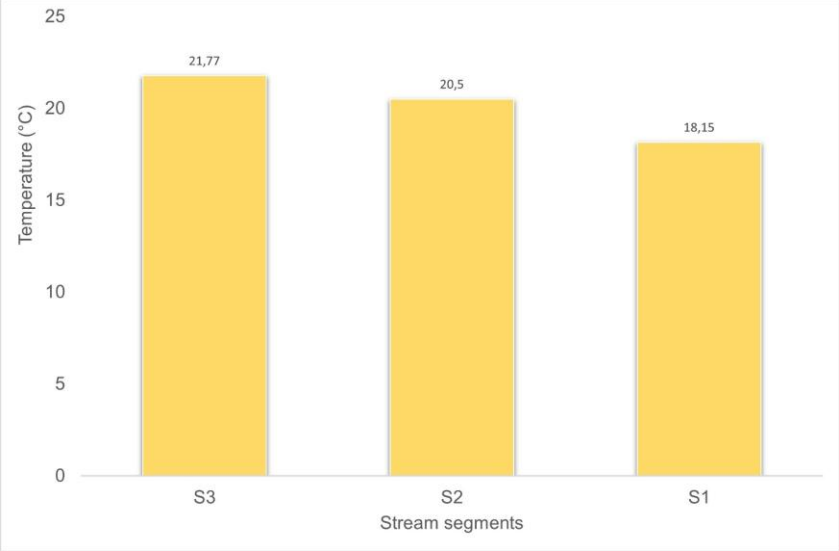
As shown in Image 4, the highest turbidity concentration is recorded in segment S1 of the stream (7.71 NTU), while the lowest concentration is found in segment S2 (2.48 NTU).

The temperatures levels are shown in Figure 5.

Image 5 – Temperature levels



Source: authors' own elaboration (2024)

The temperature of the stream studied ranged from 18.15 °C to 21.77 °C, with the minimum temperature recorded in segment S1 and the maximum in segment S3, as can observed in Image 5. It is important to highlight that temperature variations follow climatic patterns, but they may be related to environmental factors, such as the presence of vegetation. A study carried out by Bueno et al. (2019) demonstrated the influence of vegetation cover on temperature, showing that the lowest temperatures were found in areas close to the stream, while the highest were observed in more urbanized areas.

The electrical conductivity of water was one of the parameters that presented the greatest variations, as shown in Image 6.

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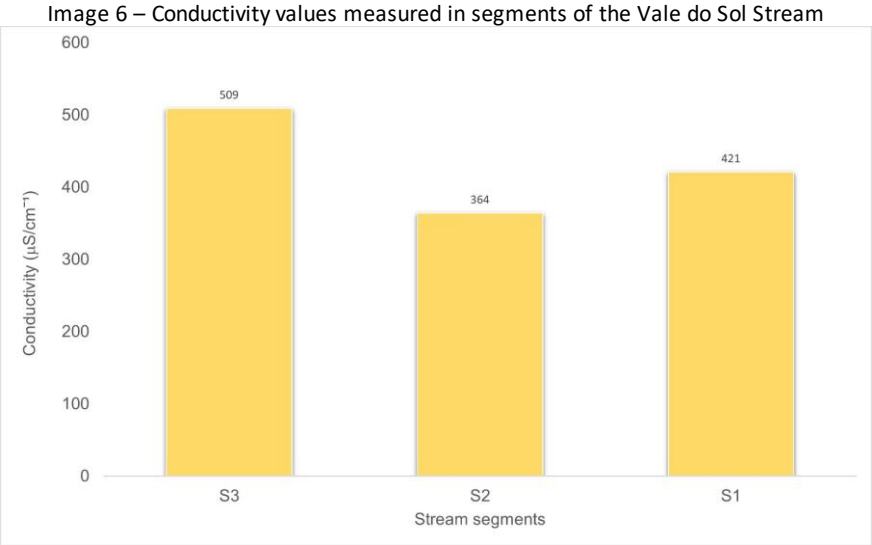
Image 6 – Conductivity values measured in segments of the Vale do Sol Stream



Source: authors' own elaboration (2024).

The highest value of electrical conductivity of water was recorded in segment S3 (509 $\mu S.cm^{-1}$) and the lowest in segment S2 (364 $\mu S.cm^{-1}$). In all segments, the values exceeded 100 $\mu S.cm^{-1}$, indicating a possible environmental impact (CETESB, 2021). Esteves (2011) observed that, when studying the electrical conductivity of inland waters, some authors reported that in environments influenced by human action, conductivity levels are higher, ranging from 283 to 455 $\mu S.cm^{-1}$.

4.3 Comparative Analysis between RAP Results and the Characteristics of the Water (Limnology)

By correlating the data from the Rapid Assessment Protocol (RAP) with the limnological parameters, it is clear that the RAP provided a simplified characterization of the environment in which the water body is located. With it, it was possible to confirm that the stream, in the analyzed segments, is characterized as an anthropized environment.

Considering that all the segments were classified as altered by the RAP, but the segments S1, S2 and S3 obtained different scores: respectively, 70, 85, and 65 — that is, segment S3 is the most altered, followed by segments S1 and S2, the latter being the least altered; it can be stated that:

1. Dissolved oxygen (Image 2) reflects this analysis by having higher concentrations in segment S2, followed by S1, and then by S3, which has the lowest. All of them are within the limits permitted by CONAMA 357/2005;
2. Regarding pH (Image 3), segment S3 was also the most alkaline, but the sequence changed slightly, followed by S2 and S1, respectively. Once again, it is worth highlighting the possibility that the previous day's rain may have influenced these results. The values were between 6 and 9, which are permitted values;
3. The same can be seen in relation to turbidity (Image 4), in which the rains may have altered the limnological values and did not alter those observed by the RAP;

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4. The variation in temperatures in Image 5 (from 18.15 °C to 21.77 °C) may reflect the water exposure conditions (increasing, from the source to the last segment) and may be influenced by the existence and number of falls and the water depth height in each assessed segment;
5. Finally, the electrical conductivity that reflects the salts present in the sections was also compatible with the alteration levels, both being higher in S3, followed by S1 and S2. It is worth noting that values higher than normal were found.

The study of the water characteristics has shown that four of the limnological parameters analyzed are within the limits established by CONAMA 357/05, indicating accordance. Nevertheless, it is important to highlight that this analysis was carried out in a single day, with no repetition of parameters on later dates to confirm the data that was obtained.

4.4 Impacts of the anthropization on the segments of the stream studied

The anthropization observed in the segments of the stream studied in the Veado Stream Basin, evidenced through the application of the RAP, has caused several changes to this environment. With the advancement of urbanization, the natural vegetation was devastated, and currently the Permanent Preservation Area (PPA) in the watershed is predominantly composed of exotic species, such as the Leucaena (*Leucaena leucocephala*), an invasive species that promotes the homogenization of the flora due to its highly competitive capacity, contributing to the loss of biodiversity and ecological relationships in this ecosystem. Despite this, the existing vegetation acts as a physical barrier, contributing to the retention of sediments and residues.

Urban growth near rivers without adequate environmental planning can cause several environmental impacts and harm to the surrounding community. A common impact on urban rivers, observed in the Vale do Sol Stream, is the presence of solid waste, resulting from inadequate disposal by the population and the dragging caused by surface runoff. Urban watercourses suffer from the illegal dumping of effluents, whether of domestic or industrial origin. Signs of effluent dumping were observed in Stream studied, such as odor and greenish coloration of the water.

5 CONCLUSIONS

The urban stream in the Veado Stream Basin analyzed in this study presented values considered adequate for four limnological parameters related to water quality, being within the standards established by CONAMA legislation 357/05. And the fact that the RAP demonstrated that the stream is “altered” demonstrates the anthropogenic interferences to which urban water bodies are commonly subject. The electrical conductivity of water showed a clear relationship with the results of the Rapid Assessment Protocol (RAP), being outside the limits established by the class in which the stream is inserted. This parameter may in fact reflect an impact on water quality due to human action on the stream. However, to confirm its relevance, additional studies are necessary. Therefore, the study indicated the efficiency of using RAP in

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quick and low-cost assessments, which can contribute to interventions that promote the improvement of the environmental conditions of the river system and its surroundings.

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DECLARAÇÕES

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Ao descrever a participação de cada autor no manuscrito, utilize os seguintes critérios:

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- **Curadoria de Dados**: Eliane Baptista Barbosa, Gabriel Itada Tamagno, Danielli Cristina Granado Romero e Fernando Sérgio Okimoto.
- **Análise Formal**: Danielli Cristina Granado Romero e Fernando Sérgio Okimoto.
- **Aquisição de Financiamento** Eliane Baptista Barbosa, Gabriel Itada Tamagno, Danielli Cristina Granado Romero e Fernando Sérgio Okimoto.
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- **Supervisão**: Danielli Cristina Granado Romero e Fernando Sérgio Okimoto.

DECLARAÇÃO DE CONFLITOS DE INTERESSE

Eu/Nós, **Eliane Baptista Barbosa, Gabriel Itada Tamagno, Danielli Cristina Granado Romero e Fernando Sérgio Okimoto**, declaramos que o manuscrito intitulado "**Avaliação ambiental simplificada em um córrego urbano na bacia hidrográfica do córrego do veado no município de Presidente Prudente - SP**":

1. **Vínculos Financeiros**: Não possui vínculos financeiros que possam influenciar os resultados ou interpretação do trabalho.
2. **Relações Profissionais**: Não possui relações profissionais que possam impactar na análise, interpretação ou apresentação dos resultados.
3. **Conflitos Pessoais**: Não possui conflitos de interesse pessoais relacionados ao conteúdo do manuscrito.