

Sanitation Challenges and Advances in the UGRHI-22 of Pontal do Paranapanema – SP – Brazil

Ellen Rabelo Cremasco

Master's Student, UNESP, Brazil
ellen.cremasco@unesp.br
ORCID iD 0009-0009-0672-0707

Letícia Vieira Santos

Master's Student, UNESP, Brazil
leticia.v.santos@unesp.br
ORCID iD 0009-0002-3615-8355

Maria Cristina Rizk

Doctor Professor, UNESP, Brazil
mc.rizk@unesp.br
ORCID iD 0000-0003-2414-6680

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Desafios e avanços do saneamento na UGRHI-22 do Pontal do Paranapanema – SP – Brasil

RESUMO

Objetivo – O presente estudo teve como objetivo analisar as variáveis relacionadas ao saneamento — abastecimento de água, esgotamento sanitário, manejo de resíduos sólidos, drenagem urbana e controle de erosão — no contexto da Unidade de Gerenciamento de Recursos Hídricos do Pontal do Paranapanema (UGRHI) 22, correspondente à Bacia Hidrográfica do Pontal do Paranapanema.

Metodologia – A pesquisa adotou uma abordagem quali-quantitativa, fundamentada na revisão bibliográfica de dados secundários. A análise histórica baseou-se nos Relatórios de Situação da UGRHI-22 referentes aos anos de 2016, 2017, 2019, 2021 e 2023. Os indicadores de saneamento foram organizados em gráficos-síntese para subsidiar a interpretação das tendências temporais.

Originalidade/relevância – O artigo apresenta uma abordagem original ao focar na região do Pontal do Paranapanema, região pouco explorada em estudos sobre recursos hídricos e saneamento. Sua relevância se evidencia na integração entre diagnóstico técnico e propostas práticas. Ao combinar aspectos sociais, ambientais e infra estruturais, o estudo oferece uma visão multidisciplinar e inovadora, com potencial de servir como modelo replicável para outras regiões com problemas semelhantes, contribuindo para o planejamento sustentável e a melhoria da qualidade de vida local.

Resultados – A análise dos dados evidenciou avanços no saneamento básico da UGRHI-22. No entanto, drenagem urbana e controle de erosão seguem como desafios. Os resultados reforçam a necessidade de gestão integrada e investimentos contínuos para consolidar as políticas públicas na região do Pontal do Paranapanema. Logo, o estudo oferece uma análise histórica da situação do saneamento na região, estabelecendo prioridades para o planejamento e a gestão da bacia hidrográfica. Ademais, gera contribuições sociais ao embasar o planejamento de bacias hidrográficas para melhoria das condições ambientais e de saúde pública.

Contribuições teóricas/metodológicas – O estudo contribui teoricamente ao reforçar a importância de uma abordagem integrada e multidisciplinar na gestão de recursos hídricos e saneamento, articulando conceitos como sustentabilidade, justiça ambiental e governança territorial. Metodologicamente, destaca-se pela aplicação de uma análise histórica baseada em dados secundários, organizados em gráficos para facilitar a interpretação de tendências e compreender os desafios regionais de forma contextualizada, oferecendo subsídios para o planejamento de políticas públicas eficazes e sustentáveis.

Contribuições sociais e ambientais – O estudo apresenta importantes contribuições sociais e ambientais ao evidenciar a necessidade de ampliar o acesso ao saneamento básico na região da UGRHI-22, promovendo melhorias diretas na saúde pública e na qualidade de vida das comunidades locais. Socialmente, fortalece o planejamento participativo e a conscientização da população sobre práticas sustentáveis. Ambientalmente, contribui para a preservação dos recursos hídricos e para o controle de impactos como erosão e poluição, ao propor ações integradas de drenagem urbana e manejo de resíduos.

PALAVRAS-CHAVE: Saneamento. Relatório de Situação de Recursos Hídricos. Bacia Hidrográfica.

Sanitation Challenges and Advances in the UGRHI-22 of Pontal do Paranapanema – SP – Brazil

ABSTRACT

Objective – This study aimed to analyze variables related to sanitation—water supply, sewage, solid waste management, urban drainage, and erosion control—in the context of the Pontal do Paranapanema Water Resources Management Unit (UGRHI) 22, corresponding to the Pontal do Paranapanema Watershed.

Methodology – The research adopted a qualitative and quantitative approach, based on a literature review of secondary data. The historical analysis was based on the UGRHI-22 Situation Reports for the years 2016, 2017, 2019, 2021, and 2023. Sanitation indicators were organized into summary graphs to support the interpretation of temporal trends.

Originality/Relevance – The article presents an original approach by focusing on the Pontal do Paranapanema region, a region little explored in studies on water resources and sanitation. Its relevance is evident in the integration of

technical diagnosis and practical proposals, such as environmental education and participatory management, aligning with the Sustainable Development Goals. By combining social, environmental, and infrastructural aspects, the text offers a multidisciplinary and innovative perspective, with the potential to serve as a replicable model for other regions with similar problems, contributing significantly to sustainable planning and improving local quality of life.

Results – Data analysis demonstrated progress in basic sanitation in the UGRHI-22. However, urban drainage and erosion control remain challenges. The results reinforce the need for integrated management and continued investment to consolidate public policies in the Pontal do Paranapanema region. Therefore, the study offers a historical analysis of the sanitation situation in the region, establishing priorities for planning and management of the river basin. Furthermore, it generates social contributions by supporting the planning of river basins to improve environmental and public health conditions.

Theoretical/Methodological Contributions – The study contributes theoretically by reinforcing the importance of an integrated and multidisciplinary approach to water resource and sanitation management, articulating concepts such as sustainability, environmental justice, and territorial governance. Methodologically, it stands out for its application of a historical analysis based on secondary data, organized into graphs to facilitate the interpretation of trends and understand regional challenges in context, providing support for the planning of effective and sustainable public policies.

Social and Environmental Contributions – The study presents important social and environmental contributions by highlighting the need to expand access to basic sanitation in the UGRHI-22 region, promoting direct improvements in public health and the quality of life of local communities. Socially, it strengthens participatory planning and raises public awareness of sustainable practices. Environmentally, it contributes to the preservation of water resources and the control of impacts such as erosion and pollution by proposing integrated urban drainage and waste management actions.

KEYWORDS: Sanitation. Water Resources Status Report. River Basin.

Desafíos y Avances en Saneamiento en la UGRHI-22 de Pontal do Paranapanema – SP – Brasil

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RESUMEN

Objetivo – Este estudio tuvo como objetivo analizar las variables relacionadas con el saneamiento (abastecimiento de agua, alcantarillado, gestión de residuos sólidos, drenaje urbano y control de la erosión) en el contexto de la Unidad de Gestión de Recursos Hídricos (UGRHI) 22 de Pontal do Paranapanema, correspondiente a la Cuenca Hidrográfica de Pontal do Paranapanema.

Metodología – La investigación adoptó un enfoque cualitativo y cuantitativo, basado en una revisión bibliográfica de datos secundarios. El análisis histórico se basó en los Informes de Situación de la UGRHI-22 de los años 2016, 2017, 2019, 2021 y 2023. Los indicadores de saneamiento se organizaron en gráficos resumen para facilitar la interpretación de las tendencias temporales.

Originalidad/Relevancia – El artículo presenta un enfoque original al centrarse en la región de Pontal do Paranapanema, una región poco explorada en los estudios sobre recursos hídricos y saneamiento. Su relevancia se evidencia en la integración del diagnóstico técnico con propuestas prácticas. Al combinar aspectos sociales, ambientales y de infraestructura, el estudio ofrece una perspectiva multidisciplinaria e innovadora, con el potencial de servir como modelo replicable para otras regiones con problemas similares, contribuyendo a la planificación sostenible y a la mejora de la calidad de vida local.

Resultados – El análisis de datos demostró avances en saneamiento básico en la UGRHI-22. Sin embargo, el drenaje urbano y el control de la erosión siguen siendo desafíos. Los resultados refuerzan la necesidad de una gestión integrada y de una inversión continua para consolidar las políticas públicas en la región de Pontal do Paranapanema. Por lo tanto, el estudio ofrece un análisis histórico de la situación del saneamiento en la región, estableciendo prioridades para la planificación y la gestión de la cuenca hidrográfica. Además, genera contribuciones sociales al apoyar la planificación de cuencas hidrográficas para mejorar las condiciones ambientales y de salud pública.

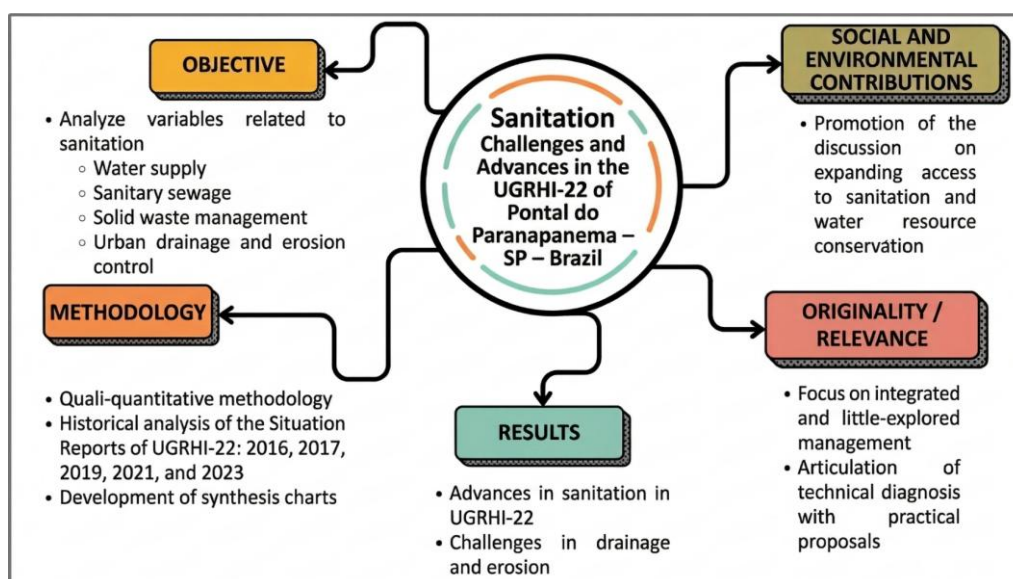
Contribuciones teóricas/metodológicas: El estudio contribuye teóricamente al reforzar la importancia de un enfoque integrado y multidisciplinario para la gestión de los recursos hídricos y el saneamiento, articulando conceptos como la sostenibilidad, la justicia ambiental y la gobernanza territorial. Metodológicamente, destaca por la aplicación de un

análisis histórico basado en datos secundarios, organizados en gráficos para facilitar la interpretación de tendencias y comprender los desafíos regionales en contexto, brindando apoyo para la planificación de políticas públicas efectivas y sostenibles.

Contribuciones sociales y ambientales: El estudio presenta importantes contribuciones sociales y ambientales al destacar la necesidad de ampliar el acceso al saneamiento básico en la región UGRHI-22, promoviendo mejoras directas en la salud pública y la calidad de vida de las comunidades locales. En el ámbito social, fortalece la planificación participativa y sensibiliza a la ciudadanía sobre prácticas sostenibles. En el ámbito ambiental, contribuye a la preservación de los recursos hídricos y al control de impactos como la erosión y la contaminación, proponiendo acciones integradas de drenaje urbano y gestión de residuos.

PALABRAS CLAVE: Saneamiento. Informe sobre el estado de los recursos hídricos. Cuenca hidrográfica.

GRAPHICAL ABSTRACT



1 INTRODUCTION

Water represents a common good for living beings, playing a fundamental role both in the maintenance of life and in socioeconomic development (Rodrigues; Cruvinel, 2022). According to Decree nº 24.643, of July 10, 1934, also known as the Brazilian Water Code, everyone is allowed to use any public waters, and it is the responsibility of the Union to guarantee the fulfillment of this right to each citizen (Brasil, 1934).

Article 21, item XIX, of the 1988 Constitution of the Federative Republic of Brazil establishes that it is the responsibility of the Union to manage national water resources, and it must "establish a national system for the management of water resources and define criteria for granting rights to their use" (Brasil, 1988).

Federal Law No. 9,433, of January 8, 1997, popularly known as the "Water Law," establishes the National Water Resources Policy (PNRH) and creates the National Water Resources Management System (SINGREH) (Brasil, 1997). This Law introduced the model of the World Water Association, which is based on the principles of integration, decentralization, and participation (Nicollier; Kiperstok; Bernardes, 2023).

The PNRH states that water represents a public domain asset, being a limited natural resource with economic value. Even so, the territorial unit for its implementation, considering the multiple uses of water, is a hydrographic basin. The second paragraph of the PNRH consists of "guaranteeing to present and future generations the need for water, in quality standards adequate to their respective uses" (Brasil, 1997).

To achieve its objectives, the National Water Resources Plan (PNRH) relies on water resources management instruments, namely: Water Resources Plans; the classification of water bodies according to the predominant uses of water; the granting of water use rights; the charging for the use of water resources; compensation to municipalities; and the Water Resources Information System (Brasil, 1997).

Water Resources Plans (PRHs) determine the water resources agenda at the national, state, or river basin level, guide the application of other instruments of the National Water Resources Policy (PNRH), and finally, provide updated data on the region they cover, feeding various databases, such as SINGREH. In them, action plans are determined for the management of water resources, with the proposal of various goals to be achieved in each period, which aim at the implementation of multiple uses of water, the guarantee of water security in the river basin, and the improvement of water quality and quantity conditions (ANA, 2025a).

In view of the above, there are Water Resources Situation Reports, which carry out the systematic analysis and monitoring of water resources in a region, providing data, statistics, and indicators related to water. In addition, they present information on the hydrological cycle, the uses of water resources, quality and quantity, management, among others. These reports assess compliance with the goals set by the PRHs, serving as a complement to them (ANA, 2025b).

The River Basin Committees (CBHs) are, among others, entities that make up the SINGREH, being responsible for fulfilling the objectives of the PNRH (ANA, 2025c). They consist of consultative and deliberative collegiate bodies, in which various entities participate as members and manage the water resources of a river basin by defining rules to be followed regarding water use (ANA, 2011). They are decentralized by river basin and include the

participation of public authorities, users and civil society organizations, which ensure that the rules are applied through their regulatory power (ANA, 2011).

The River Basin Committees (CBHs) have the responsibility of periodically developing Water Resources Plans within the hydrographic basin in which they are located, as well as the Water Resources Situation Report for the region they manage.

The State of São Paulo has the State Water Resources Policy (PERH), Law No. 7,663, of December 30, 1991, which establishes the Integrated Water Resources Management System (SIGRH) and is also based on the principles of participation, decentralization, and integration for the sustainable management of water resources (São Paulo, 1991). The PERH of the State of São Paulo also considers the hydrographic basin as the territorial unit for planning and management (Nicollier; Kiperstok; Bernardes, 2023).

Thus, an alignment can be seen between the State of São Paulo's Water Resources Plan (PERH) and the National Water Resources Policy (PNRH), which are based on the same principles and foresee the articulation between water resources management, socioeconomic development, and environmental protection (Nicollier; Kiperstok; Bernardes, 2023).

Given the context presented, this work focuses on the Water Resources Management Unit of Pontal do Paranapanema, UGRHI-22, which integrates 26 municipalities that are part of the Pontal do Paranapanema Hydrographic Basin, whose hydrographic network is composed of the Santo Anastácio, Paranapanema, and Paraná Rivers, as well as their tributaries (CBH-PP, 2025).

The Water Resources Situation Reports for the Pontal do Paranapanema region, produced by the Pontal do Paranapanema Hydrographic Basin Committee (CBH-PP), responsible for the planning and management of UGRHI-22, present a summary of the water resources situation in a given year, covering aspects of water availability, water demand and water balance (Theme 1), sanitation (Theme 2), water quality (Theme 3) and institutional management (Theme 4).

Sanitation acts as a link between environmental improvement and disease elimination for health promotion. From this perspective, sanitation actions should involve housing (intra- and peridomiciliary), community and public management of water and waste within a network of health issues (FARIA et al., 2023).

The Social Determinants of Health (SDH), proposed by the World Health Organization (WHO), are fundamental to the production of health policies.

Thus, the different health conditions observed among different population segments are determined by interrelated "social" factors: nutrition and daily habits; gender and ethnic-racial differences; occupation, work and income; unequal access to health care and technologies and to cultural and educational resources; unhealthy environments and precarious and violent social environments. But also by macro-social determinants, such as health policy, macroeconomic policy, state organization, etc., which would form the socio-economic and political context (MARIO, 2023, p. 3).

Thus, it is evident that sanitation is intrinsically linked to environmental conditions that affect the health of the population, also encompassing dimensions of individual and social well-being. Studies such as those by Sclar et al. (2018) reinforce this dependence by concluding that the experience of privacy and security in the use of sanitation infrastructure is influenced by

contextual and individual factors, such as the location of sanitation facilities and even the user's gender identity.

In the current scenario, Brazilian legislation details basic sanitation as a set of four essential services. These are defined by Law nº. 14.026, of July 15, 2020, which updates the legal framework for basic sanitation, and by Law No. 9,984, of July 17, 2000, which creates the National Water and Basic Sanitation Agency (ANA). As explained by Borges and Britto (2025, pp. 244-245), since the beginning of the 1990s, Brazil has been directing the basic sanitation sector towards the private sector. This process became notorious after the promulgation of the then legal framework, which, according to the authors, indicates that the country is inclined to believe that the private sector is the greater provider of the common good in relation to state management.

The components of basic sanitation are: drinking water supply, sewage disposal, urban cleaning and solid waste management, and drainage and management of rainwater (Brazil, 2020). According to the World Health Organization, in 2022 only 57% of the global population used safely managed sanitation services, equivalent to 4.6 billion people; furthermore, more than 1.5 billion people did not have access to basic sanitation services, such as private toilets and latrines.

Regarding the first component, water supply consists of the activities of supplying and maintaining essential operational infrastructure for the supply of drinking water, from the catchment to the building connections and their measuring instruments (Brazil, 2020). In the Situation Reports, the indices related to water supply are the urban water service index and the water distribution system loss index.

Sanitary sewage is the set of activities, infrastructure, and facilities necessary for the collection, transportation, and proper final disposal of sewage, including building connections, disposal into the environment, or the production of reclaimed water (Brazil, 2020). In the Situation Reports, the parameters related to sanitary sewage are the proportion of domestic effluents collected and treated in relation to that generated, the efficiency of the treatment system, and the remaining domestic polluting organic load.

Urban cleaning and solid waste management services refer to the activities of providing and maintaining infrastructure for collection, manual and mechanized sweeping, transportation, treatment, and final disposal of waste (Brasil, 2020). The Situation Reports address the index of urban solid waste disposed of that classified as adequate and the landfill quality index (IQR).

Urban drainage is the set of activities, facilities, and infrastructure aimed at managing rainwater, including transportation, detention or retention for flood flow attenuation, treatment, and disposal of drained water (Brazil, 2020). Some of the UGRHI-22 Situation Reports address the coverage rate of underground urban drainage.

The UGRHI-22 Situation Reports title Theme 2 as "Sanitation" (more comprehensive), although they consider specific topics of basic sanitation, which allows other issues related to the physical environment that impact the health of the population to be addressed. For example, the Situation Reports have recently added urban drainage and mentioned erosion control as part of the theme.

2 OBJECTIVES

Considering the relevance of the aforementioned aspects, this work aimed to analyze the sanitation variables (water supply, sewage disposal, solid waste management, urban drainage, and erosion control) in UGRHI-22, based on the Situation Reports from the years 2016, 2017, 2019, 2021, and 2023.

3 METHODOLOGY

This article employed a qualitative-quantitative research methodology, based on a literature review of secondary data and the analysis of historical series available in official documents, aiming to understand the panorama of basic sanitation in the region under study.

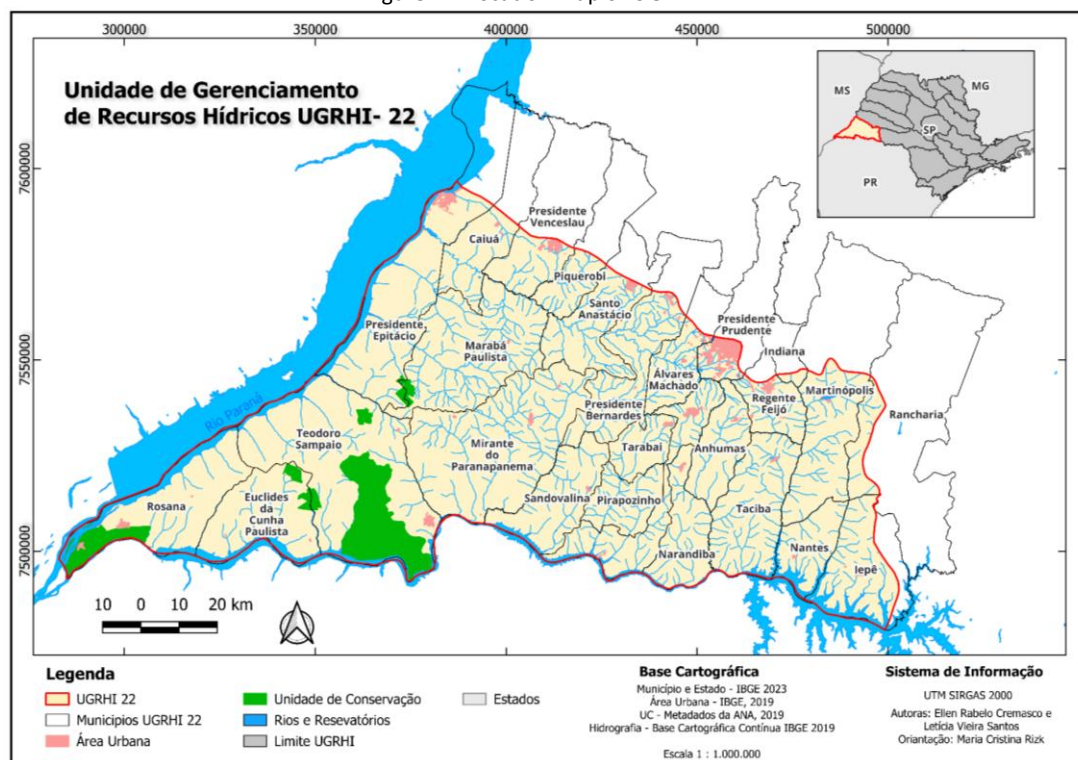
The study was based on the synthesis and historical analysis of the main components of sanitation: water supply, sewage disposal, solid waste management, urban drainage, and erosion control. The data were collected from the Situation Reports of the Pontal do Paranapanema Water Resources Management Unit (UGRHI-22), prepared by the Pontal do Paranapanema Hydrographic Basin Committee (CBH-PP).

The historical analysis carried out referred to the years 2016, 2017, 2019, 2021, and 2023, which are the most recent publication years of this document, available on the CBH-PP website. To this end, based on the evaluation of primary index data presented in the reports, summary graphs were created to allow for the visualization and interpretation of information in a temporal and comparative manner, in order to support the critical discussion on basic sanitation within the scope of UGRHI-22. A systematic bibliographic search was also conducted in recognized scientific databases to broaden the understanding of the determining factors of sanitation and to situate the results in a wider context.

4 RESULTS

Figure 1 shows the location of UGRHI-22 (Pontal do Paranapanema Hydrographic Basin), which is in the west of the State of São Paulo and borders the State of Paraná to the south and the State of Mato Grosso do Sul to the west. UGRHI-22 is delimited by two important rivers under federal jurisdiction: the Paraná River (border with Mato Grosso do Sul) and the Paranapanema River (border with Paraná).

Figure 1 – Location Map of UGRHI-22.



Source: Authors, 2025.

The UGRHI-22 encompasses, in whole or in part, the territory of 26 municipalities in São Paulo. Its territorial area is 12,333 square kilometers, considering the limits of the hydrographic basin that defines it (São Paulo, 2021 apud PERH, 2006).

According to the UGRHI-22 Situation Report for the year 2023, the main watercourses and reservoirs present in this location are the Santo Anastácio River and its tributaries; the Paranapanema River and its tributaries; the Paraná River and its tributaries; the Anhumas Stream; the Pirapozinho Stream; and the Laranja Doce Stream (CBH-PP, 2024).

Moreover, the region stands out for the hydraulic potential of its rivers, possessing 5 energy generation projects, which are responsible for approximately 17% of the total energy produced in the State of São Paulo. The main reservoirs of the UGRHI-22 are: Reservoirs of the Rosana, Taquaruçu, Porto Primavera, Capivara and Laranja Doce hydroelectric power plants (CBH-PP, 2024).

In addition to the prominence of water reservoirs and electricity generation, the UGRHI-22 is characterized by the high degree of mechanization of agriculture, mainly sugarcane cultivation, with agro-industries such as meatpacking plants, food industries and service sector activities also being relevant, especially in the municipality of Presidente Prudente (São Paulo, 2021).

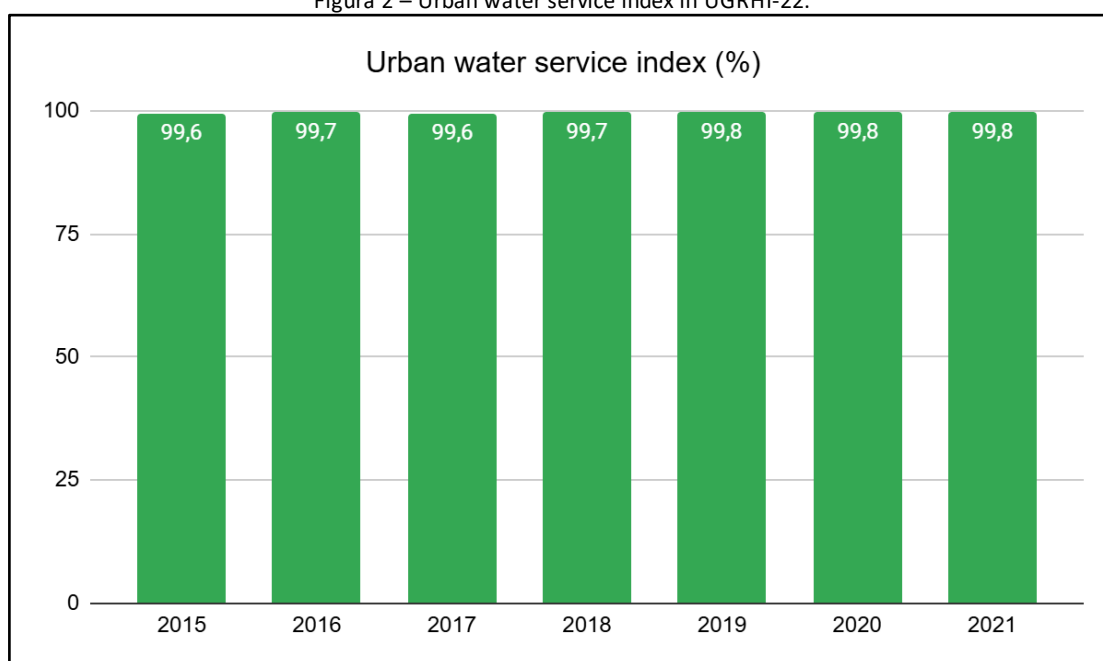
The UGRHI-22 has conservation units with important remnants of natural vegetation, as well as urban areas that concentrate most of the region's population, with approximately 92.26% of the inhabitants residing in them (CBH-PP, 2024).

Given that basic sanitation has a direct influence on the environment, public health, and socioeconomic development, the following discussions will address data related to the

components of basic sanitation: water supply, sewage disposal, solid waste management, urban drainage, and erosion control, collected in the Water Resources Situation Reports of UGRHI-22 (base years 2016, 2017, 2019, 2021, and 2023).

Regarding urban water supply, Figure 2 shows that urban water service coverage rates in UGRHI-22 remained high during the analyzed years, with averages above 99.6% across the territory, indicating that the region has an excellent water supply service. From 2019 to 2021, the percentage remained at 99.8%, meaning that approximately the entire population residing in the urban area of Pontal do Paranapanema is served with water supply, demonstrating that the common right of the people to access water is being ensured in the Pontal do Paranapanema Hydrographic Basin.

Figura 2 – Urban water service index in UGRHI-22.

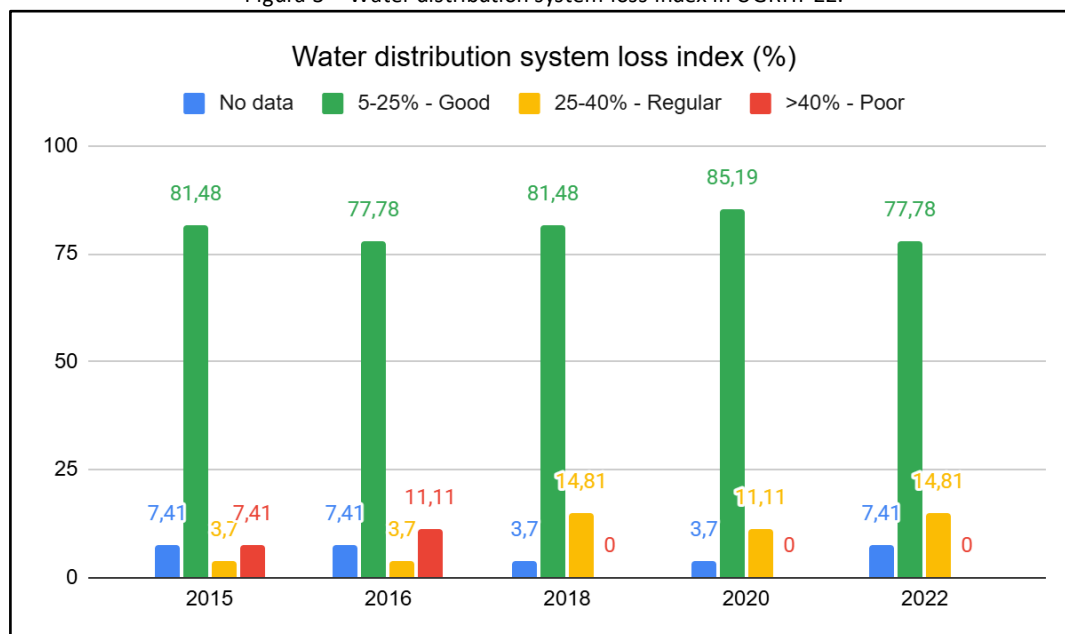


Source: Authors, 2025.

Araujo et al. (2022), based on analyses of 2019 data from the National Sanitation Information System (SNIS) and the Water Quality Surveillance Information System for Human Consumption (Sisagua), found that approximately 83.7% of the total population and 93% of the urban population are served by Water Supply Systems in Brazil. However, while in the Southeast, South, and Midwest regions, at least 85-90% of the regional population was served, in the Northeast and North regions, respectively, 73.9% and 58% of the regional population had access to water supply.

Still addressing the urban supply component, Figure 3 shows that the loss rates in water supply systems were high in the years 2015, 2016, 2018, 2020, and 2022. Although most municipalities presented water distribution system loss rates considered "good" (with losses of up to 25% of water), there are municipalities with percentages of losses classified as "regular" (when water loss is between 25 and 40%) and "poor" (when the system loses more than 40% of water) in all the years analyzed

Figura 3 – Water distribution system loss index in UGRHI-22.



Source: Authors, 2025.

The water distribution system loss index represents the recurring waste of water resources in the region, which leads to excessive pressure on the reservoirs of the UGRHI-22, potentially causing long-term water scarcity.

According to the Situation Reports, the municipalities that stood out negatively for their water losses in the analyzed periods were: Rancharia, Presidente Venceslau, Martinópolis, Presidente Prudente, Taciba, Caiuá, and Narandiba.

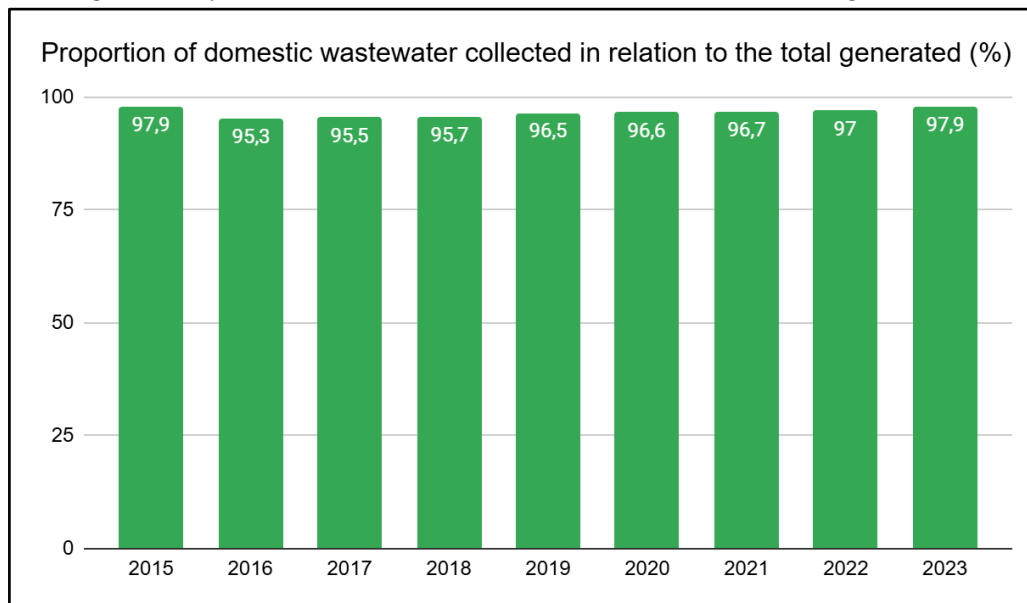
The last time there were municipalities with a "bad" classification, regarding the water distribution system loss index, was in 2016, which indicated an improvement for this variable in the hydrographic basin. However, the amount of water lost by the distribution systems was still high. In addition, more recent data (year 2022) showed that the number of municipalities with indices classified as "good" decreased, highlighting the need for attention to the issue. Furthermore, based on the data analyzed in this study, it was found that there were municipalities in UGRHI-22 that did not provide data on this index, which made a more precise assessment difficult.

Cominetiet al. (2025), based on SNIS data from 2021, points out that in 2020 in Brazil only 45% of Brazilian households had access to a sewage system, a value below the global average of 54% with access to safe sewage systems in 2020, according to the WHO. Furthermore, of the sewage collected, only 80% was treated in Brazil in 2020, according to SNIS data from 2021.

In UGRHI-22, in the period from 2015 to 2023, the proportion of domestic effluent collected in relation to the amount generated remained at good levels, above the national and global averages previously presented, indicating average values above 95%, as can be seen in Figure 4. In addition, it is observed that from 2016 there was a constant growth of this variable, which went from 95.3% to 97.9% in 2023. This indicates that the municipalities of Pontal do Paranapanema have been investing in the domestic sewage collection system, especially in

urban areas, where there is a greater population concentration and, consequently, a greater generation of effluents.

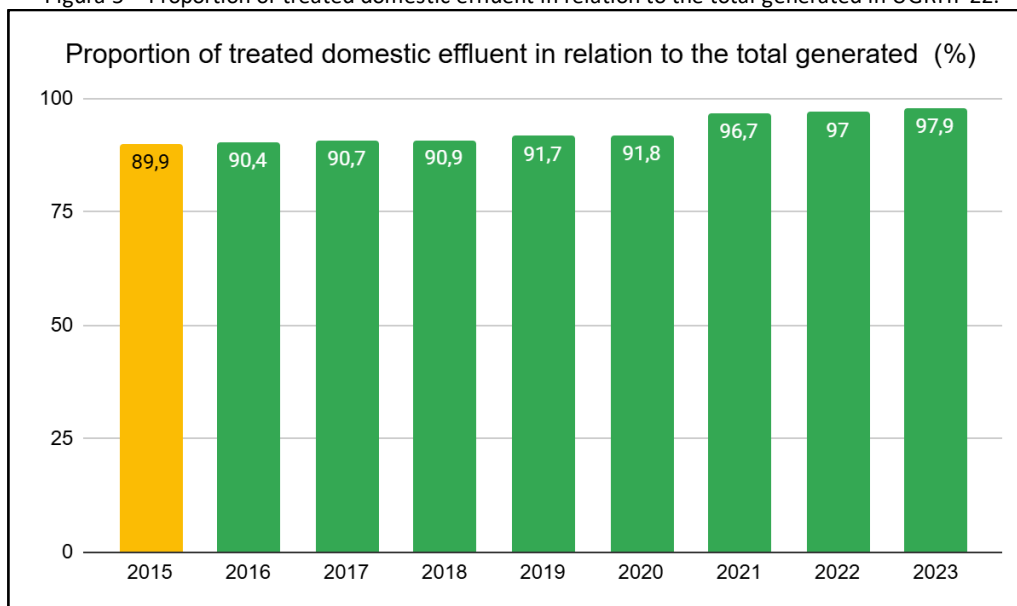
Figura 4 – Proportion of domestic wastewater collected in relation to the total generated in UGRHI-22.



Source: Authors, 2025.

According to Figure 5, the proportion of treated domestic effluent in relation to the total generated varied from 89.9% in 2015, considered "regular," to 97.9% in 2023, considered "excellent." The growth of this index from 2020 onwards was mainly due to the completion of the South Wastewater Treatment Plant (WWTP) in the municipality of Presidente Venceslau (CBH-PP, 2024).

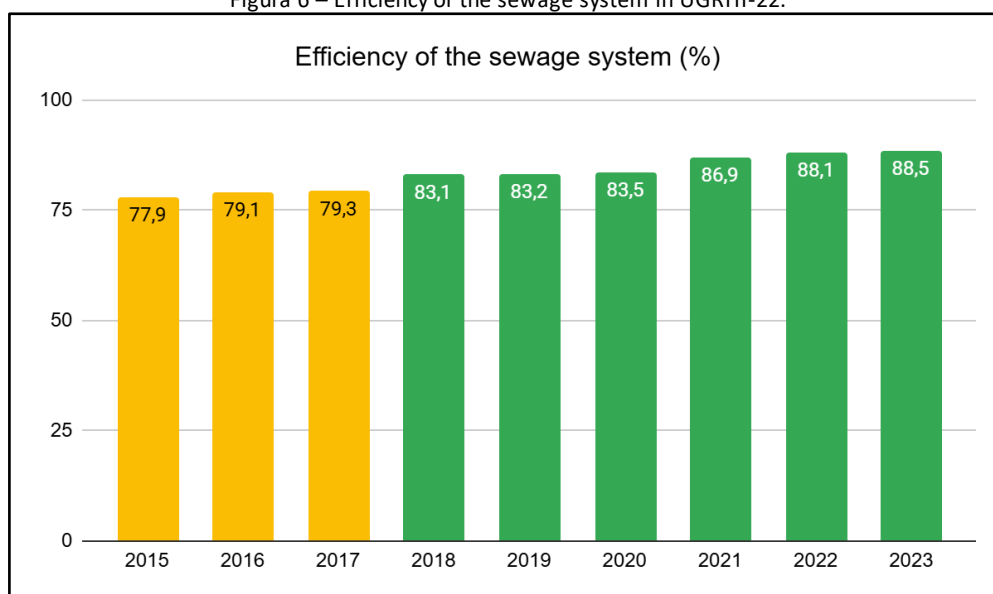
Figura 5 – Proportion of treated domestic effluent in relation to the total generated in UGRHI-22.



Source: Authors, 2025.

Regarding the sanitation component, in Pontal do Paranapanema, a constant increase in the efficiency of the sewage system is observed throughout the analyzed period (Figure 6). From 2015 to 2017, this index was classified as "regular," with percentages of 77.9%, 79.1%, and 79.3%, respectively. From then on, the efficiency of the region's systems was considered "excellent," with values between 83.1% (2018) and 88.5% (2023). Again, there was an improvement in this parameter from 2020 onwards due to the completion of the construction and the start of operation of the domestic wastewater treatment plant at the South Wastewater Treatment Plant in Presidente Venceslau, as previously mentioned (CBH-PP, 2024).

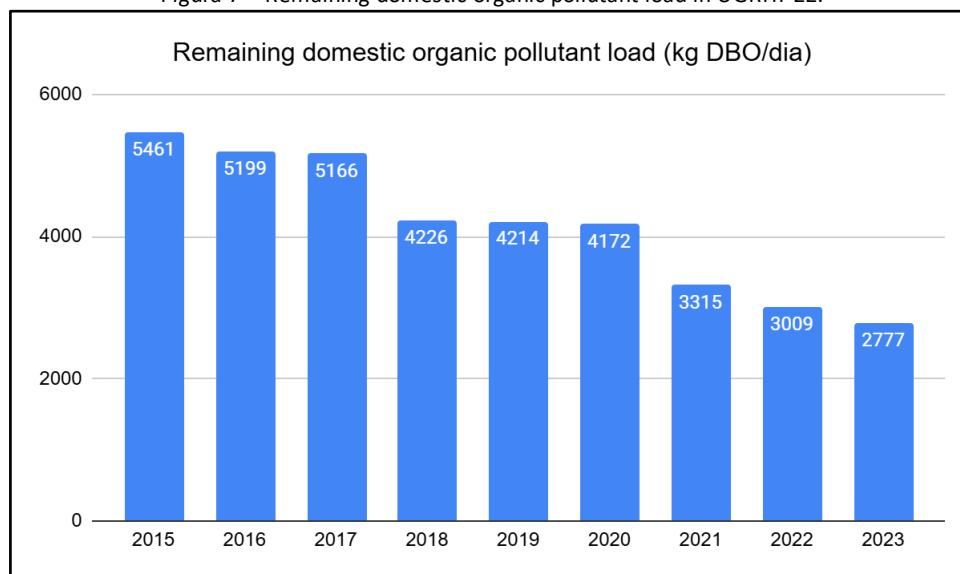
Figura 6 – Efficiency of the sewage system in UGRHI-22.



Source: Authors, 2025.

Furthermore, it is noticeable, through the analysis of Figure 7, that there is a decrease in the amount of remaining domestic polluting organic load in the domestic effluent generated in UGRHI-22. This occurrence can be explained by the population growth projection presented by the State Data Analysis System (Seade), an institution responsible for providing population estimates and projections annually, which are used by CBH-PP to produce the Pontal do Paranapanema Situation Reports.

Figura 7 – Remaining domestic organic pollutant load in UGRHI-22.

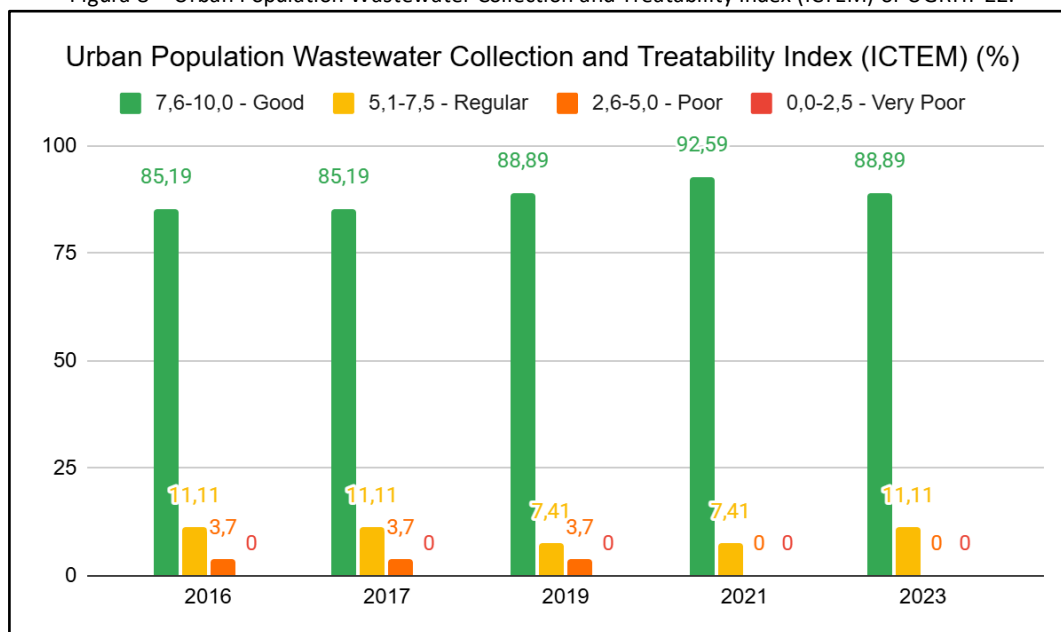


Fonte: Authors, 2025.

Seade provided data showing that the geometric annual growth rate of the population of the Pontal do Paranapanema Hydrographic Basin has been declining, even reaching negative values in 2023, indicating that the projection was possibly overestimated by the agency (CBH-PP, 2024). Thus, assuming that the population of the analyzed region has been decreasing, the organic loads generated and, consequently, the reduced and remaining loads showed a decrease in the period between 2015 and 2023, going from 5,461 kg of BOD/day to 2,777 kg of BOD/day.

Figure 8 presented the annual values of the Urban Population Sewage Collection and Treatability Indicator (ICTEM) for UGRHI-22, which considered the criteria of collection, existence and efficiency of sewage treatment systems, efficiency of removing the organic load from sewage, proper disposal of sewage treatment rejects and, finally, the non-disqualification of the receiving water body class due to the discharge of treated effluent and untreated sewage (CBH-PP, 2024).

Figura 8 – Urban Population Wastewater Collection and Treatability Index (ICTEM) of UGRHI-22.



Source: Authors, 2025.

Between 2016 and 2023, the ICTEM (Index of Territorial Competence, Territorial and Environmental Competence) of most municipalities in the hydrographic basin were classified as "good" (with scores between 7.6 and 10.0), representing more than 85% of the territory in each year. Furthermore, the number of localities that received a "regular" rating (with values from 5.1 to 7.5) during the period analyzed remained between 2 and 3, representing 7.47% and 11.11%, respectively. As for the "poor" class of this indicator (scores from 2.6 to 5.0), in the years 2016, 2017, and 2019 only 1 municipality (3.7% of the territory) was classified as such. However, in 2021 and 2023, no municipality was classified in this way. Finally, the ICTEM was not classified as "very poor" (which considers values up to 2.5) in the Pontal do Paranapanema region during the years analyzed.

Considering this, there was an improvement in the region's ICTEM from 2020 onwards, as the municipalities began to fall into only the two best categories, indicating that sanitation management in UGRHI-22 became more effective.

It is worth pointing out that the municipalities that were classified as "regular" and/or "poor" during the analyzed period were: Mirante do Paranapanema, Presidente Venceslau, Rancharia, Rosana, Iepê, and Martinópolis.

Over the past few years, investment in sanitation has been quite significant in the state of São Paulo. And, although the large sum of resources is reflected in the improvement of indicators, efforts are still needed to achieve universal access to this service in the coming years, especially regarding connections to the collection, removal, interception, and treatment systems, and the reduction of effluent loads (SÃO PAULO, 2024, p. 347).

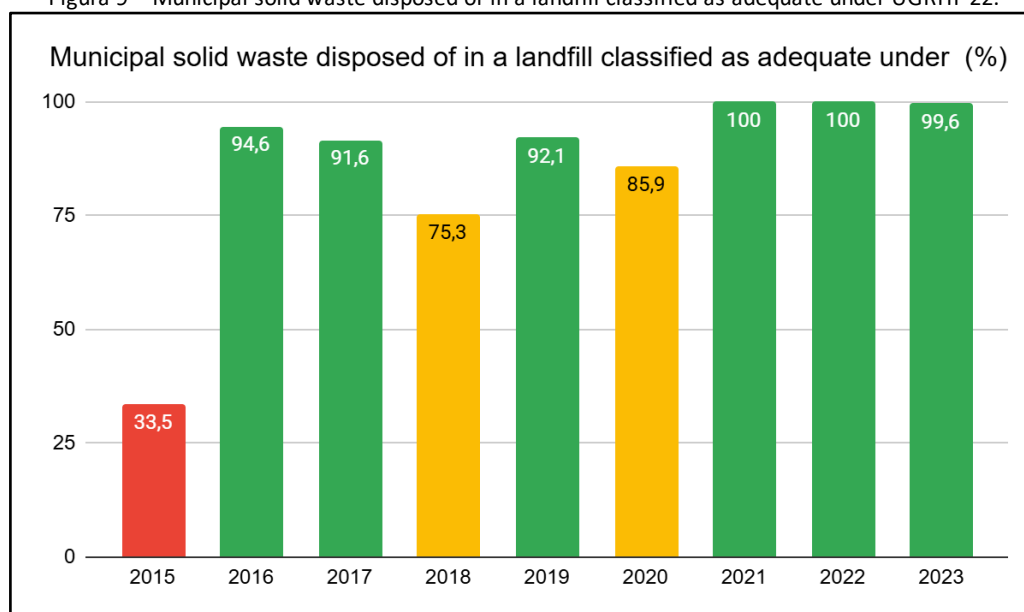
Furthermore:

the collection, removal, and proper treatment of domestic and urban sewage are a pressing environmental necessity for preserving good environmental quality and maintaining the water quality of rivers as receiving bodies and potential sources of water supply. Not all rivers are classified for all uses: some rivers are classified as suitable for public water supply, while others are classified in ways that restrict such uses to the dilution of treated effluents, for example (SÃO PAULO, 2024, p. 347).

oleta, o afastamento e o tratamento adequado dos esgotos domésticos e urbanos são uma necessidade ambiental premente para a preservação de uma boa qualidade ambiental e para a manutenção da qualidade da água dos rios como corpos receptores e possíveis mananciais de abastecimento de água. Nem todos os rios são classificados em enquadramento para quaisquer usos: há rios cujo enquadramento permite seu uso para o abastecimento público, e há rios enquadrados em classes que restringem tais usos à diluição de efluentes tratados, por exemplo (SÃO PAULO, 2024, p. 347).

For the indicator of municipal solid waste (MSW) disposed of in landfills classified as adequate (Figure 9), the status reports used the classification: "Good ($\geq 90\%$)", "Regular" ($\geq 50\%$ and $< 90\%$) and "Poor" ($< 50\%$).

Figura 9 – Municipal solid waste disposed of in a landfill classified as adequate under UGRHI-22.



Source: Authors, 2025.

In 2015, UGRHI-22 recorded an index of MSW disposed of in landfills classified as adequate but considered "poor," with only 33.5% of waste disposed of in adequate landfills. Most MSW was disposed of in municipal landfills, lacking leachate collection structures and soil waterproofing, with irregularities in drainage systems, receiving industrial waste, among other issues, potentially impacting the soil, groundwater, surface water, and public health. The low adequacy index in 2015 was a direct reflection, mainly, of three municipalities responsible for 57.7% of the total volume of MSW in the hydrographic basin (Presidente Prudente, Pirapozinho, and Presidente Epitácio) (CBH, 2016).

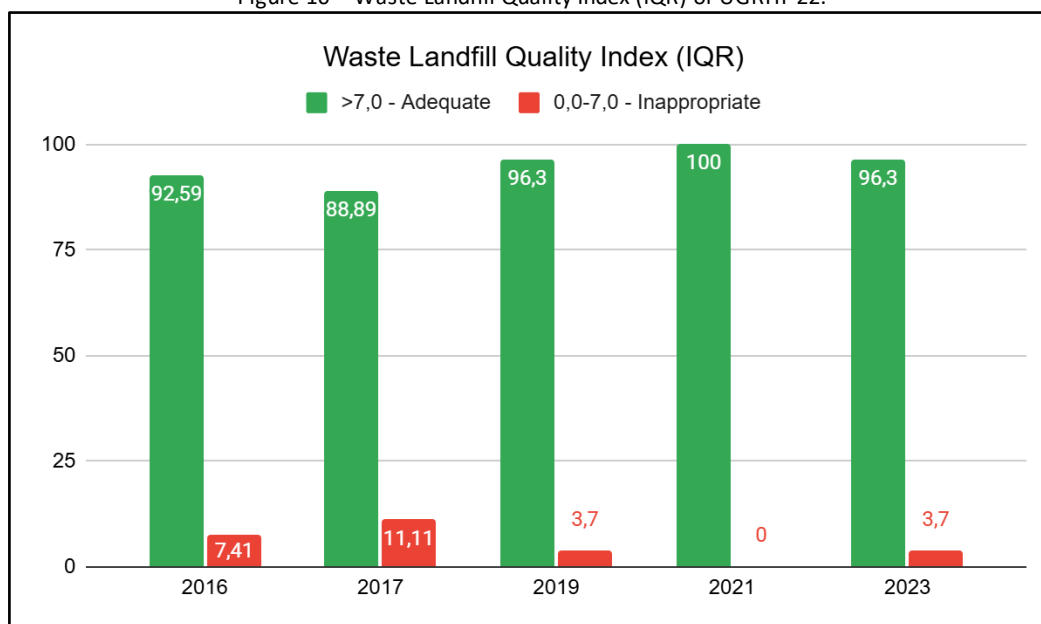
In 2016, this index showed a significant improvement, reaching 94.6% and being classified as "good." This evolution occurred mainly due to an agreement for the decommissioning of the "dumps" in Presidente Prudente and Presidente Epitácio (CBH, 2017).

In 2017, the landfills in Caiuá, Presidente Venceslau, and Álvares Machado were considered inadequate, resulting in a total of 91.6% of waste being disposed of in adequate landfills. However, in 2018, this rate decreased to 75.3%, being considered "regular." Consequently, in 2019, only the municipality of Presidente Venceslau was listed as inappropriate. The rates remained at high levels in subsequent years, with 100% adequacy in 2021 and 2022.

In 2023, the daily generation of MSW in UGRHI-22 was 363.1 tons, indicating a reduction compared to previous years, which can be explained by the negative population growth projection for the region, as already mentioned. The percentage of waste disposed of in adequate landfills was 99.6%, with only the municipality of Caiuá having a landfill classified as "Inappropriate".

The Waste Landfill Quality Index (WQI) in UGRHI-22 classifies landfills as "adequate" (WQI > 7) or "inappropriate" (WQI from 0 to 7). This index is directly related to the index of urban solid waste disposed of in landfills classified as suitable and reveals, in general, a positive evolution in the final disposal of waste between 2015 and 2023 (Figure 10).

Figure 10 – Waste Landfill Quality Index (IQR) of UGRHI-22.



Source: Authors, 2025.

In 2016, 7.41% of landfills were considered inappropriate. This rate increased in 2017 (11.11%) and decreased again in 2019 (3.7%), reaching zero in 2021. However, although 100% of landfills were considered adequate in 2021, this value decreased in 2023, since one of the landfills was considered inadequate in the region.

In Brazil, in 2022, approximately 39% of the 76.1 million tons of MSW collected went to inadequate disposal, such as open dumps and controlled landfills, despite the existence of the new legal framework for sanitation. This occurs because in 2,826 of the 5,570 Brazilian

municipalities, open dumps and/or controlled landfills predominate as a form of final disposal of MSW, a weakness that can exacerbate the low recycling rate. It is a known fact that environmentally inadequate final disposal can harm opportunities, such as the production of biogas and electricity (Freitas, Pires, Benincá, 2024).

Although sanitary landfills promoted the environmentally adequate final disposal of 61% of MSW collected in 2022 and the presence of sanitary landfills in 2,744 municipalities constitutes a force for MSW management, the high costs for their construction and maintenance represent a real threat. This threat, however, can be minimized with the strength of the intermunicipal consortium model, as it is an option to minimize costs and increase gains through shared management, a measure encouraged in the National Solid Waste Policy (PNRS) (Freitas, Pires, Benincá, 2024).

Regarding urban drainage and erosion control in Pontal do Paranapanema, the Situation Reports consistently pointed to soil erosion and siltation of water bodies as critical points throughout the years analyzed. Initially, the 2016, 2017, and 2019 Reports did not detail the coverage of the underground urban drainage network with indices. However, it was mentioned that UGRHI-22 was "very susceptible to erosion."

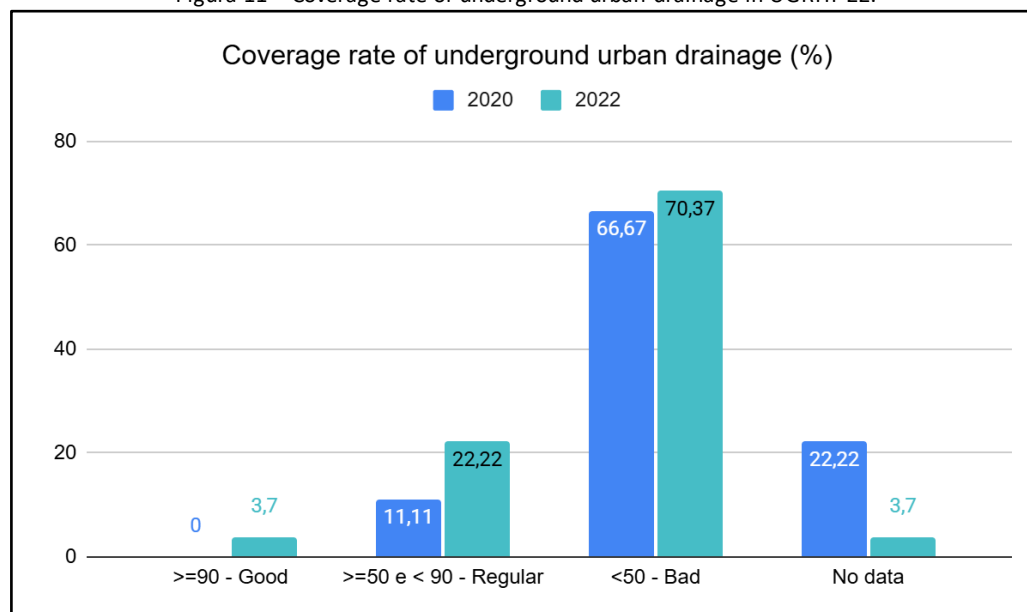
It is worth noting that since 2007, Brazil has sought to consolidate the institutional structure of the urban drainage and stormwater management sector with the enactment of Law No. 11,445, defining responsibilities and tariff mechanisms that did not previously exist. However, it was only in 2020 that the legal review established the Basic Sanitation Legal Framework, Law No. 14.026, which created the National Water and Basic Sanitation Agency (ANA) and formally assigned to it the responsibility of establishing reference standards in the sector (Mendes et al., 2025).

As a result, starting in 2021, situation reports began to include a specific topic on the subject, and the indicators pointed to an incomplete urban drainage network with ongoing problems of rural erosion, favoring soil loss and siltation of water bodies in the UGRHI.

Between 2020 and 2022, there was progress in information on the coverage rate of the urban drainage network. In 2020, 22.2% of municipalities lacked data, while in 2022 this percentage decreased to 3.7%. In 2020, there were no municipalities with a drainage coverage rate considered "good," and in 2022 this category came to represent 3.7% of municipalities. In both years, the predominant index was "bad," as can be seen in Figure 11.

Despite the scenario being considered "bad," the 2023 Situation Report highlighted constant funding initiatives, mainly through the State Water Resources Fund (FEHIDRO), for stormwater drainage and energy dissipator works, to improve the criticality of soil erosion and siltation of water bodies. Furthermore, in 2023 a positive aspect was presented regarding vulnerability to flooding: a maximum of 5% of households in risk areas.

Figura 11 – Coverage rate of underground urban drainage in UGRHI-22.



Source: Authors, 2025.

Water erosion is a phenomenon that affects populations, impacting food security and the quality of surface waters through siltation. The intensity of soil loss processes can worsen due to environmental changes caused by deforestation, lack of conservation practices, and soil compaction by livestock farming, among others (FRANCISCO, 2024). Furthermore, the siltation process intensifies even under variations in land use and occupation. According to Ciupa; Suligowski (2023, p. 14), there is a proportional relationship between the reduction in the volume of water reservoirs and the increase in impermeable areas in a hydrographic basin.

Regarding soil fragility, the Pontal do Paranapanema region has a predominance of sandy soils. The high susceptibility to erosion in the region is the result of the combination of three main factors: intense and concentrated rainfall in the summer, relief of wide slopes, and fragile sandstone geology in the drainage headwaters. In UGRHI-22, 3,250 linear erosions were identified (FRANCISCO, 2024), a fact that highlights the need for investments and efforts in monitoring and controlling erosion in Pontal do Paranapanema.

Based on the data analyzed, it is observed that UGRHI-22 has shown significant progress in several components of basic sanitation, especially about water supply and sewage disposal, whose indicators demonstrated broad coverage and increasing efficiency. Solid waste management has also evolved significantly, although it still requires attention regarding waste valorization strategies.

On the other hand, urban drainage and erosion control remained the most critical points, marked by data gaps and the persistence of unsatisfactory rates. This scarcity of data is corroborated by Moraes; Hanai (2024, p. 14), who highlight the complexity in obtaining public data at the municipal level on sanitation, as observed in the study carried out in the municipality of São Carlos, State of São Paulo. These aspects highlight the need for continuous and planned investments, especially in terms of infrastructure, so that the progress made in other areas of sanitation is not compromised by uncontrolled environmental pressures.

Thus, the joint analysis of the indicators reinforces the importance of integrated management and constant monitoring to strengthen public policies and improve the quality of life in the Pontal do Paranapanema region.

5 CONCLUSION

The results obtained from the analysis of data from the Water Resources Situation Reports of UGRHI-22 enabled a historical assessment of the sanitation situation in the region. This assessment encompassed the main aspects related to water supply, sewage disposal, solid waste management, urban drainage, and erosion control.

Regarding water supply, the region has consistently maintained urban service levels classified as "excellent" throughout the analyzed period, between 2016 and 2023. However, a challenge lies in the high loss rates in water distribution systems, which demonstrate a waste of water resources, potentially leading to scarcity situations in the future if this scenario is not mitigated.

In relation to sewage disposal, there has been a notable improvement in the proportion of domestic effluent collected and treated. Despite this progress, the presence of municipalities with collection and treatability indicators classified as "regular," as well as the need for attention to the management of diffuse pollution sources and the implementation of tertiary treatment, indicate that the final quality of water bodies may still be compromised in the region.

Regarding urban solid waste, the hydrographic basin recorded a substantial improvement in the percentage of waste disposed of in adequate landfills. However, municipalities face the problem of the cost associated with this disposal. For a more comprehensive analysis of this topic, in addition to information on landfills, it is important to consider aspects of urban cleaning, waste recovery rates, such as recycling, among others.

Urban drainage and erosion control, as seen, present a scarcity of indicators for analysis. The existing information indicates that most of the urban drainage in the region is considered "poor," suggesting the occurrence of erosion and siltation of the water bodies of UGRHI-22, being the point of greatest attention for planning and management measures.

Therefore, improvements in sanitary indicators related to water supply, sewage disposal, and solid waste management, as well as their monitoring, such as in the case of urban drainage and erosion control, are intrinsically linked to improvements in environmental quality and public health in the Pontal do Paranapanema region.

Monitoring these indicators through Water Resources Situation Reports is a fundamental part of defining priority actions and providing input to the Basin's Water Resources Plan, as seen throughout this work. It is possible to conclude, then, that the Situation Reports discussed here are part of the water resources management instruments and are of paramount importance for water resources planning and management.

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DISCLOSURES

AUTHOR CONTRIBUTIONS

- **Study Conception and Design:** Ellen Rabelo Cremasco; Letícia Vieira Santos; Maria Cristina Rizk.
 - **Data Curation:** Ellen Rabelo Cremasco; Letícia Vieira Santos.
 - **Formal Analysis:** Ellen Rabelo Cremasco; Letícia Vieira Santos.
 - **Acquisition of financing:** There was no financing obtained
 - **Investigation:** Ellen Rabelo Cremasco; Letícia Vieira Santos.
 - **Methodology:** Ellen Rabelo Cremasco; Letícia Vieira Santos.
 - **Writing – Initial Writing:** Ellen Rabelo Cremasco; Letícia Vieira Santos.
 - **Writing - Critical Review:** Ellen Rabelo Cremasco; Letícia Vieira Santos; Maria Cristina Rizk.
 - **Review and Final Edit:** Maria Cristina Rizk.
 - **Supervision:** Maria Cristina Rizk.
-

DECLARATION OF CONFLICTS INTEREST

We, **Ellen Rabelo Cremasco; Letícia Vieira Santos; Maria Cristina Rizk**, declare that the manuscript entitled **"Sanitation Challenges and Advances in the UGRHI-22 of Pontal do Paranapanema – SP – Brazil"**:

1. **Financial Ties:** There are no financial ties that could influence the results or interpretation of the work. No funding institution or entity was involved in the development of this study.
 2. **Professional Relationships:** No professional relationships relevant to the content of this manuscript have been established.
 3. **Personal Conflicts:** No personal conflicts related to the content have been identified.
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