ISSN: 2447-3359

REVISTA DE GEOCIÊNCIAS DO NORDESTE

Northeast Geosciences Journal

v. 11, nº 2 (2025)

https://doi.org/10.21680/2447-3359.2025v11n2ID40611

Conflicts over the occupation of the area surrounding the Pedro Moura Júnior reservoir in the Ipojuca River watershed

Conflitos pela ocupação do entorno do reservatório Pedro Moura Júnior da bacia do rio Ipojuca

Renan Bezerra Rosa[1]; Sabrina Dafyne Soares Araújo[2]; Taiza Karla Alves Souza[3]; Marcella Vianna Cabral Paiva[4]; Silvanete Severino da Silva[5]; Saulo de Tarso Marques Bezerra[6]; Anderson Luiz Ribeiro de Paiva[7]; Eduardo Soares de Souza[8]

[1] Federal Rural University of Pernambuco (UFRPE), Academic Unit of Belo Jardim (UABJ), Belo Jardim/PE, Brazil. Email: renan.bezerra@ufrpe.br
ORCID: https://orcid.org/0009-0001-7578-567X

[2] Federal Rural University of Pernambuco (UFRPE), Academic Unit of Belo Jardim (UABJ), Belo Jardim/PE, Brazil. Email: sabrina.dafyne@ufrpe.br
ORCID: https://orcid.org/0009-0006-8927-0630

[3] Federal Rural University of Pernambuco (UFRPE), Academic Unit of Belo Jardim (UABJ), Belo Jardim/PE, Brazil. Email: taiza.alvessouza@ufrpe.br
ORCID: https://orcid.org/0000-0001-9298-1173

[4] Pernambuco Sanitation Company (Compesa), Petrolina/PE, Brazil. Email: marcelaviana@compesa.com.br
ORCID: https://orcid.org/0000-0003-2466-121X

[5] Federal Rural University of Pernambuco (UFRPE), Academic Unit of Belo Jardim (UABJ), Belo Jardim/PE, Brazil. Email: silvanete.silva@ufrpe.br
ORCID: https://orcid.org/0000-0002-3167-0811

[6] Federal University of Pernambuco (UFPE), Agreste Campus, Caruaru/PE, Brazil. Email: saulo.tarso@ufpe.br
ORCID: https://orcid.org/0000-0002-5815-5908

[7] Federal University of Pernambuco (UFPE), Recife/PE, Brazil. Email: anderson.paiva@ufpe.br
ORCID: https://orcid.org/0000-0003-3475-1454

[8] Federal Rural University of Pernambuco (UFRPE), Serra Talhada Academic Unit (UAST), Serra Talhada/PE, Brazil. Email: eduardo.ssouza@ufrpe.br
ORCID: https://orcid.org/0000-0002-5488-5284

Abstract: The study of land use and occupation is fundamental for understanding the environmental characteristics of a territory. In this context, the present research aims to investigate, identify, and analyze the socio-economic conflicts surrounding the Pedro Moura Júnior Reservoir, located in the Ipojuca River watershed, with an emphasis on the challenges faced by the riverside population. The study was conducted in the area surrounding the reservoir and employed remote monitoring techniques using CHIRPS satellite data, as well as dynamic analyses of land use and occupation over the last 20 years (2003–2023). The identified changes were complemented by field visits, which allowed for the registration of locations through direct observation, interviews with residents, and photographic records. The results corroborate significant transformations in land use and reveal that the few public policies implemented in the area are generally insufficient, especially in the more distant and vulnerable regions. This water vulnerability, combined with the lack of effective public policies, intensifies socio-economic conflicts and highlights the urgent need for integrated interventions by the government and responsible agencies, together with the state sanitation company.

Keywords: Water resources; Environmental sanitation; Remote sensing.

Resumo: O estudo sobre o uso e a ocupação do solo são fundamentais para a compreensão das características ambientais de um território. Nesse sentido, esta pesquisa teve como objetivo investigar, identificar e analisar os conflitos socioambientais no entorno do reservatório Pedro Moura Júnior, inserido na bacia hidrográfica do rio Ipojuca, com ênfase nos desafios enfrentados pelas populações ribeirinhas. O estudo foi conduzido na zona limítrofe do reservatório e empregou técnicas de sensoriamento remoto, utilizando dados do satélite CHIRPS e a análise da dinâmica do uso e cobertura do solo ao longo dos últimos 20 anos (2003–2023). As mudanças identificadas foram complementadas por visitas *in loco*, que permitiram registrar a realidade local por meio de observações diretas, entrevistas com moradores e registros fotográficos. Os resultados evidenciaram transformações significativas no uso do solo e revelaram que as poucas ações públicas implementadas na área são, em geral, insuficientes, sobretudo nas zonas mais afastadas e vulneráveis. Essa vulnerabilidade hídrica, aliada à ausência de políticas públicas eficazes, itensifica os conflitos socioambientais e reforça a necessidade urgente de intervenções integradas por parte do poder público e dos órgãos responsáveis, como a companhia estadual de saneamento.

Palavras-chave: Recursos hídricos; Saneamento ambiental; Sensoriamento remoto.

Received: 24/06/2025; Accepted: 22/10/2025; Publication: 04/11/2025.

1. Introduction

Conflicts related to the use and distribution of water represent a topic of constant debate, requiring innovative approaches for the identification and resolution of emerging issues during analysis. When it comes to environmental conflicts, understanding socio-environmental dynamics is essential, especially regarding land use and occupation in semiarid regions. These areas, characterized by low rainfall, high evapotranspiration, sparse vegetation, and shallow soils often lacking plant cover, are susceptible to becoming arid and thus more vulnerable to anthropogenic transformations that, when combined, lead to desertification (SOBRAL et al., 2018).

Therefore, the dynamic study of land use and occupation in a given region is fundamental for understanding the environmental characteristics that have been modified over time (MARTINS et al., 2022). The replacement of natural areas by human activities, when carried out without adequate planning, legal support, and rational use of resources, may cause severe impacts on any biome, intensifying environmental degradation and aggravating conflicts over access to and management of natural resources (PAULA, MAGNAGO & TAGLIAFERRE, 2025).

Accordingly, a dynamic process was observed in the Pedro Moura Júnior Reservoir area, where the transformations resulting from different land uses have created discrepancies in sanitation services between urban and rural zones. Such conditions intensify environmental impacts and limit the availability of water resources, compromising the sustainability of local ecosystems and the quality of life of populations that depend on these resources (SILVA et al., 2017; FERNANDES, CARDOSO & QUEIROZ, 2020; ROSA et al., 2024). These contrasts are further aggravated by the vulnerability of the Caatinga, the predominant biome in the region, classified as semiarid.

Although previous studies, such as that of Silva et al. (2023), have addressed environmental conflicts in other reservoirs within the Ipojuca River watershed—such as the Engineer Severino Guerra Reservoir—there remains a scarcity of information regarding the Pedro Moura Júnior Reservoir. This informational gap is particularly evident in relation to urban expansion, which now occupies areas previously classified as rural. Despite the reservoir's relevance to the municipality and the Ipojuca River watershed, there is still little information about the population living in the surrounding areas, which is frequently marginalized due to its distance from the urban center.

In light of this scenario, the present study aims to investigate, identify, and analyze the environmental conflicts surrounding the Pedro Moura Júnior Reservoir, located within the Ipojuca River watershed. The research seeks to understand the disputes over water use and management of this water source, considering the different stakeholders involved and the challenges associated with the management of these essential resources. Specifically, it aims to analyze the socio-environmental conflicts in the surroundings of the Pedro Moura Júnior Reservoir, with emphasis on the challenges faced by the local population.

2. Metodologia

The present study was conducted at the Pedro Moura Junior Reservoir, which belongs to the Ipojuca River watershed and is located four kilometers southeast of the municipality of Belo Jardim, in the Agreste region of Pernambuco State. This reservoir has a total capacity of 35 million cubic meters and is the largest in terms of demand for public water supply, playing a vital role in meeting the region's water needs (COMPESA, 2019), as shown in Figure 1.

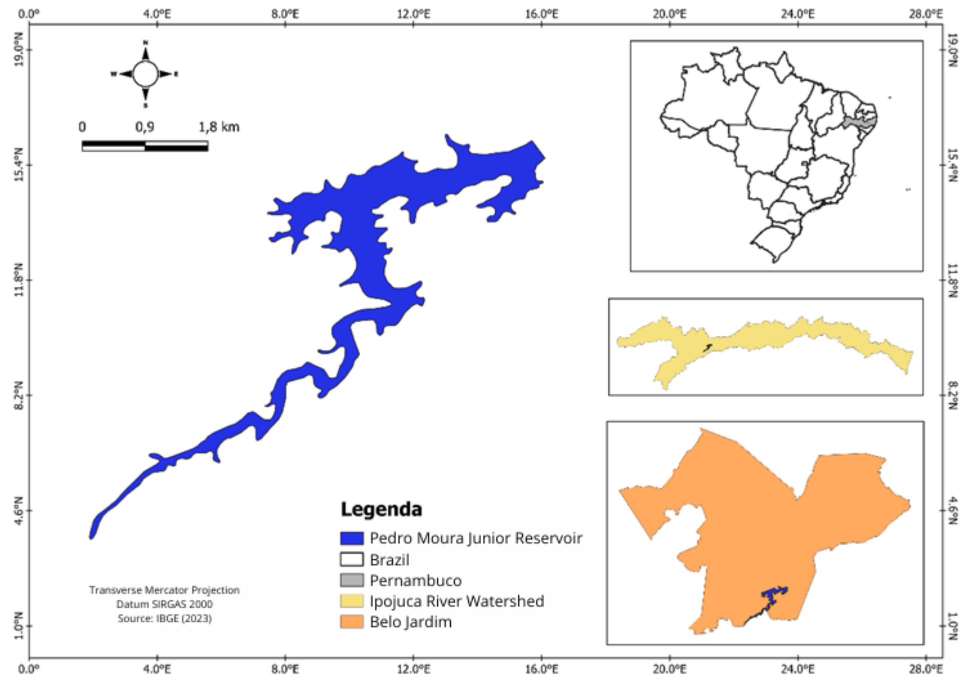

Figure 1 – Pedro Moura Junior Reservoir location.
Source: By the author, using IBGE (2023) data.

The research methodology is both qualitative and quantitative, based on a case study approach and supported by representative data, including document analysis, interviews, photographs, and direct observation.

To create the location map, data from the Instituto Brasileiro de Geografia e Estatística (IBGE – Brazilian Institute of Geography and Statistics) were used, downloaded in shapefile format. For the land use and land cover map, data in GeoTIFF format were obtained from MapBiomas Brasil, which is a collaborative initiative monitoring land use and cover from 1985 onwards, using satellite images. In the Figure 1 map, a color composition was performed, along with the creation of a 1 km buffer around the reservoir perimeter for the analyzed years, and clipping was carried out over the vector layer of the Belo Jardim municipality, provided by IBGE. The procedures, data analysis, RGB composition, and map production were conducted using the QGIS geoprocessing software, version 3.34.5. For the land use and land cover classes, class codes and color schemes from MapBiomas Brasil Collection 9 were applied for consistency and adaptation.

For comparison purposes, the satellite Sentinel-2A's images were used, accounted with in loco records, and classified according to the MapBiomas Brasil classes. The temporal analysis has a 20-year range, segment in 10-year intervals (2003, 2013, and 2023). Furthermore, the observation based on photographic records was made in February 12th, 2025.

In addition, a questionnaire was applied to local residents using the population perception data-gathering method. A convenience sample was used, as the sample size corresponded to the number of residents present during the field visit. The questionnaire was divided into two sections. The first addressed the sociodemographic characteristics of the interviewees, while the second focused on sanitation conditions, including water supply and solid waste management, aiming to identify residents' perceptions of the risks involving men and environment interactions.

The data analysis was performed using simple descriptive statistics, taking into account the sample size. The information provided by the interviewees was presented in graphs and tables.

3. Results and Discussion

To comparatively analyze the spatiotemporal variations in land use and land cover over a 20-year period, as outlined in the proposed methodology of this study, monthly rainfall data were collected for the years 2003, 2013, and 2023. These data were obtained from pluviometric station No. 374, selected because it presents a complete record for the analyzed period and is located 5.03 kilometers from the Pedro Moura Junior Reservoir, being the closest among the available stations. The data were obtained from the Agência Pernambucana de Águas e Clima (APAC – Pernambuco Water and Climate Agency).

Figure 2 presents the monthly precipitation (in millimeters) for the years 2003, 2013, and 2023, allowing the identification of the wettest and driest periods in each year. In 2003, the months with the highest precipitation were February and March, with 104.30 mm and 111.20 mm, respectively, while the driest months were July and December, with precipitation below 20 mm. In 2013, the months with the most rainfall were April, June, and July, with July reaching the maximum value of over 160 mm, whereas January, February, March, and September recorded the lowest rainfall, with precipitation below 10 mm. In 2023, the highest precipitation occurred between May and July, with 139.80 mm and 190.10 mm, respectively. In contrast, February and the period from July to December experienced the lowest rainfall, with values below 40 mm.

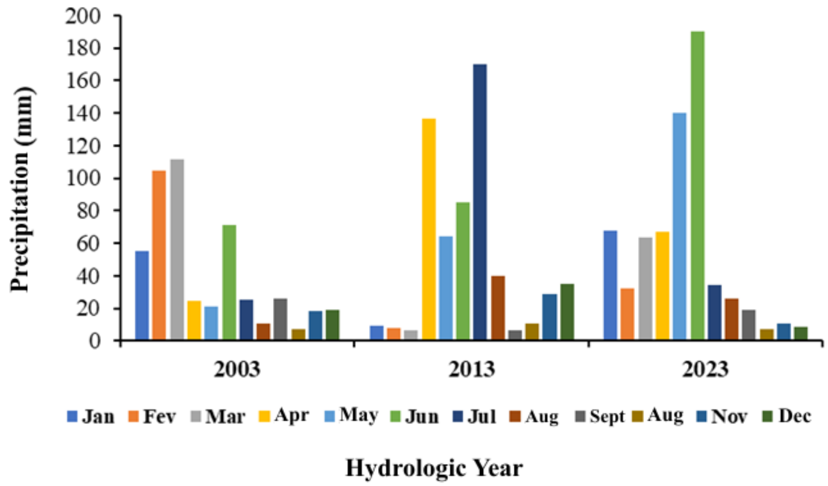

Figura 2 - Comparative Analysis of Anual Distribution of Precipitation Along the Last 20 Years in the Pedro Moura Junior Reservoir, Belo Jardim - PE.
Source: By the author (2025).

The geoprocessing and remote sensing analyses provided evidence of significant changes in land use and land cover during the years 2003, 2013, and 2023, totaling a 20-year period (Figure 3). The data analysis indicated a trend of natural vegetation recovery and significant changes in land use and cover between 2003 and 2013. The Forest Formation showed a remarkable increase of 100%, followed by the Savanna ecosystem, which grew by 87.83%, and the Grassland Formation, which increased by 66.72%. These results indicate the regenerative expansion of these areas, possibly due to natural processes associated with high rainfall during the period, as well as the inherent climatic conditions of the semiarid region.

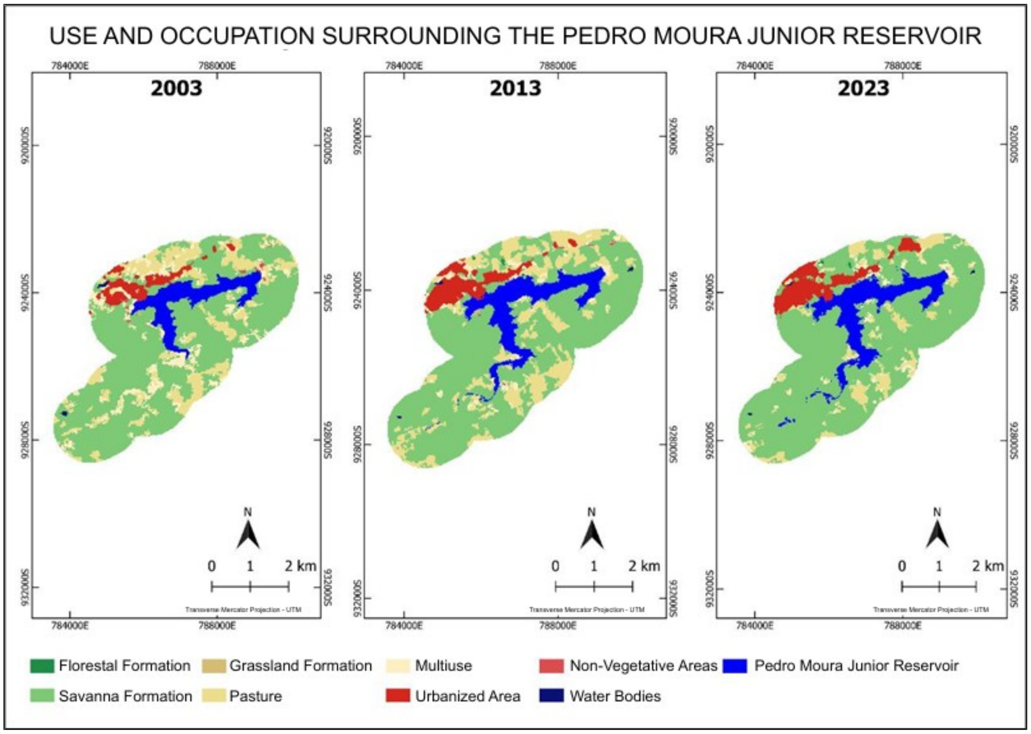

Figure 3 - Soil usage and occupation Map of the Pedro Moura Junior Reservoir belonging to the Ipojuca River watershed, located in Belo Jardim, Pernambuco.
Source: By the author (2025).

In fact, the vegetation of the Caatinga biome is predominantly composed of deciduous species, which exhibit seasonal leaf loss during periods of water scarcity as an adaptive strategy to cope with irregularities in the regional rainfall regime. According to Marques (2023), in his monograph discussing the spatial variability and growth structure of Jatropha mollissima (Pohl) Baill. in Caatinga areas of the semiarid region of Paraíba, it was concluded that the biome's plant species generally display morphophysiological adaptations to water limitation, such as the reduction of metabolic activity through leaf abscission during dry periods. Furthermore, due to leaf loss during the dry season, satellite sensors have greater visibility of the exposed soil surface. This occurs because each object on the Earth's surface exhibits a unique energy curve within the electromagnetic spectrum, known as its spectral signature.

Simultaneously, the urban area increased by 38.99%, suggesting population growth and, consequently, the expansion of infrastructure. In addition, the Pedro Moura Junior Reservoir showed a 32.79% increase, which is related to higher precipitation levels. According to data from IBGE (2022), the municipality of Belo Jardim had a population of 68,698 inhabitants in 2003. In 2013, this number increased by 3,734, reaching a total of 72,432, which corresponds to a 5.44% increase over the period.

An increase of 19.73% was observed in the area designated for pasture, corroborating the expansion of agricultural and livestock activities, although to a lesser extent compared with the regenerative vegetation. As a consequence of this process, a significant rural population can be observed in the municipality, whose concentration has grown particularly around the reservoir, driven by the expansion of the municipal territory. This expansion has occurred continuously over the years, accompanying industrial development at both local and regional scales, which has led to an increasing overlap between urban and rural spaces (Table 1).

Table 1 - Classification and area of soil usage and occupation around the Pedro Moura Junior Reservoir belonging the

the Ipojuca River watershed, located in Belo Jardim, Pernambuco, during the analyzed period.

Class	Description	Land usage and occupation areas (km²)		
		2003	2013	2023
Florestal Formation	A vegetation type characterized by the predominance of continuous canopy - Wooded Steppe Savanna, Deciduous and Semi-deciduous Seasonal Forest.	0	17.695	23.004
Savanna Formation	A vegetation type characterized by the predominance of semi-evergreen canopy: Arborized Steppe-Savanna and Arborized Savanna, characteristics of the Caatinga biome.	7.925.990	14.887.130	13.370.732
Grassland Formation	A vegetation type characterized by the predominance of herbaceous species. (Park Steppe-Savanna, Grassy-Wooded Steppe-Savanna, Savanna Park, Savanna Grassy-Wooded) + (Floodable areas with web of interconnected lakes, localized along the water courses and in depression areas which accumulate water, with a predominantly herbaceous or shrubland vegetation).	7.960	13.271	15.926
Pasture	Areas of planted pasture, directly related to the agriculture and livestock activities. The areas of natural pasture are predominantly characterized as grassland formations or flooded fields, possibly being used for pasture practices. In the Amazon, there may be recently deforested areas where agricultural and livestock activities have not yet been initiated.	3.596.430	4.305.967	3.126.602
Mosaic of Uses	Areas where the agriculture and livestock activities weren't distinguishable between agriculture and pasture. May include areas of peri-urban occupation, such as rural properties, farms, and apartment complexes.	2.215.350	704.252	1.657.981
Urbanized Areas	Areas with significant edification and road density, including areas of allowed construction and infrastructure.	948.450	1.318.278	1.751.810
Non-Vegetative Areas	Areas with impermeable surface (infrastructure, urban expansion or mining) unmapped in its classes.	88.470	30.966	6.193
Water Bodies	Rivers, lakes, dams, reservoirs, and other water bodies.	38.930	29.196	40.697
Pedro Moura Junior Reservoir	Study area (Pedro Moura Junior Dam).	1.888.920	2.508.231	3.822.927

Source: By the author (2025).

In contrast, some classes experienced significant reductions. The Mosaic of Uses decreased by 68.21%, indicating that these areas were converted to other land-use types, such as vegetative formations or urban areas. Non-vegetative areas decreased by 65%, possibly due to vegetation growth or urban expansion. Meanwhile, water bodies showed a 25% decrease, suggesting processes such as drainage, siltation, or a reduction in flooded areas.

Referring to the period between 2013 and 2023, the Forest Formation and the Grassland Formation showed increases of 30% and 20.01%, respectively. In contrast, the Savanna Formation decreased by 10.19%, as did areas designated for agriculture and livestock, primarily pastures, which experienced a reduction of 27.39%, while the Mosaic of Uses for activities expanded by 135.42%. Non-vegetative areas exhibited a notable decrease of 80% compared to other classes, likely due to the growth of Mosaic of Uses and urban areas, which increased by 32.89%. The water surface of the reservoir increased by 52.42%, with other water bodies showing a 39.39% rise. According to data from APAC (2025), this increase is attributed to the high precipitation accumulation of 665.9 mm recorded in 2023 in the municipality of Belo Jardim, Pernambuco.

To compare the quantitative data on changes in land use and occupation over the 20-year period, as proposed in this study, precipitation data were collected from APAC on a monthly basis and supplemented with data obtained from the Climate Hazards Center InfraRed Precipitation with Station Data (CHIRPS) satellite. CHIRPS has been responsible for collecting precipitation data covering almost the entire globe for more than 30 years, as shown in Figure 4.

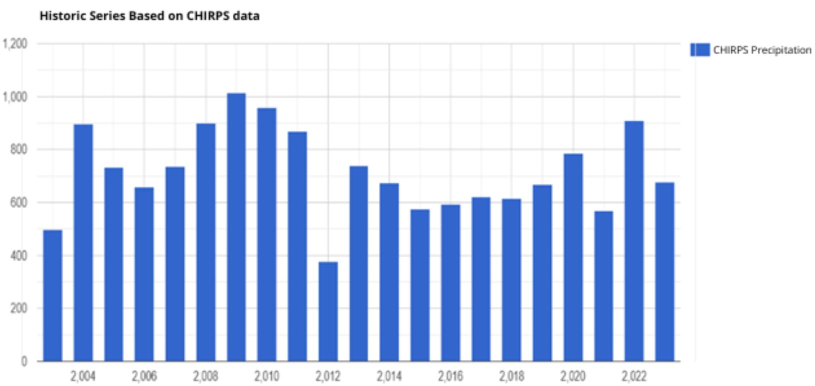

Figure 4 - Precipitation Distribution on the course of 20 years in the Pedro Moura Junior Reservoir, Belo Jardim - PE. Source: By the authors (2025).

CHIRPS integrates 0.05°-resolution satellite imagery with in-situ station data to create gridded precipitation time series, which can be used to analyze trends and monitor seasonal droughts. The data are available in the collection ee.ImageCollection("UCSB-CHG/CHIRPS/DAILY") (Funk et al., 2015). Data processing was performed using the Google Earth Engine (GEE), which is capable of combining multiple petabytes of satellite imagery and geospatial data with planetary-scale analysis tools.

The analysis is consistent with data obtained from APAC's pluviometric monitoring stations. Over the 20-year period analyzed, only five years—2003, 2012, 2015, 2016, and 2021—recorded precipitation below the agency's average. During these years, the region experienced elevated temperatures and below-average rainfall, compromising water availability and necessitating water rationing policies. These measures led to adjustments in the operational schedule of the State Water Supply Concessionaire, the Companhia Pernambucana de Saneamento (COMPESA). Public participation played a fundamental role in understanding and adhering to the company's proposed schedule, contributing to the restoration of the reservoir's water level.

Regarding the water surface area of the Pedro Moura Junior Reservoir, following excavation over the wetlands, there was a decrease in flood levels, without extensive excavation to create a deep basin. The significant increase in water surface area, along with the reduction of other land uses, can be attributed to the reservoir's expansion project, completed in 2017, which increased its maximum capacity by 11%, from 30.7 million to 35 million cubic meters (COMPESA, 2019). The soils surrounding the Pedro Moura Junior Reservoir were identified as lithic soils (IBGE, 2023). These soils have a crystalline structure with low water retention capacity, and therefore do not exhibit an intermittent fluvial regime, although they can influence the classification of such regimes.

According to Martins et al. (2022), the construction of the reservoir on shallow soils, with earth fill in floodable areas, reduced infiltration, increased surface runoff, and amplified sediment load in water bodies, resulting in siltation, leads to inefficient rainfall retention and the burial of river springs. Consequently, these springs become intermittent, with flow interruptions during the dry months.

During the on-site visit, residents living around the reservoir reported that they rely on their own wells as a source of water supply. According to their reports, the water quality is irregular, with occasional changes in odor, color, or taste. These findings corroborate the study conducted by Oliveira and Guimarães (2024), which evaluated the presence of phenolic compounds in the water supply of the Rio Claro municipality, in the state of São Paulo. The authors concluded that such organoleptic characteristics may negatively affect human health, as well as reduce the acceptability of the water for consumption.

In fact, a certain resistance was observed among the residents, despite recommendations to store water in individual containers, while the municipal government provides chemical products for water treatment. The distribution of these chemicals, primarily chlorine, is carried out by health agents. Rodrigues and Oliveira (2022) emphasized the importance of water treatment for disinfecting water intended for human consumption, with the main objective of removing pathogenic microorganisms. Despite variations in water quality, the residents reported no cases of water-related diseases in their households.

The evaluation of risks associated with high chlorine concentrations is a sensitive issue that must be assessed for each individual well used as a water supply source, since the water characteristics and its reactions with certain organic compounds can lead to the formation of trihalomethanes (THMs). It is worth noting that THMs are not the only potential risk associated with water chlorination. According to Brazilian water potability regulations, specifically Portaria de Consolidação nº 05/2017 (Ministry of Health, Administrative Consolidation), water must undergo a disinfection process to inactivate pathogenic microorganisms (Meyer, 1994; Menezes Junior & Souza, 2021).

Regarding basic sanitation, sanitary effluents are directed to septic tanks, with reports of leaks or malfunctions in these structures. However, the community lacks an adequate sewage treatment system, which represents a critical gap in the local infrastructure. Concerning solid waste management, it was observed that burning trash in open fields is a recurring practice—an inappropriate method due to the environmental risks and the emission of pollutants harmful to public health. These findings are consistent with the study conducted by Ribeiro (2024), which evaluated the environmental impacts of uncontrolled landfills, specifically in open areas without proper waste segregation and disposal, in the city of Pinheiro, state of Maranhão. Ribeiro concluded that the major public health problems are associated with insufficient solid waste management.

Residents around the reservoir emphasized the need for government intervention, requesting stronger oversight and management for the efficient collection of solid waste, as well as the proper implementation of water supply treatment by COMPESA. It was also noted that the area faces significant structural challenges, particularly in ensuring water potability, sustainable waste management, and universal access to sewage treatment. The adoption of integrated public policies, coordinated by the relevant authorities, is recommended to mitigate the identified environmental and sanitary risks, ensure compliance with legal regulations, and promote the population's quality of life.

To support the results with satellite imagery and complement the field analysis, photographs were taken in the surroundings of the reservoir to further illustrate the discussion (Figure 5).

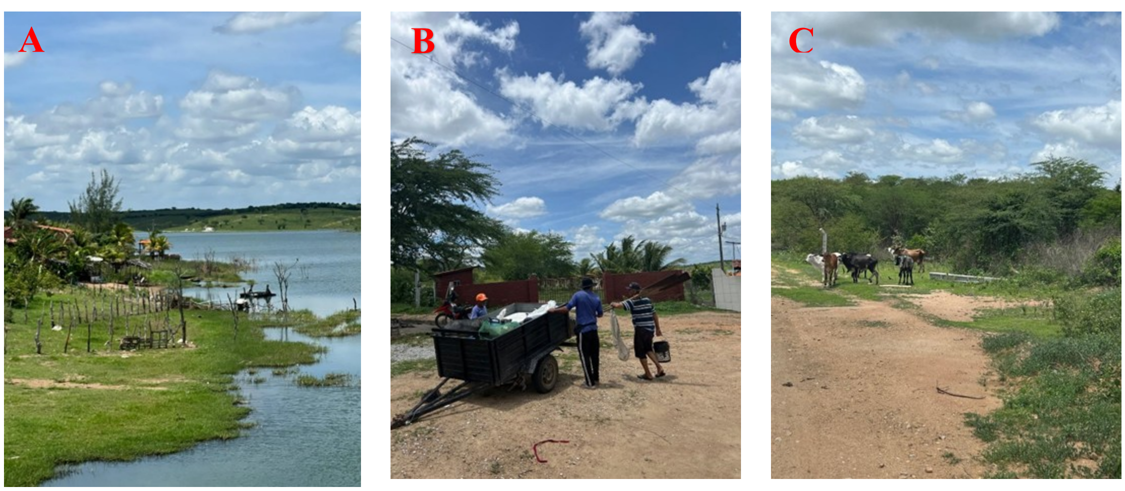

Figura 5 - Land use and land occupation in the area of influence of the Pedro Moura Júnior Reservoir, belonging to the

Ipojuca River watershed, located in Belo Jardim, Pernambuco: left bank compared to upstream (A); residents around the reservoir (B); land occupied by animals (C); soil exposed to burning (D); soil exposed to erosion on the right bank upstream (E); reservoir spillway (F); open-air solid waste (G); plastic bags along the reservoir banks (H); photovoltaic panels (I); exposed pipelines along the reservoir bank (J); excessive plant growth (K); and direct discharge of domestic effluents into the soil (L).
Source: Captured on site by the authors (2025).

As shown in Figure 5A, the occupation around the Pedro Moura Júnior Reservoir has noticeably increased, particularly on the left bank near the spillway, where there are agricultural crops, recreational areas, animals, and residences. In Figure 5B, it can be observed that the residents gather and manage the agricultural systems collectively, while in Figure 5C, although the animals have designated areas, they can still roam freely around the reservoir. Indeed, the area is difficult to access, and despite the increasing number of residents, it still constitutes a diffuse rural landscape, assuming a role of invisibility, since there is no basic sanitation (sewage, water supply, and wastewater treatment, and solid waste management).

In Figure 5D, taken from the left side near the reservoir spillway, it can be observed that a possible burning of objects occurred, although the origin could not be identified, as only traces of soil exposed to fire are visible in the image. Figure 5E depicts what is most common in this section: soil exposed with stones and signs of local vegetation loss. In Figure 5F, the spillway is shown with only 5 cm remaining until overflow, which is expected to occur in March, at the onset of the rainy season. According to climatological data calculated from a 30-year series, the website Climatempo (2025) indicated that the months of highest precipitation in the municipality are March, April, May, and June.

Figure 5G shows the improper disposal of solid waste in the open, combined with the irregular burning of materials. The image was captured near residences surrounding the reservoir, highlighting environmental and public health risks. Additionally, the presence of a zucchini plantation can be observed, indicating the use of land for agricultural activity in the region. In Figure 5H, an accumulation of plastic bags along the reservoir banks is evident, resulting from deficiencies in the public waste collection service in the community, according to residents' reports.

Regarding Figure 5I, photovoltaic panels installed in the area stand out, presumably intended to supply electricity to nearby residential or recreational zones, considering the urban density in the locality. According to Silva, Drach, and Barbosa (2019), this modality is characterized by electricity generation close to the point of consumption or directly at the consuming establishment. The excess energy produced can be sold to the local utility company.

In Figure 5J, exposed pipes discharging effluents directly into the reservoir banks can be observed, and the image also shows animal containment structures (corrals) made of wood. The discharge of untreated effluents, combined with animal waste that may be carried into the riverbed, directly impacts water quality, as evidenced by the visible change in water coloration. Costa et al. (2021) assessed the influence of anthropogenic activities on water quality in urban lakes, while França (2024) evaluated environmental impacts in the Caiçara stream watershed in Aurora, Brazilian state of Ceará. The aforementioned authors concluded, respectively, that the disposal of untreated effluents and animal excrement compromises water quality.

Figure 5K highlights the excessive growth of macrophytes, associated with nutrient loads from untreated effluents released into the environment. This observation corroborates the study by Santos et al. (2021), which assessed water quality in Pampulha Lagoon (Lagoa da Pampulha), Belo Horizonte, Minas Gerais. The cited authors concluded that raw effluents contain varying concentrations of nutrients; for example, excess phosphorus leads to eutrophication, promoting the uncontrolled growth of algae and aquatic plants. Additionally, fires in adjacent areas have been recorded, further exacerbating environmental degradation.

Regarding Figure 5L, the direct discharge of residential effluents onto the soil is observed, a practice that can lead to contamination of the soil as well as surface and groundwater resources. This situation underscores the urgent need for structural interventions by public authorities, aiming at the universalization of basic sanitation and the mitigation of socio-environmental impacts in the region. The area characterized as urbanized reflects the growth and development of the municipality, although this zone currently overlaps with rural areas due to inadequate services in some locations. In certain sections, riparian areas can be identified, where houses still lack plumbing systems and/or septic tanks, as shown in Figure 6.

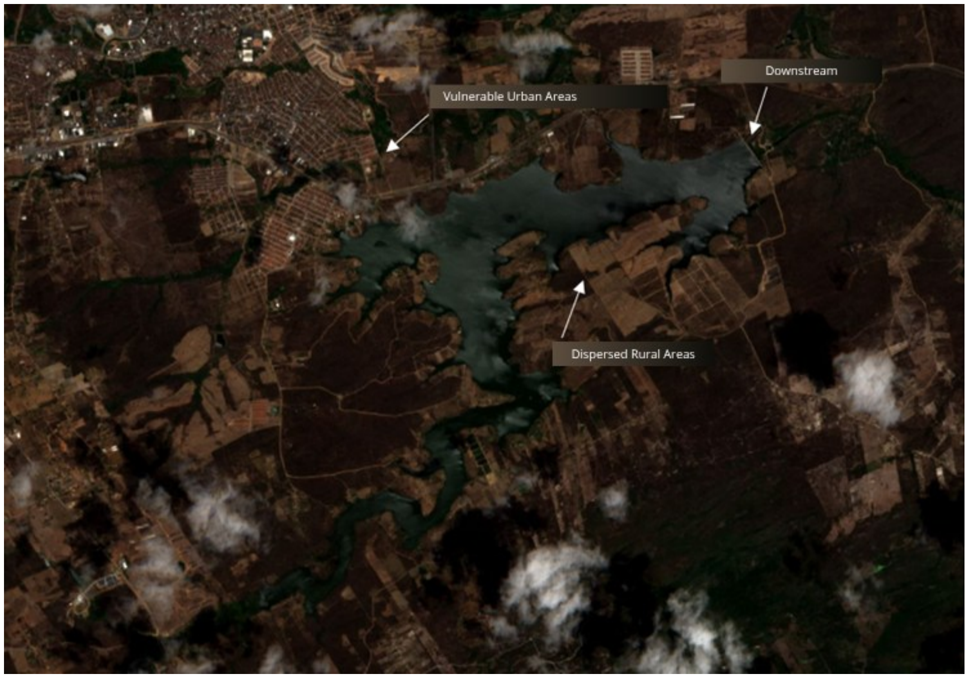

Figura 6 - Delimitation of land use and land occupation in the Pedro Moura Júnior Reservoir, part of the Ipojuca River watershed, located in Belo Jardim, Pernambuco. Sentinel-2A satellite image, acquired through the Copernicus BROWSER platform, with RGB composition performed in QGIS.
Source: By the authors (2025).

Furthermore, there is an extensive rural area with scattered residences, few of which are connected to a sewage system. As in the Ipojuca River watershed, studies indicate challenges related to water quality, including a high potential for soil salinization when water is used for irrigation (ROSA et al., 2024). Therefore, effective management is essential to ensure the sustainability of the reservoir's multiple uses and the environmental preservation of the region.

4. Final Considerations

The study conducted around the Pedro Moura Júnior Reservoir allowed for the identification and integrated analysis of the main socio-environmental conflicts affecting the region, relating them to land use and occupation dynamics, rainfall variability, and basic sanitation conditions. The region has experienced significant changes in land cover and land use over the past 20 years, influenced by climatic factors, urban expansion, and agricultural activities. The analyses showed substantial regeneration of native vegetation, while at the same time an increase in urbanization and reservoir area was observed, reflecting both climatic variations and anthropogenic actions, such as the expansion of the reservoir's capacity. Simultaneously, field data highlights a social reality marked by deficiencies in basic infrastructure, particularly regarding the supply of potable water, the absence of a sewage system, and inadequate solid waste management. Despite the sporadic provision of materials for domestic water treatment, the local population still relies on the reservoir itself, whose water quality is noticeably unstable.

This water vulnerability, combined with the insufficiency of effective public policies, intensifies socio-environmental conflicts and increases the challenges for water resource management and environmental sustainability. Unplanned urban expansion, pressure from agricultural activities, and the lack of basic sanitation services directly compromise water quality and ecosystem health, requiring coordinated actions that integrate different levels of management and involve social participation. Community engagement, together with strengthened water governance and the involvement of public agencies and sanitation providers, is essential to mitigate the observed impacts and ensure the sustainable use of natural resources.

Finally, this study contributes to filling an existing gap in the literature on the Pedro Moura Júnior Reservoir and provides technical and scientific support for the development of strategies aimed at the integrated and sustainable management of water resources, environmental preservation, and the improvement of the quality of life of populations that depend directly on this water body. Field observations confirmed the insufficiency of public services, particularly regarding the supply of treated water, sewage systems, and solid waste management. The discharge of untreated effluents, open-air burning of waste, and inadequate access to potable water highlight conditions that compromise the quality of life of riverside populations and the environmental sustainability of the reservoir.

References

APAC. Agência Pernambucana de Águas e Clima. *Monitoramento Pluviométrico, 2025*. Disponível em: http://old.apac.pe.gov.br/meteorologia/monitoramento-pluvio.php. Acesso em: 15/06/2025.

CLIMATEMPO. *Climatologia em Belo Jardim, BR*, *2025*. Disponível em: https://www.climatempo.com.br/climatologia/2179/belojardim-pe. Acesso em: 16/06/2025.

COMPESA. Companhia Pernambucana de Saneamento. *Maior barragem de Belo Jardim volta a acumular água depois de três anos em colapso, 2019*. Disponível em: https://servicos.compesa.com.br/maior-barragem-de-belo-jardim-volta-a-acumular-agua-depois-de-tres-anos-em-colapso/?utm_source=chatgpt.com. Acesso em: 16/06/2025.

Costa, K.A. et al. Influência das atividades antrópicas sobre a qualidade da água em lagos urbanos: um estudo de caso / Influência de atividades antrópicas na qualidade da água em lagos urbanos: um estudo de caso. *Revista Brasileira de Desenvolvimento*, v. 2, pág. 19889–19907, 2021.

Fernandes, M. F.; Cardoso, D.; Queiroz, L. P. An updated plant checklist of the Brazilian Caatinga seasonally dry forests and woodlands reveals high species richness and endemism. *Journal of Arid Environments*, v. 174, p. 1-8, 2020.

FRANÇA, J. S. A. *A identificação dos impactos ambientais na Bacia Hidrográfica do Riacho da Caiçara, no Sítio Logradorzinho, Aurora – CE.* Cajazeiras, 2024. 54f. Monografia (Licenciatura em Geografia) - Centro de Formação de Professores, Universidade Federal de Campina Grande, Cajazeiras, Paraíba, Brasil, 2024.

Funk, C., Peterson, P., Landsfeld, M. et al. Os perigos climáticos da precipitação infravermelha com estações — um novo recorde ambiental para o monitoramento de extremos. *Revista Sci Data* 2, 2015.

IBGE. Instituto Brasileiro de Geografia e Estatística. *Cidades e Estados do Brasil*, 2022. Disponível em: https://cidades.ibge.gov.br/brasil/pe/belo-jardim/panorama. Acesso em: 14/06/2025.

IBGE. Instituto Brasileiro de Geografia e Estatística. *Pedologia, 2023*. Disponível em: https://www.ibge.gov.br/geociencias/informacoes-ambientais/pedologia/10871-pedologia.html?=&t=downloads. Acesso em: 13/06/2025.

Martins, H. L. et al. Represamento de veredas e conhecimento sobre a estrutura física de reservatórios rasos para mitigar impacto ambiental urbano. *Revista Engenharia Sanitária Ambiental*, v.27 n.3. 625-632, 2022.

MARQUES, V. E. *Variabilidade espacial e estrutura de jovens regenerantes de Jatropha mollissima (Pohl) Baill. em área de caatinga no Semiárido Paraibano.* Sumé, 2023. 44f. Monografia (Curso Superior de Tecnologia em Agroecologia) Centro de Desenvolvimento Sustentável do Semiárido, Universidade Federal de Campina Grande, Sumé, Paraíba, Brasil, 2023.

Menezes Júnior, M. Q.; Souza, C. A. Avaliação da formação de trihalometanos na água de abastecimento público da cidade de Cáceres (MT), Brasil. *Revista Eng Sanit Ambient*, v.26 n.5, set/out 2021, 927-934.

Meyer, S. T. O Uso de Cloro na Desinfecção de Águas, a Formação de Trihalometanos e os Riscos Potenciais à Saúde Pública. *Revista Cad. Saúde Públ*., Rio de Janeiro, 10 (1): 99-110, jan/mar, 1994.

Oliveira, A. M.; Guimarães, O. S. Engenharia, Gestão e Inovação. 1. ed. Belo Horizonte, MG: *Editora Poisson*, v. 12, 2024.

Paula, A.; Magnago, L. F. S.; Tagliaferre, C. Dinâmica do uso e ocupação da terra e seu efeito na temperatura e na precipitação no bioma Caatinga (Floresta Tropical Sazonamente Seca) - Brasil. *Revista Geociências do Nordeste*, v.11, n.1, (Jan-Jun) p.12-27, 2025.

RIBEIRO, J. W. P. *Impactos ambientais causados pelo lixão a céu aberto da cidade de Pinheiro no Maranhão*. Pinheiro, 2024. 37 f. Monografia (Licenciatura em Ciências Naturais – Biologia) – Universidade Federal do Maranhão, Pinheiro, Maranhão, Brasil, 2024.

Rodrigues, H. V. A.; Oliveira, C. S. P**.** Água para consumo humano: um levantamento sobre artigos publicados**.** *Revista Visão Acadêmica*, v. 2, 2022.

Silva, A. R. et al. Variações no índice de anomalia de chuva no semiárido. *Journal of Environmental Analysis and Progress*, v. 2, n. 4, p. 377-384, 2017.

Rosa, R. B. et al. Indicadores de saneamento básico: análise do sistema de abastecimento de água da bacia do Rio Ipojuca. *Revista Contribuciones a las ciencias sociales*, v. 17, n. 9, p. e10703, 2024.

Santos, K. D. et al. Estudo da qualidade da água da Lagoa da Pampulha / Belo Horizonte-MG. *Revista UniAraguaia*, v. 16, n. 1, p. 1–15, 2021.

Silva, S. S. et al. *Conflitos em torno de um reservatório urbano com capacidade para abastecimento público no semiárido do Estado de Pernambuco, Nordeste do Brasil***,** v. 10, Nº 25, p. 619-631 - 31 ago. 2023.

Silva, C. F.; Drach, P. R. C.; Barbosa, G. S., Energia solar no meio urbano: análise para diferentes formas urbanas. *Revista Tecnol. Soc***.,** v. 15, n. 37, P. 546-575, jul./set. 2019.

Sobral, M. C. et al. Impacto das mudanças climáticas nos recursos hídricos no submédio da bacia hidrográfica do rio São Francisco – Brasil. *Revista Eletrônica do PRODEMA,* v. 12, n. 3, p.95-106. 2018.