



IMPACTS OF ANTHROPOGENIC ACTIONS ON AÇUDE DO SACO: DIAGNOSIS FOR ENVIRONMENTAL PRESERVATION AND RECOVERY

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ABSTRACT

Objective: Analyze the effects of human activities on the Açude do Saco and propose sustainable strategies for the preservation of this essential resource.

Theoretical Framework: The study is based on theories regarding water resources in semi-arid regions, environmental impacts, and sustainable management practices.

Method: The research employs direct on-site observations and qualitative analysis of environmental degradation factors to identify the main challenges and propose solutions.

Results and Discussion: The results indicate that the reservoir faces serious challenges related to pollution and inadequate use of its surroundings. Sustainable management strategies, effective public policies, and environmental awareness actions were identified as priorities to reverse this scenario. The study also highlights that collective participation and integrated planning are essential to ensure environmental balance and meet the region's water demands.

Research Implications: The research highlights the need for sustainable management practices, effective public policies, and environmental education actions to mitigate impacts on the Açude do Saco, such as pollution and soil degradation. It emphasizes integrated planning involving managers, the community, and researchers as a strategy for effective solutions. The results provide a foundation for future studies and conservation initiatives, contributing to water security, quality of life, and socio-economic development in the semi-arid region.

Originality/Value: This work makes significant contributions by proposing concrete and integrated actions to mitigate environmental impacts and promote the sustainability of the Açude do Saco, benefiting the local community and the environment. The results serve as a basis for future recovery and conservation initiatives, reinforcing the importance of preserving this natural heritage in a semi-arid region with limited water resources.

Keywords: Environmental Preservation, Water Resources, Anthropogenic Actions, Eutrophication.

IMPACTOS DAS AÇÕES ANTRÓPICAS NO AÇUDE DO SACO: DIAGNÓSTICO PARA PRESERVAÇÃO E RECUPERAÇÃO AMBIENTAL

RESUMO

Objetivo: Analisar os efeitos das ações humanas sobre o Açude do Saco e propor estratégias sustentáveis para a preservação desse recurso essencial.

Referencial Teórico: O estudo fundamenta-se em teorias sobre recursos hídricos em regiões semiáridas, impactos ambientais e práticas de manejo sustentável.

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Método: A pesquisa utiliza observações diretas no local e análise qualitativa dos fatores de degradação ambiental para identificar os principais desafios e propor soluções.

Resultados e Discussão: Os resultados indicam que o açude enfrenta sérios desafios relacionados à poluição e ao uso inadequado de seu entorno. Estratégias de manejo sustentável, políticas públicas eficazes e ações de conscientização ambiental foram identificadas como prioritárias para reverter esse cenário. O estudo destaca ainda que a participação coletiva e o planejamento integrado são fundamentais para assegurar o equilíbrio ambiental e atender às demandas hídricas da região.

Implicações da Pesquisa: A pesquisa evidencia a necessidade de práticas de manejo sustentável, políticas públicas eficazes e ações de educação ambiental para mitigar os impactos no Açude do Saco, como poluição e degradação do solo. Destaca o planejamento integrado, envolvendo gestores, comunidade e pesquisadores, como estratégia para soluções efetivas. Os resultados oferecem base para estudos futuros e iniciativas de conservação. Assim, contribui para a segurança hídrica, a qualidade de vida e o desenvolvimento socioeconômico da região semiárida.

Originalidade/Valor: Este trabalho traz contribuições significativas ao propor ações concretas e integradas para mitigar os impactos ambientais e promover a sustentabilidade do Açude do Saco, beneficiando a comunidade local e o meio ambiente. Os resultados servem como base para futuras iniciativas de recuperação e conservação, reforçando a relevância da preservação desse patrimônio natural em uma região semiárida com recursos hídricos limitados.

Palavras-chave: Preservação Ambiental, Recursos Hídricos, Ações antrópicas, Eutrofização.

IMPACTOS DE LAS ACCIONES ANTRÓPICAS EN EL AÇUDE DO SACO: DIAGNÓSTICO PARA LA PRESERVACIÓN Y RECUPERACIÓN AMBIENTAL

RESUMEN

Objetivo: Analizar los efectos de las actividades humanas sobre el Açude do Saco y proponer estrategias sostenibles para la preservación de este recurso esencial.

Marco Teórico: El estudio se fundamenta en teorías sobre los recursos hídricos en regiones semiáridas, los impactos ambientales y las prácticas de manejo sostenible.

Método: La investigación emplea observaciones directas en el lugar y análisis cualitativo de los factores de degradación ambiental para identificar los principales desafíos y proponer soluciones.

Resultados y Discusión: Los resultados indican que el embalse enfrenta serios desafíos relacionados con la contaminación y el uso inadecuado de su entorno. Las estrategias de manejo sostenible, las políticas públicas eficaces y las acciones de concienciación ambiental fueron identificadas como prioridades para revertir este escenario. El estudio también destaca que la participación colectiva y la planificación integrada son esenciales para garantizar el equilibrio ambiental y satisfacer las demandas hídricas de la región.

Implicaciones de la Investigación: La investigación evidencia la necesidad de prácticas de manejo sostenible, políticas públicas eficaces y acciones de educación ambiental para mitigar los impactos en el Açude do Saco, como la contaminación y la degradación del suelo. Destaca la planificación integrada, involucrando a gestores, la comunidad y los investigadores como estrategia para soluciones efectivas. Los resultados ofrecen una base para estudios futuros e iniciativas de conservación, contribuyendo a la seguridad hídrica, la calidad de vida y el desarrollo socioeconómico en la región semiárida.

Originalidad/Valor: Este trabajo aporta contribuciones significativas al proponer acciones concretas e integradas para mitigar los impactos ambientales y promover la sostenibilidad del Açude do Saco, beneficiando a la comunidad local y al medio ambiente. Los resultados sirven como base para futuras iniciativas de recuperación y conservación, reforzando la importancia de preservar este patrimonio natural en una región semiárida con recursos hídricos limitados.

Palabras clave: Preservación Ambiental, Recursos hídricos, Acciones Antrópicas, Eutrofización.



1 INTRODUCTION

The United Nations (UN, 2010) emphasizes that access to clean, safe and sufficient drinking water is essential for the maintenance of life for all organisms, as well as for the balance of ecosystems, the development of communities and the progress of economies. However, water quality has been progressively threatened on a global scale, driven by population growth, the intensification of agricultural and industrial activities and the impacts of climate change, which promote significant alterations in the planetary hydrological cycle.

As the effects of climate change worsen on the planet, several regions have faced significant challenges, including the growing need for tools that guarantee access to one of the most essential resources for human survival: water. Regardless of its nature, whether industrial or not, practically all production processes depend on the use of water, consolidating it as an indispensable and vital resource for the maintenance of life and socioeconomic development.

Despite its great importance, access to water remains limited and out of reach for millions of people in many regions of the planet. What should be a universal right has increasingly become a privilege to be achieved daily. Water scarcity goes beyond the simple absence of water, triggering a series of negative impacts that permeate all sectors of society, affecting everything from agricultural production to public health.

Menezes et al. (2016) highlight that the deterioration of water quality in rivers, lakes and reservoirs has emerged as a critical ecological concern in recent decades. This situation is amplified by inadequate soil management, combined with rapid population growth and the intensification of industrial activities. These interconnected factors significantly compromise the availability and quality of water resources, putting environmental sustainability and the ability to meet the essential demands of ecosystems and society at risk.

Another aspect is eutrophication, which occurs due to excess nutrients such as nitrogen and phosphorus, often resulting from the improper disposal of organic waste and sewage. This excessive supply of nutrients stimulates the uncontrolled growth of algae and cyanobacteria. After completing their life cycle, these algae decompose, consuming large quantities of oxygen dissolved in the water. This accelerated consumption drastically reduces the oxygenation of the



aquatic environment, creating adverse conditions for the survival of organisms such as fish and invertebrates, compromising the ecological and functional balance of the reservoir.

The climatic conditions of the Brazilian Northeast, marked by long periods of drought and irregular rainfall, make the region especially vulnerable to the impacts of water scarcity. In the semi-arid region, this vulnerability is aggravated by a drainage network with limited surface runoff, characterized by extremely low runoff coefficients, in addition to the poor quality of the available water (Zanella, 2014).

In the state of Rio Grande do Norte, more than 90% of the municipalities are located in the Drought Polygon, making it one of the states most affected by the impacts of irregular rainfall and water scarcity (Troleis and Silva, 2018). According to the Brazilian Institute of Geography and Statistics (IBGE, 2020), 86.2% of the municipalities in Rio Grande do Norte faced a prolonged period of drought, enough to trigger a serious hydrological imbalance, with negative repercussions for the population and the environment.

Historically, the construction of dams has been considered the main solution to problems arising from drought, based on the premise that the storage of large volumes of water can mitigate water scarcity (Assunção and Livingstone, 1993). The implementation of these reservoirs significantly transformed semiarid regions, by providing conditions that favored the increase in population concentration and the guarantee of "necessary conditions for the existence of life" (Neto, 2017, p. 289).

An emblematic example of this strategy is the Saco Reservoir, a water infrastructure built through collective effort to ensure a strategic water reserve. This reservoir played a central role in the history and socioeconomic development of the Itajaí community. However, inappropriate human actions have compromised the quality of the water and the surrounding area of the reservoir, resulting in significant damage to both water resources and associated ecosystems, which demands the urgent adoption of preservation and recovery measures.

The main objective of this study is to analyze the human actions carried out in the surroundings of the Saco Reservoir, located in the municipality of Itajá/RN, and their respective environmental impacts. The research seeks to identify and evaluate the human interventions that have contributed to the degradation of water quality and the associated ecosystem, highlighting the factors that compromise the sustainability of this important reservoir.

In this context, the study also aims to highlight the relevance of the Saco Reservoir for the region's water security, demonstrating how its conservation is essential to guarantee water supply, especially during periods of prolonged drought. Based on this analysis, the aim is to



provide support for the development of environmental management and conservation strategies, with a focus on mitigating impacts and promoting the area's water and ecological sustainability.

2 THEORETICAL FRAMEWORK

Water resource management aims to overcome challenges related to water scarcity and inadequate use, proposing strategies that ensure its rational and sustainable use for the benefit of society. To achieve these objectives, the development and implementation of robust public policies are essential. Such policies provide guidelines for planning, controlling and optimizing water use, in addition to enabling the effective management of variables that influence established plans (Setti et al., 2001).

Well-structured public policies are fundamental foundations for efficient water resource management. They promote the integration of diverse interests, conflict resolution and harmonization between socioeconomic development and environmental preservation. Thus, effective water resource management contributes to sustainability, ensuring its availability for future generations and minimizing impacts on ecosystems, aligning human needs with environmental conservation in a balanced and responsible manner.

Mapping land use and vegetation cover plays a crucial role in understanding the spatial-temporal dynamics and changes associated with these dynamics in a specific region. Data obtained from land use surveys have broad applicability in different areas of interest, providing essential support for various planning and management initiatives. In the context of planners and competent bodies, such information is indispensable, as it allows detailed recognition of the conditions of the natural environment and the territorial occupation of the study area. This integrated analysis enables the formulation of actions and strategies aimed at the rational and sustainable use of natural resources (Pereira and Pinto, 2007).

The occurrence of different types of erosion in river basins represents a growing concern in the environmental and economic context, due to their negative impacts on natural resources and agricultural production. According to Valle Júnior et al. (2010), erosion processes contribute significantly to soil degradation and reduced water availability, which in turn leads to silting of reservoirs. These factors not only compromise the productive capacity of agriculture, but also affect the sustainability of water systems, highlighting the need for integrated management of natural resources.

In the context of the Brazilian Northeast, the challenges related to soil and natural resource degradation are even more pronounced due to the economic and environmental



characteristics of the region. Silva et al. (2018) highlight that economic activity is often conducted aggressively, employing practices such as deforestation and burning, which intensify the processes of soil, biodiversity and water resource degradation. This dynamic is particularly evident in biomes such as the Caatinga, where the replacement of native vegetation by short-cycle crops, combined with high evapotranspiration rates and scarce rainfall, accelerates erosion processes and may, in the long term, contribute to desertification.

Therefore, understanding the interaction between socioeconomic, environmental and climatic factors that influence erosion processes is essential for formulating mitigation and recovery strategies. The literature shows that environmental degradation not only compromises local ecosystems, but also poses significant challenges to water security, biodiversity and the socioeconomic resilience of affected communities. Thus, addressing these issues in the context of the Northeast river basins requires an integrated approach that combines sustainable practices with the rational use of natural resources.

3 METHODOLOGY

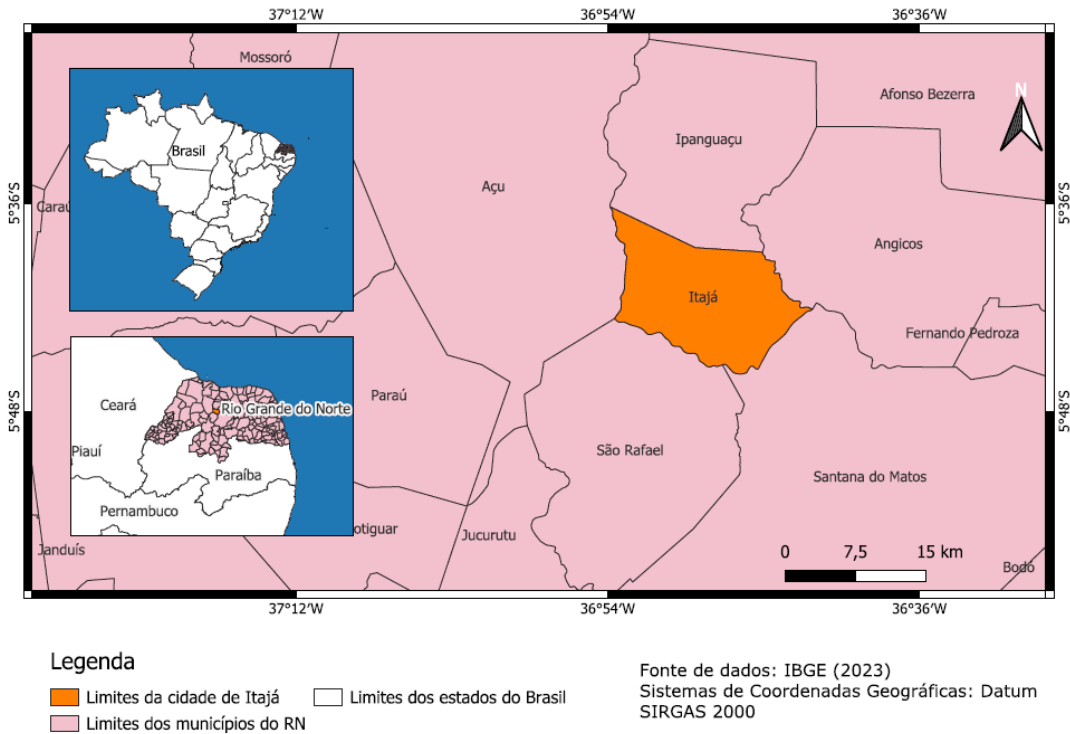
3.1 LOCATION OF THE MUNICIPALITY

The research was carried out in the city of Itajá, located in the interior of the state of Rio Grande do Norte, approximately 204.6 kilometers from the capital, Natal. According to the census of the Brazilian Institute of Geography and Statistics (IBGE, 2022), the municipality has an area of 203.624 km² and a population of 7,292 inhabitants. Among its main geographical attributes is the Armando Ribeiro Gonçalves Dam, recognized as the largest freshwater reservoir in the state and one of the main tourist attractions, which receives visitors from various locations in the region. This geographic and socioeconomic context makes the city a strategic location for the analysis of human actions and their environmental impacts, with a specific focus on the Saco Reservoir.



Figure 1

Location of the municipality of Itajá /RN



Source: own authorship (2024)

It has a hot and semi-arid climate, the landscape is mostly composed of a drier character, with a rainy season that runs from February to May (PROFILE OF YOUR MUNICIPALITY ITAJÁ, 2008). Among the most commonly found plant species is the carnauba (*Copernicia prunifera*) xique-xique (*Pilosocereus polygonus*) and jurema (*Acacia jurema*), the latter plays an important role in the local economy, being widely used as a fuel source in the ceramic burning process for the production of tiles and bricks, which represent the main economic activity in the municipality.

The methodology of this study was based on an environmental diagnosis, carried out through direct observations in the surroundings of the Saco Reservoir, located in the municipality of Itajá/RN. Field visits were conducted at different strategic points of the reservoir in December 2024, with the objective of identifying anthropic actions, polluting factors and possible environmental impacts on the water source. During these observations, visual and descriptive data were recorded on solid waste disposal, presence of organic materials and degradation of native vegetation, as well as evidence of silting and abnormal water coloration. This approach allowed an empirical analysis of local conditions, providing essential



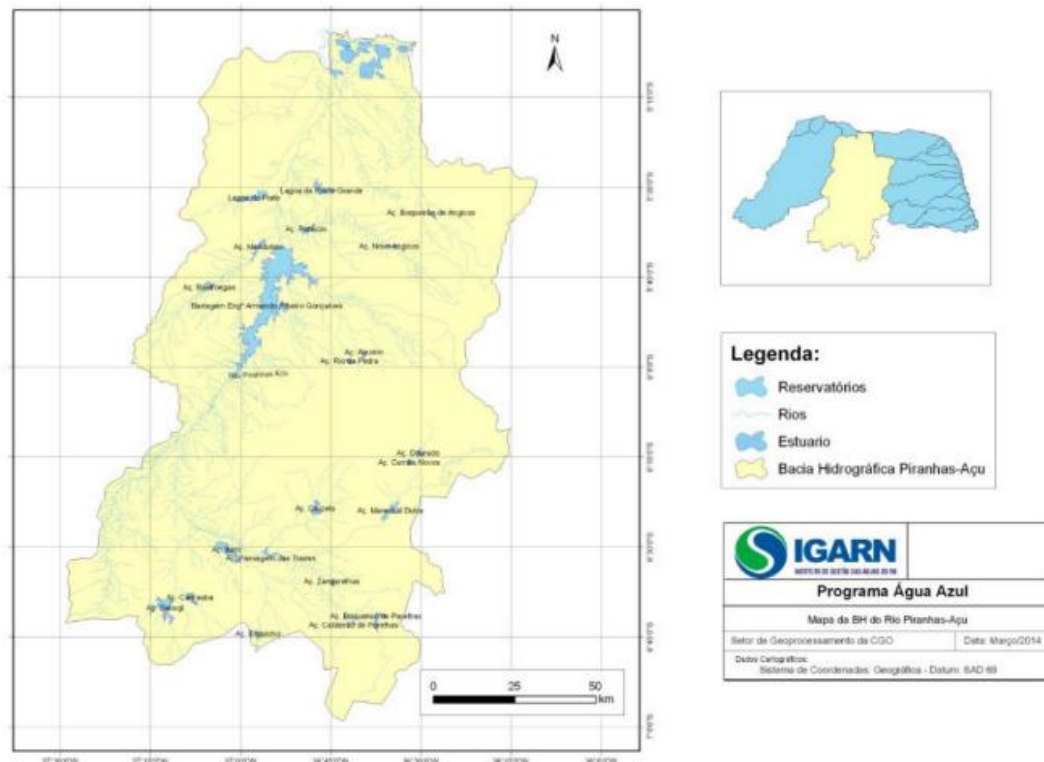
information for understanding the problems faced by the reservoir and for supporting management and conservation proposals.

3.2 PIRANHAS/AÇU HYDROGRAPHIC BASIN

The Piranhas-Açu River Basin (BHRPA) plays a strategic role in the water context of the states of Rio Grande do Norte and Paraíba, to which it belongs. With an area of 17,432 km² and a perimeter of 817 km, the basin is home to an extensive drainage network composed of 90 river segments, totaling 1,450 km in length. Of these, the Piranhas-Açu River, the main watercourse in the basin, contributes 245 km (DE AZEVEDO, Pedro Vieira et al., 2020).

Figure 2

Piranhas/Açu river basin



Source: IGARN (2014)

3.3 SACO DAM IN ITAJÁ/RN

The Saco Reservoir plays a fundamental role as the municipality's main source of water supply, being essential for the population that depends on its water resources. Built in 1903 through a joint effort organized by the local community, the reservoir initially had a storage

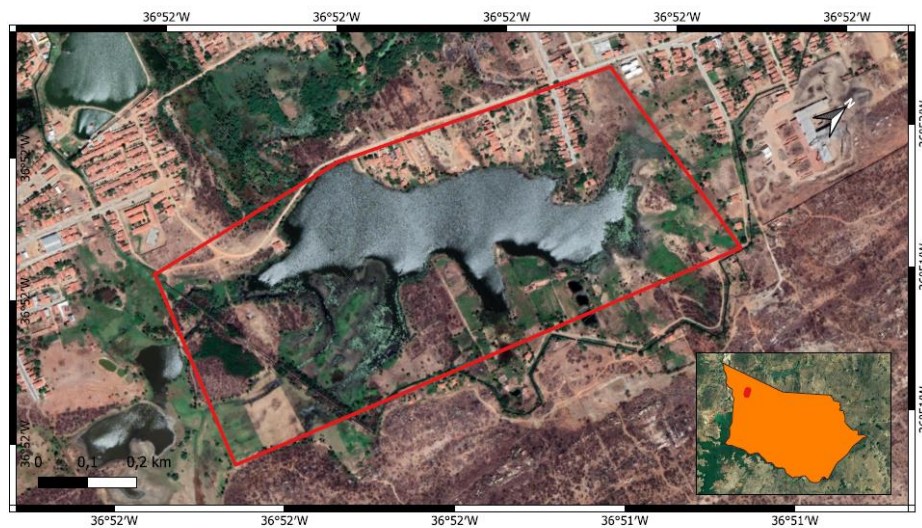


capacity of 1,800 m³ (LOPES, 1987). In addition to its importance for the municipality, the reservoir also contributes to the Piranhas-Açu River Basin, serving as an important source of water supply and feeding the Cabugi Central pipeline, which distributes water to regions dependent on this system.

Historically, the Saco Reservoir has been an integral part of the local population's daily lives, performing multiple functions. It is used both as a source of economic support and for leisure activities. The reservoir is home to several species of fish, such as tilapia and tucunaré, which are consumed by local residents. In addition, small farmers and livestock breeders use the water to irrigate crops and supply livestock, reinforcing its importance for the community's subsistence and socioeconomic development.

Figure 3

Location of Saco Reservoir



Legenda

- Açude do Saco
- Itajá/RN

Sistemas de coordenadas Geográficas: Datum SIRGAS 2000

Source: own authorship (2024)



4 RESULTS AND DISCUSSIONS

4.1 ANTHROPOGENIC ACTIONS IN THE SURROUNDINGS OF THE SACO RESERVOIR

The Saco Reservoir, despite its socioeconomic and environmental importance, has faced significant impacts due to various human actions in its surroundings. Such interventions have generated serious consequences for the water source, compromising not only its water storage and supply capacity, but also the quality of this essential resource. The proximity of homes to the reservoir, combined with the lack of adequate infrastructure and environmental awareness, has contributed to the inadequate disposal of solid waste, aggravating the problem.

Figure 4

Concentration of residences near the reservoir



Source: own authorship (2024)

The accumulation of garbage on the banks and in the water body represents one of the main sources of environmental degradation, causing silting of the reservoir and harming aquatic fauna. Fish species, such as tilapia (*Oreochromis niloticus*) and peacock bass (*Cichla ocellaris*), which are important resources for local subsistence, are particularly vulnerable to contamination and reduced habitat quality. In addition, these practices compromise the ecological balance of the reservoir, negatively affecting the environmental services it provides.

Another critical point is the impact of recreational and economic activities carried out around the reservoir. Fishermen and visitors often do not adopt sustainable practices, contributing to the intensification of the environmental problem. The lack of management and monitoring policies further aggravates the situation, highlighting the need for structured actions to preserve the reservoir.

Given this scenario, it is necessary to implement measures to minimize the impacts of human actions on the reservoir. Some of the necessary initiatives include environmental



education campaigns, the installation of adequate infrastructure for the collection and disposal of solid waste, and the strengthening of environmental monitoring. These actions are essential to guarantee the sustainability of the Saco Reservoir, ensuring its capacity to meet the region's water demands and preserve its biodiversity.

Figure 5

Solid waste near the Saco Reservoir



Source: own authorship (2024)

Another critical factor that compromises the quality of the water in the Saco Reservoir is pollution from domestic sewage, which significantly increases the levels of pathogens in the water. This contamination poses a serious risk to public health, especially for the population that uses the reservoir for drinking, irrigation or recreational activities. Illegal occupation in the vicinity of the reservoir has aggravated this problem, since, in the absence of adequate basic sanitation systems, waste ends up being discarded directly into the environment.

Furthermore, it is common to observe a large concentration of fecal matter, both human and animal, on the banks of the reservoir, which intensifies pollution and increases the biological load in the water. This situation not only compromises the quality of the water resource, but also negatively impacts aquatic biodiversity and the ecological balance of the water source. The presence of waste contributes to the development of harmful organisms, reducing the viability of the reservoir as a safe source of water and as a habitat for native species.



Figure 6

Concentration of fecal material near the Saco Reservoir



Source: own authorship (2024)

This scenario highlights the need for interventions, including the implementation of basic sanitation policies, control of irregular occupation and raising awareness among the population about the importance of environmentally responsible practices. Without these measures, the Saco Reservoir will continue to face the degradation of its resources, putting at risk its ability to meet the needs of the community and preserve the ecosystem services it provides.

The removal of vegetation cover around the reservoir is another significant human action that has had a negative impact on the Saco Reservoir. This practice drastically reduces the soil's ability to retain sediment, accelerating erosion processes and contributing to increased water turbidity. The loss of native vegetation, which plays a crucial role in stabilizing the soil and protecting the banks, compromises the quality of the water resource and the environmental balance of the reservoir.

Figures 7 illustrate the removal of native vegetation around the reservoir and the impacts generated by this practice. In addition to erosion, there is an accumulation of organic matter left on site, which can intensify the proliferation of microorganisms and compromise water quality, directly affecting aquatic fauna and human uses, such as consumption and recreation.

Figure 7

Removal of vegetation from around the reservoir



Source: own authorship (2024)



This scenario highlights the need for environmental recovery measures, such as replanting native species, implementing sustainable management practices, and establishing permanent protection zones around the reservoir. Such actions are essential to mitigate the impacts of removing vegetation cover, ensuring the preservation of the reservoir and its ecosystem services.

The factors identified have had a significant impact on the water quality of the Saco Reservoir. Direct observations made at different points in the reservoir indicate the presence of a thick layer of sludge on the water surface, giving it a characteristic greenish color. This phenomenon is a direct result of the accumulation of organic matter, which has intensified the eutrophication process, Figure 8.

Figure 8

Change in the color of the water in the reservoir



Source: own authorship (2024)

The scenario highlights the need for interventions to contain the entry of nutrients into the reservoir. Measures such as the installation of efficient sewage treatment systems, the recovery of riparian vegetation to act as a natural filter and the promotion of sustainable practices around the reservoir are essential to mitigate the effects of eutrophication.

5 CONCLUSION

This study aimed to analyze the human actions that negatively impact the Saco Reservoir, highlighting the damage caused to the water source and reinforcing the importance of its recovery and preservation. The results show that inadequate practices, such as the irregular disposal of solid waste and fecal matter, have directly contributed to the degradation of water quality and the reduction of the reservoir's functional capacity. These factors, in addition to compromising environmental health, limit sustainable access to an essential resource for the local population.



Based on the observations made, it became clear that actions that promote both community awareness and the commitment of managers and authorities to implement effective preservation measures are urgently needed. Restoring the reservoir requires joint efforts, including the creation of public policies aimed at proper waste management, the protection of surrounding areas and the implementation of sanitation systems.

In addition to contributing to the understanding of the environmental problems faced by the Saco Reservoir, this work is an important basis for future research in the region, since no previous records using the same approach have been found. Thus, this study not only alerts the local population to the risks of degradation, but also highlights the need for strategic planning and legal interventions to ensure the preservation of this vital water resource for the sustainable development of the region.

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