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URBAN STREAMS IN PETROLINA, PERNAMBUCO: ENVIRONMENTAL DEGRADATION AND CHALLENGES FOR WATER MANAGEMENT

Riachos urbanos em Petrolina, Pernambuco: degradação ambiental e desafios para gestão hídrica

Arroyos urbanos en Petrolina, Pernambuco: degradación ambiental y desafíos para la gestión hídrica

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ABSTRACT

The municipality of Petrolina (PE) is known as a fruit-growing center due to the use of the São Francisco River's waters for irrigation. However, as the city developed, its urban streams began to face increasing anthropogenic pressures, such as irregular occupation of the banks and the discharge of untreated domestic effluents, which significantly contributed to the environmental degradation of these water bodies. For this reason, this study aims to analyze the factors that negatively influence the environmental quality of Petrolina's urban streams, with an emphasis on the Vitória Stream. The research adopted a qualitative, descriptive approach, developed from a literature review of articles, local newspaper reports, and the analysis of official documents and urban planning instruments, including the Federal Constitution (1988), the City Statute, and the municipal Master Plan, as well as field observations in different parts of the city. The results indicate that the current environmental scenario of Petrolina's urban streams is worrying, given that signs of degradation are present in most of these watercourses, especially those that cross areas near residential clusters and irrigated agricultural zones in the municipality's rural areas, where water pollution is exacerbated by the inadequacy of the sewage collection and treatment network in the face of urban expansion. In this context, the need for the implementation of structuring public policies focused on environmental management and the expansion of investments in basic sanitation aimed at the recovery and revitalization of these watercourses becomes evident.

Keywords: São Francisco River; Urban pollution; Petrolina; Vitória Stream; Degradation.

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RESUMO

O município de Petrolina (PE) é conhecido como polo fruticultor a partir do uso das águas do rio São Francisco na irrigação. Entretanto, à medida em que a cidade se desenvolveu, seus riachos urbanos passaram a enfrentar crescentes pressões antrópicas, a exemplo da ocupação irregular das margens e o lançamento de efluentes domésticos in natura, que contribuíram significativamente para a degradação ambiental desses corpos hídricos. Por essa razão, este estudo tem como objetivo analisar os fatores que influenciam negativamente a qualidade ambiental dos riachos urbanos de Petrolina, com ênfase no Riacho Vitória. A pesquisa adotou uma abordagem qualitativa, de natureza descritiva, desenvolvida a partir da revisão bibliográfica em artigos, matérias jornalísticas locais e na análise de documentos oficiais e instrumentos de planejamento urbano, a citar a Constituição Federal (1988), o Estatuto da Cidade e o Plano Diretor municipal, além de observações de campo em diferentes trechos da cidade. Os resultados indicam que o atual cenário ambiental dos riachos urbanos de Petrolina é preocupante, haja vista que os sinais de degradação estão presentes na maioria desses cursos d'água, especialmente naqueles que atravessam áreas próximas a aglomerados habitacionais e a zonas de agricultura irrigada nas áreas rurais do município, onde a poluição hídrica é potencializada pela insuficiência da rede de coleta e tratamento de esgoto frente a expansão urbana. Nesse contexto, torna-se evidente a necessidade de implementação de políticas públicas estruturantes voltadas à gestão ambiental e a ampliação dos investimentos em saneamento básico visando à recuperação e revitalização desses cursos d'água.

Palavras-chave: Rio São Francisco**;** Poluição urbana; Petrolina; Riacho Vitória; Degradação.

RESUMEN

El municipio de Petrolina (PE) es reconocido como polo frutícola gracias al uso de las aguas del río São Francisco para riego. No obstante, el crecimiento urbano ha intensificado las presiones sobre sus arroyos, como la ocupación irregular de riberas y el vertido de aguas residuales sin tratamiento, contribuyendo a su degradación ambiental. Este estudio tiene como objetivo analizar los factores que afectan negativamente la calidad ambiental de los arroyos urbanos, con énfasis en el arroyo Vitória. Se adoptó un enfoque cualitativo y descriptivo, basado en revisión bibliográfica, análisis de documentos oficiales, como el Estatuto de la Ciudad y el Plan Director y observaciones de campo en distintas áreas del municipio. Los resultados evidencian una situación preocupante, con signos de degradación en la mayoría de los arroyos, especialmente en zonas cercanas a áreas residenciales y agrícolas. La contaminación se agrava por la insuficiencia de infraestructura de saneamiento frente a la expansión urbana. Se concluye que es fundamental implementar políticas públicas orientadas a la gestión ambiental y ampliar las inversiones en saneamiento básico, con el fin de recuperar y preservar estos cursos de agua.

Palabras clave: Río São Francisco; Contaminación urbana; Petrolina; Arroyo Victoria; Degradación.

1 INTRODUCTION

The Brazilian Semiarid occupies 12% of the national territory and hosts about 28 million people, distributed between urban (62%) and rural (38%) areas. For this reason, water resources management in the region is configured as a significant challenge, due to its climatic and geographic characteristics, marked by high temporal and spatial rainfall

variability, high evaporation rates, and soils that often do not retain large amounts of water (INSA, 2021).

In this sense, the water bodies in the Semiarid play a crucial role in the region's economic, social, and environmental life. Despite the challenges imposed by climate variability, periods of prolonged drought, and urban pressures, the area has several rivers, reservoirs, ponds, and aquifers, that are essential for socio-economic development and the maintenance of local ecosystems, with special emphasis on the São Francisco River, which plays a central role in irrigation, human supply, and environmental preservation.

Known as the "River of National Integration," the São Francisco is the most important body of water in northeastern Brazil. It originates in the country's Southeast, in the state of Minas Gerais, and, with a total length of 2,863 kilometres, flows through the northeastern states of Bahia, Pernambuco, Alagoas, and Sergipe, bathing a large portion of the Semiarid. Its river basin covers 505 municipalities, considering the river and its tributaries, and is divided into four physiographic regions: upper, middle, lower-middle, and lower São Francisco (CBHSF, 2025).

In the Petrolina area, located in the Pernambuco portion of the São Francisco's middle region, the municipality is internationally known as a fruit-growing hub due to the use of São Francisco waters for irrigation. Thus, it highlights some of its important tributaries, such as Riacho Porteiras and Riacho Vitória, which extend across the plain where the city's urban nucleus developed, eventually discharging into the São Francisco river.

However, as Petrolina expanded, its urban streams began facing increasing anthropogenic pressures, such as irregular occupation of riverbanks, discharge of domestic and industrial effluents, soil impermeabilization, and inadequate sanitation infrastructure, all of which have significantly contributed to the environmental degradation of these waterways.

In this context, the city's streams, which once played essential roles such as rainwater drainage, ecological balance, and recharge of the main river, are today deeply altered in their water quality, stripped of their natural value and ecological-functional role.

Given this degradation scenario, considering the importance of these water bodies for public supply, for the agricultural activities developed in the municipality, and for the maintenance of local ecosystems, as well as the scarcity of studies that allow an integrated diagnosis of the area, this work aims to analyse how pollution sources negatively interfere with the environmental quality of the urban stretch of the Vitória creek, in the municipality of Petrolina, state of Pernambuco.

The choice of Vitória Creek is justified by its relevance as one of the main tributaries

of the São Francisco River, standing out especially for its direct influence on the quality of water drawn for Petrolina's public supply during the rainy season. Furthermore, its placement within an urban area makes it susceptible to various anthropogenic pressures, such as discharge of effluents and improper disposal of solid waste, factors that have significantly compromised its environmental quality over the years.

Based on official planning documents and on field observations, the analyses conducted a reveal of the fragility of environmental management in the municipality and reinforce the need for structural actions that allow understanding the degradation dynamics, their impacts, and the possibilities for recovering these fluvial systems, essential for the urban and water sustainability of Petrolina.

2 OVERVIEW OF THE TRANSFORMATION OF RIVERS AND STREAMS IN URBAN AREAS

Urban spaces nowadays concentrate the largest share of the global population, accounting for about 55% of people. According to a projection by the United Nations (UN, 2018), this percentage is expected to rise to 68% by 2030, a reality that makes cities a scomplex environments where, in most cases, artificial and natural elements reflect the human–nature relationship in an inharmonious way. Driven by an expansion process that is increasingly rapid and tied to slow urban-planning, the rising demand for the use of natural capital resources in the name of development has compromised their quality and availability, especially water.

Throughout history, several cities and civilizations have been built along the banks of rivers, lakes, and streams, with the aim of using their waters for commercial and agricultural activities and for survival, as in Egypt with the Nile, Paris with the Seine, and São Paulo with the Tietê and Tamanduateí rivers. For this reason, Peixoto (2016) states that it is impossible to dissociate the term river from city. However, this union produced a great transformation, which resulted in the replacement of river landscapes by urban landscapes over the years.

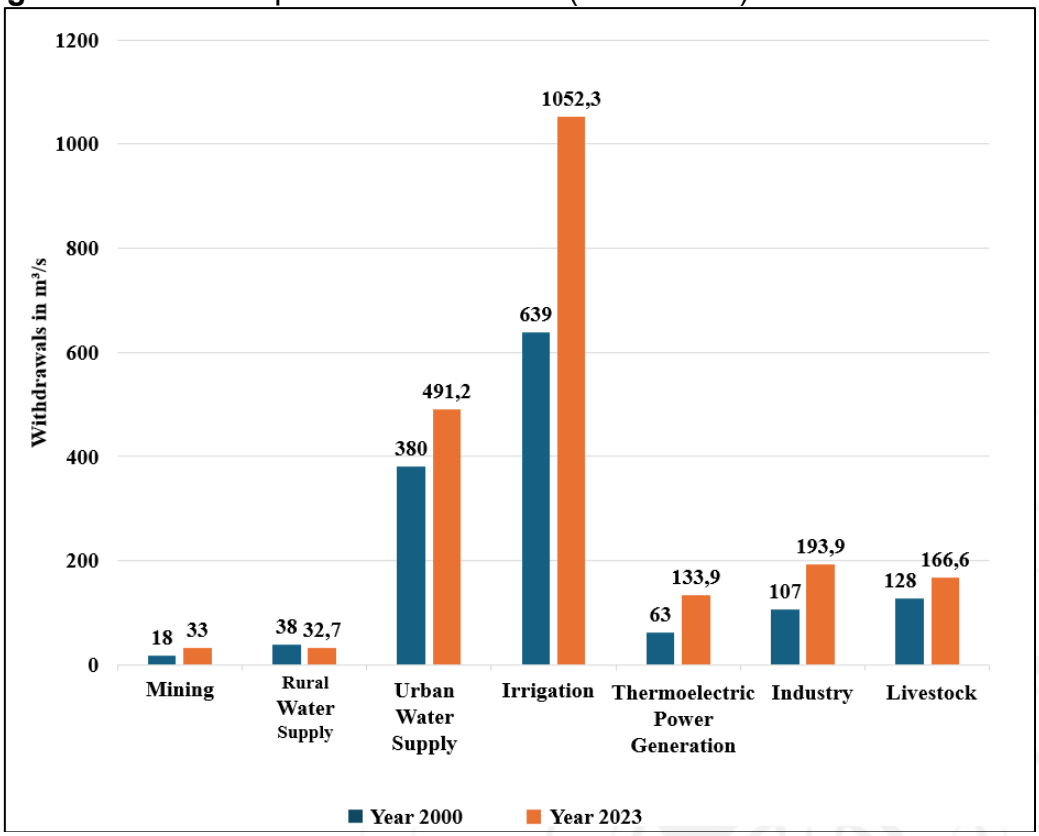
With the advent of the Industrial Revolution in the eighteenth century in England, which later gradually expanded to the rest of Europe and North America, the ways of producing goods and of occupying geographic space were altered, consolidating industrial capitalism. Thus, the process of industrialization triggered a significant increase in urban demographic concentration, accelerating urbanization to adapt to the necessary conditions for production, which changed the relationship between humans and natural resources had

been seen merely as sources to be exploited for the production of goods and, consequently, for wealth generation (Vieira et al., 2023; Barbosa; Nobrega, 2025).

In Brazil, the pattern was not different. According to Pires (2023), although the process began later - between the late 19th and early 20th centuries -, the industrialization process intensified the pace of urban growth, with the Southeast and Central-West regions as pioneers, spreading to other regions over the decades in an uneven manner. Thus, cities materialized as attractive hubs, mainly due to the availability of employment in various industrial and service sectors, becoming larger and more populous, thereby increasing the demand for natural resources to sustain maintenance.

A prime illustration of this growth is water consumption. According to data compiled by the Brazilian National Water Agency (ANA, 2024), consumptive water demand - defined by Article 1, §2 of the National Water Resources Plan 2022–2040 as the volume extracted for human and livestock supply, industry, mining, irrigation, and thermoelectric power generation - has increased substantially in recent decades (Figure 1).

Figure 01 – Consumptive Water in Brazil (2000–2023) – Withdrawals in m³/s



Source: Adapted from ANA (2024)

According to the data presented, this growth stands out, especially in urban supply

indices, which account for 23.4% of water withdrawals, and in irrigation, which consumes 50% of the total—two sectors that are relevant for the country's economic development, with cities driving the service sector and irrigation driving agricultural activities. According to ANA, the largest water demands in the country occur in the Water Resources Management Units (UGRHs): São Francisco, Paraná, Uruguay, Tocantins-Araguaia, Paranaíba, and Grande.

Based on Atlas Água (2021), Brazil currently has 3,125 surface water sources used as sources of urban supply; these water bodies are under increasing pressure, as 43% of the country's cities depend exclusively on surface water sources, especially in the states of Espírito Santo, Pernambuco, Paraíba, Bahia, Rio de Janeiro, and Rondônia, while another 14% depend on mixed supply from both surface and groundwater sources, totalling 57% of urban hubs that are supplied at least in part by surface water bodies.

For this reason, Capilé (2015) highlighted the importance of analysing rivers and urban streams in their entirety, taking into account the natural and social aspects that compose them, addressing their occurrence not only by the surface flow that cuts through cities but as an integral part of a river basin. Thus, urban rivers, as well as their drainage areas and tributaries, play a crucial role not only in maintaining urban water supply but also in the development of agricultural activities and in the balance of local ecosystems.

However, despite their importance, urban rivers and streams have been losing space in cities due to a process known as denaturalization, in which natural elements such as trees, soils, and waters lose their value of nature because they no longer correspond to the modern aspects of the urban environment. In his writings, Santos (2006) already warned about the devaluation of nature due to development:

> The history of humanity moves from a world of things in conflict to a world of actions in conflict. In the beginning, human actions settled in the interstices of natural forces; today, it is the natural world that occupies those interstices. Previously, society inhabited natural places little modified by humans; now, natural events occur in increasingly artificial places, which alter the value and meaning of those natural events (Santos, 2006, p. 96).

In this context, the artificial landscape contrast created by the rapid growth of cities at the expense of rivers and streams has altered how people perceive them; they no longer recognize these waterways as elements of nature, but rather as places for waste disposal, industrial residues, and mosquito proliferation. Thus, rivers and streams in urban environments ceased to be elements representing biodiversity and geodiversity and have come to function as sewage channels, fetid, abandoned spaces that stand as obstacles to

development (Nigro, 2015).

Once deprived of their natural value because they are far from the ideal landscape status currently defined by society as modern, the neglect of urban planning toward water bodies becomes justified, promoting the fragility of rivers and streams that are exposed to various forms of degradation without objection from the authorities or the public.

3 ENVIRONMENTAL DEGRADATION

Given the context of changes related to water resources, their relationship with the urban environment has become the central focus of debates among managers, researchers, and specialists due to the occurrence of various socio-environmental problems which, in the short, medium, and long term, can compromise the quality of life of the population and directly impact environmental dynamics. According to Resolution No. 01, dated January 23, 1986, of the National Environment Council (CONAMA), environmental impact is considered as:

> any alteration of the physical, chemical, and biological properties of the environment, caused by any form of matter or energy resulting from human activities that, directly or indirectly, affect: I - the health, safety, and well-being of the population; II - social and economic activities; III - biota; IV - aesthetic and sanitary conditions of the environment; V - the quality of environmental resources (Brazil, 1986, p. 1)

In this sense, the consequences of these impacts can be either positive or negative depending on the changes arising from this process. Regarding urban rivers and streams, those affected have brought about negative changes, culminating in water contamination, a decline in aquatic life, and jeopardized use for a variety of human activities. This situation gets intensified when one considers that, in the urban space, rivers have taken on another function, that is, according to Munford (1965, p. 583), “[the] cheapest and most convenient place to dump all soluble or semi-soluble forms of detritus,” effectively turning rivers into open sewers.

Corroborating the reality described decades ago by Munford, the current situation faced by urban rivers and streams is not so different. Cities have expanded even further, disrespecting the natural forms of rivers that have been straightened and canalized in an attempt to fix old problems caused by poor planning of urban watercourses (Fagundes, 2020).

However, Pestana (2025) highlights that, from an environmental perspective,

channelizing urban water bodies is inherently inefficient, as it fails to mitigate water contamination, offers inadequate flood control, and accelerates ecosystem degradation. Consequently, whether open or closed, channelization merely conceals the underlying issues - creating a superficial aesthetic harmony in urban centers while simultaneously degrading ecological systems and displacing environmental impacts to downstream areas.

Regarding this issue, when considering the urban organization of cities, all inhabitants are exposed to the “ups and downs” of nature, since, in the course of expansion, the natural limits of rivers, streams, and ponds have been breached. However, this vulnerability disproportionately affects the poorer population living in city outskirts, a situation worsened by the absence of basic services such as sanitation and water supply (Almeida, 2010; Saito et al., 2019).

From this perspective, it was observed that this situation is directly linked to the process of social segregation in cities, as, in most cases, the places where channels are located have lower-lying terrain and are prone to flooding, being devalued by the real estate sector and occupied by economically vulnerable populations (Cometti; Cabral; Conceição, 2019).

Consequently, Gouveia and Selva (2020) emphasize that urban peripheries bear the brunt of river-related environmental degradation. Stripped of protective riparian vegetation through gradual riverbank occupation, these areas become heightened vulnerability zones for seasonal flooding. Furthermore, the authors note that the environmental degradation stemming from informal riverbank settlements extends beyond localized reaches; because these tributaries feed into the main river basin, they continuously transport sediment and solid waste downstream.

Federal Law No. 14,285/2021—which regulates land regularization on federal property, urban land subdivision, and Permanent Preservation Areas (APPs) surrounding urban waterways—stipulates in Section 5 that "the limits of permanent preservation areas adjacent to any natural watercourse in urban areas shall be determined in master plans and municipal land-use laws, subject to consultation with state and municipal environmental councils" (Brazil, 2021). Nevertheless, despite statutory provisions establishing shared municipal and state governance, illegal occupation in these protected zones persists due to the absence of decisive enforcement and relocation measures by relevant authorities.

In addition to irregular occupancy, another factor that aggravates the environmental quality of urban water bodies is the lack of basic sanitation. Although it is a fundamental right for all citizens, as established in paragraph IX of Article 23 of the Federal Constitution (1988),

which assigns to the Union, states, the Federal District and municipalities the responsibility to “promote housing construction programs and improve housing conditions and basic sanitation,” in practice, this guarantee is not realized due to deep regional, state, and municipal inequalities.

These inequalities, directly related to economic, geographic, and institutional factors, hinder the implementation of public policies that ensure access to water supply and to adequate sewage collection and treatment, since poorer and hard-to-reach areas face higher costs and lower capacity for investment and management (Ferreira, 2021).

Several additional regulatory mechanisms support the implementation of sustainable management strategies for urban water bodies in Brazil. Notably, Federal Law No. 11,445/2007 established national guidelines for basic sanitation, later updated by Federal Law No. 14,026/2020 (the New Basic Sanitation Framework). This reform encouraged private-sector participation, targeted universal service coverage by 2033, and transferred regulatory oversight to the National Water and Sanitation Agency (ANA). Under this updated legislation, basic sanitation comprises public services, infrastructure, and operational facilities across four main pillars: potable water supply, sanitary sewerage, urban cleaning and solid waste management, and urban stormwater drainage and management. Complementing these statutory frameworks, CONAMA Resolution No. 430/2011 stipulates conditions, parameters, standards, and guidelines for effluent discharges into water bodies.

However, even with the enactment of laws and resolutions to discuss and guide the implementation of basic sanitation in the country, Ferreira (2021) emphasizes that, in practice, the Brazilian sanitation reality remains fragile and backward. According to data from the National Information System on Basic Sanitation (SINISA), in 2024, the percentage of treated sewage in the country relative to water consumed stood at 49.4%. Regional comparisons reveal an even greater disparity: 22.9% in the North, 34.7% in the Northeast, 57.9% in the Southeast, 44.7% in the South, and 56.6% in the Midwest (SINISA, 2024).

Within this context, SINISA (2024) data indicate that just over half of Brazilian households (53.5%) are connected to sewerage systems. In Pernambuco, coverage is even lower, with sewage collection reaching only 43.3% of households. Consequently, urban rivers serve as the ultimate discharge point for untreated wastewater, degrading water quality by depleting dissolved oxygen levels, triggering fish kills, and concentrating nutrients like nitrogen and phosphorus that promote harmful algal and cyanobacterial blooms.

Beyond direct impacts on water, soil, and biodiversity, the degradation of water resources in urban areas also indirectly influences the formation of heat islands and changes

in air quality, which in turn lead to higher energy and water consumption by the population. In this context, the absence of efficient management combined with the excessive use of water resources forms a vicious circle, fed by an ever-growing demand from nature (Silveira; Polidori, 2024).

In this sense, it is evident that urbanization involves a need to develop at any cost - expanding, building, canalizing, and modernizing - while neglecting people's quality of life and the environment. However, considering the current scenario, given the environmental impacts observed in various places, it is clear that sustainable development cannot be achieved without addressing the economic, environmental, and social dimensions—fundamental and inextricably linked factors that must be treated holistically (Nogueira; Gomes; Lopes, 2022).

4 METHODOLOGY

The research is qualitative and descriptive, developed from bibliographic, documentary, and field procedures, with the goal of understanding the factors that influence the environmental degradation of urban streams in the municipality of Petrolina, in the São Francisco hinterland of Pernambuco.

Bibliographic procedures were carried out through reading scientific articles, books, theses, and dissertations, aiming to build an environmental diagnosis of the watersheds and their relationships with the urban water bodies, in order to understand the geoenvironmental configuration of the São Francisco River basin. Subsequently, documentary research was conducted based on the analysis of official documents and urban planning instruments, such as the 1988 Federal Constitution, the Petrolina City Statute, the municipality's master plan, technical reports, and regulations related to land use and occupation and to water resources management. This stage provided the necessary grounding to understand the legal guidelines related to urban planning and environmental management of the municipality.

Journalistic reports published in local newspapers and blogs over the last ten years were also analysed, with the aim of identifying the main recurring problems reported by Petrolina's population, such as improper disposal of solid waste and the irregular discharge of raw effluents into the city's urban streams.

Finally, field visits were conducted for on-site analysis of portions of Petrolina's main urban streams, which showed a high degree of degradation associated with urbanization, with emphasis on Riacho Vitória, where the negative impacts of pollution and anthropogenic

interventions on fluvial morphology and drainage patterns were most evident, up to its discharge into the São Francisco River.

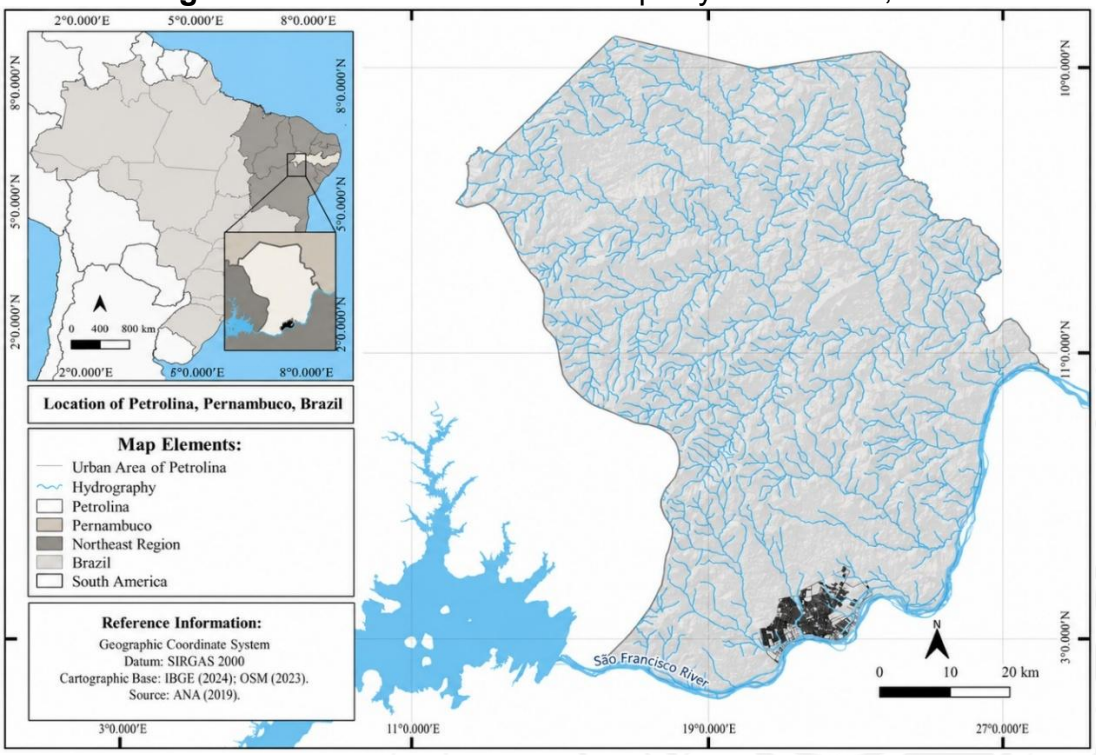
During the field visits, photographic records were made to document environmental conditions, land use, anthropogenic interventions, besides visible impacts on fluvial morphology and drainage patterns. Concurrently, municipal maps of the studied watercourses were prepared by using the QGIS software (open-source geographic information system), with the aim of georeferencing observation points and spatially mapping the urban drainage network.

4 RESULTS AND DISCUSSION

4.1 Petrolina and Its Urban Streams

Located in northeastern Brazil within the mesoregion of São Francisco Pernambucano, the municipality of Petrolina (Figure 2) covers an area of 4,561.87 km² and has a population of 386,791 inhabitants. Hydrographically, it situated across the São Francisco River Basin, the Pontal River Basin, and the Group of Small Interior River Basins (GI8), all of which drain into the left bank of the São Francisco River (IBGE, 2022; APAC, 2025).

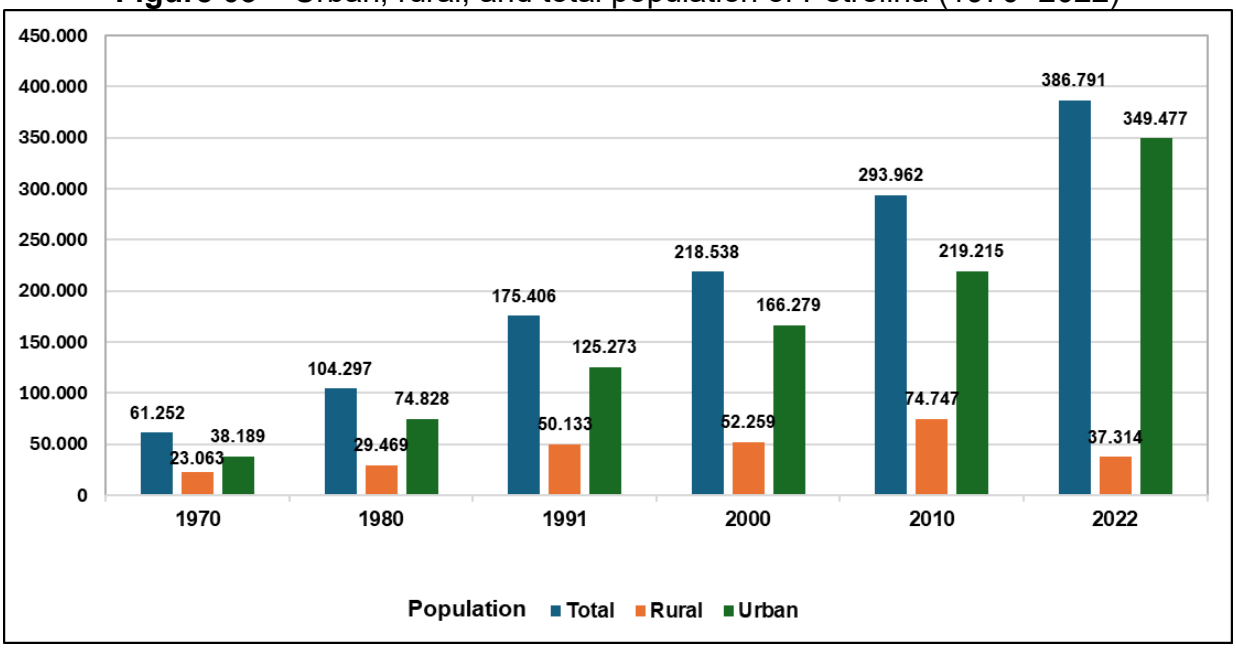
Figure 02 – Location of the Municipality of Petrolina, PE



Source: Prepared by the authors (2025).

Its privileged geographical position significantly contributed to Petrolina's consolidation as one of the most important cities in the middle São Francisco region, especially since the implementation of the Senator Nilo Coelho Public Irrigation Project in 1984, in the rural area of the municipality, which spurred the region's economic development and demographic growth (Figure 03).

Figure 03 – Urban, rural, and total population of Petrolina (1970–2022)



Source: Adapted from IBGE (1970, 1980, 1991, 2000, 2010, 2022).

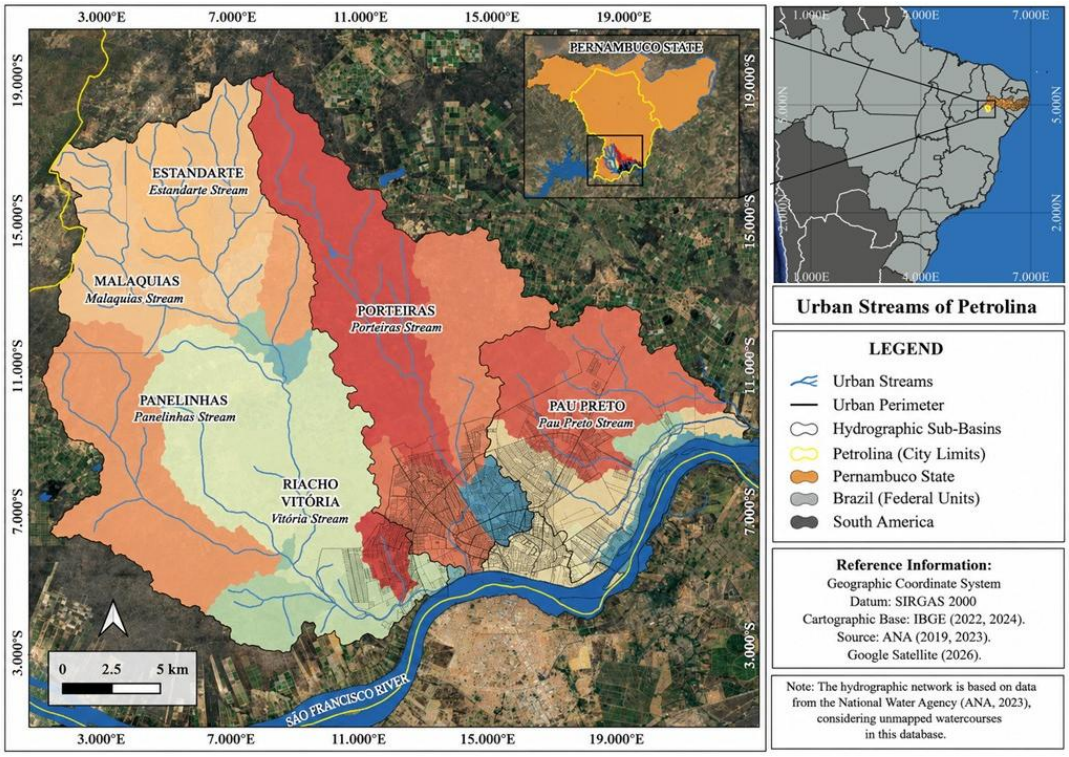
Currently, the municipality is nationally and internationally recognized as a hub of irrigated fruit production, ranking third among the most populous cities in the state of Pernambuco (IBGE, 2022).

This relevance is deeply linked to its historical relationship with the São Francisco River, established long before its consolidation as a municipality in 1894. Initially, the "Passagem de Juazeiro," as it was known, operated as a strategic trade route between the states of Piauí, Ceará, Bahia, Minas Gerais, Rio de Janeiro, and São Paulo, which fostered local economic and social development and supported the urbanization process (Municipal Government of Petrolina, 2014).

However, as observed in many other Brazilian municipalities, this rapid growth entailed significant adverse urban impacts, including unplanned land use and occupation. Consequently, throughout its urbanization process, Petrolina underwent extensive spatial restructuring - expanding infrastructure for commercial development, residential complexes, and road networks - aimed at shedding its provincial status in favor of modern urban ideals.

Thus, the natural aspects of the watercourses that run through the city were altered, transforming urban streams into large channels for wastewater discharge. According to data from the Pernambuco Water and Climate Agency (APAC, 2022), the city's drainage network is formed by several intermittent and ephemeral streams that extend from the rural area to the urban area (Figure 04), with the most important being the Vitória, Porteiras, Salina, Bebedouro, and Imburana streams, which drain the southern portion of the municipality.

Figure 04 – Urban creeks of Petrolina – PE



Source: Prepared by the authors (2025).

In addition to the streams already mentioned, the Municipal Basic Sanitation Plan (2019) points to other streams that complement Petrolina's hydrographic network, such as Mulungú, Talúpio, and Pau Preto streams, which, according to the document, are located near the Wastewater Treatment Plants (ETE) of the Pernambuco Sanitation Company (Compesa) and receive effluent loads only after proper treatment.

Overall, the municipal seat of Petrolina has nine active wastewater treatment plants: Antônio Cassimiro, Centro, Cohab VI, Dom Avelar, João de Deus, Marcela, Ouro Preto, Jardim Petrópolis, and Loteamento Recife (Prefeitura Municipal of Petrolina, 2019).

However, even with about 75% coverage of the collection and treatment of all produced sewage, the Municipal Basic Sanitation Plan (2019) admits that:

> Furthermore, several decommissioned sewage pumping stations broaden the spatial distribution of potential contamination sources, posing environmental risks particularly to the Vitória, Porteiras, and Baraúna Velha streams and, ultimately, to the São Francisco River (Prefeitura Municipal de Petrolina, 2019, p. 100).

Thus, the fragility of the sewer collection systems becomes evident, as they often prove insufficient to meet the growing demand and leave local urban water bodies susceptible to recurrent contamination. A clear example of this is the ongoing disputes between Compesa and the Petrolina City Hall regarding responsibility for cases of pollution caused by the discharge of untreated sewage into the São Francisco River (Figure 05).

Figure 05 – Articles published in newspapers and blogs about sewage in the São Francisco River.

Source: G1 (2021); G1 (2024); Brito (2018); Nossa Voz (2025). Prepared by the author (2025).

Frequent media coverage, compounded by public dissatisfaction with services provided by Compesa and the municipal administration, underscores that effective wastewater collection and treatment remain a critical challenge across both urban and rural areas of the municipality. Indeed, a significant portion of rural residences relies on "individual treatment systems such as septic tanks or discharges [effluents] directly into streams and rivers" (Prefeitura Municipal de Petrolina, 2019, p. 100).

As this issue persists, local streams suffer ongoing contamination from untreated sewage and solid waste, emitting foul odors and degrading the ecological balance of these tributaries and, by extension, the São Francisco River (Figure 6).

Figure 06 - Riacho Porteiras. (A–C) discharge of sewage and waste in an urban stretch of the creek, near Mix Mateus, Cohab Massangano neighborhood, Petrolina-PE.

Source: Prepared by the authors (2024).

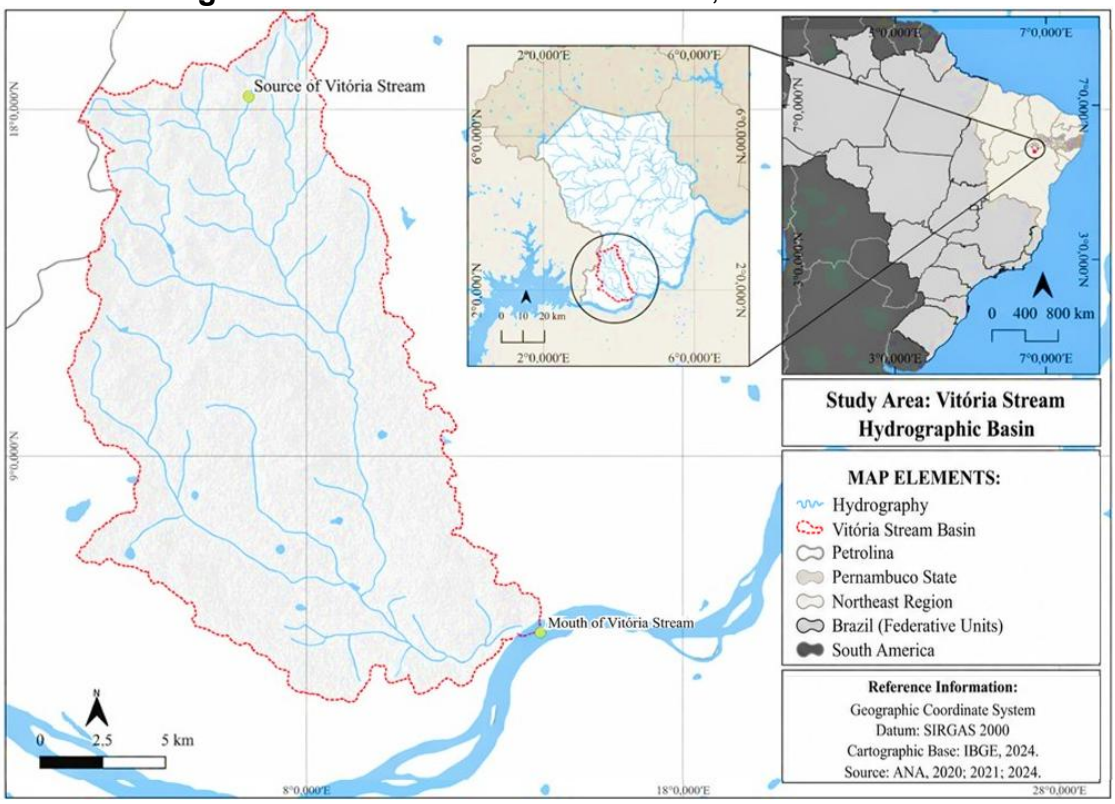
Based on this analysis, the environmental status of the city's urban streams is critical. The degradation observed in Porteiras Stream is mirrored to varying degrees across numerous other watercourses in Petrolina, many of which have effectively function as open-air sewage channels due to institutional neglect by both the sanitation utility and the municipal government.

4.2 Vitória Stream

Riacho Vitória (Figure 07) is part of the Group of Small Interior River Basins (GI8) that make up Petrolina's drainage network and constitutes an important tributary of the São

Francisco River (APAC, 2025). Due to its natural intermittent regime, in which the water flow is reduced during dry periods, it is not possible to determine precisely the exact location of its source. However, there are indications that it is in the vicinity of the Curral Queimado district, in the rural area of the municipality, where groundwater springs are observed.

Figure 07 – Location of Riacho Vitória, Petrolina – PE.



Source: Prepared by the authors (2026).

Historically, the Vitória Stream has undergone significant anthropogenic alterations driven by the rapid expansion of Petrolina's urban area. These include channel narrowing, the construction of bridges and dams, riparian deforestation, informal housing development along its margins, and raw effluent discharges (Figure 08)—factors that collectively placed the stream at the forefront of local environmental discourse (CBHSF, 2021).

Figure 08 – Contamination by untreated effluents in an urban segment of Vitória Stream (A); bridge over Vitória Stream, Cohab São Francisco neighborhood, Petrolina, PE (B); Permanent Preservation Area (APP) signage near the Vitória I Water Treatment Plant (C).

Source: Prepared by the authors (2025).

However, concerns regarding the environmental quality of Vitória Stream are long-standing. Approximately a decade ago, local news coverage and blogs reported widespread community complaints highlighting solid waste accumulation, agricultural pesticide run-off, and untreated effluent discharges as the primary factors compromising the city's public water supply during rainy seasons (Figure 09).

Figure 09 - Riacho Vitória in local blogs and media.

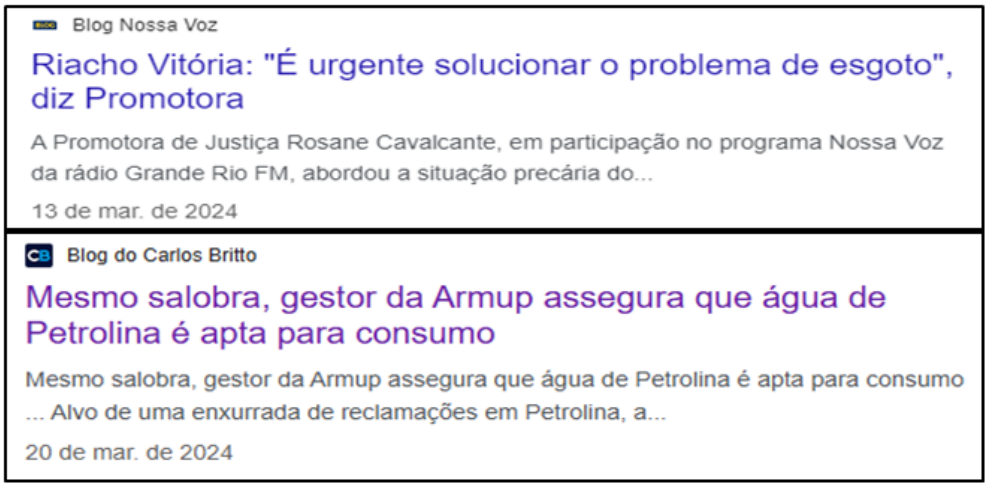
Source: Brito (2016); Alves (2021); Fernandes (2022).

This occurs due to the location of the creek's mouth, situated upstream of the Compesa Water Treatment Plant (WTP) responsible for water abstraction from the São Francisco River. During periods of higher rainfall, the increased discharge of the Vitória Creek promotes the intake of a portion of its flow by the WTP, escalating the risks to the quality of the water distributed to the population.

In light of this context, in 2022, the Public Prosecutor's Office of Pernambuco (MPPE) was requested to intervene and initiated a civil inquiry to investigate the landfilling of the Vitória Creek, located within a Permanent Preservation Area (APP) of the federal river. Upon verifying the condition of the water body, the MPPE recommended, through the Environmental Defense Prosecution Office of Petrolina, that the municipal administration urgently submit a revitalization project for the Vitória Creek (CBHSF, 2022).

However, despite MPPE's recommendations, the Petrolina city government failed to implement an effective plan to mitigate the problems, a factor that brought Riacho Vitória back into the spotlight of the discussion, since the rains in the first months of 2024 led to questions about the quality of water supplied by Compesa, which again showed changes in color and taste (Figure 10).

Figure 10 – Local blog articles about the water of Riacho Vitória in 2024



Source: Blog Nossa Voz (2024); Brito (2024).

Despite recurring discussions, the environmental condition of Vitória Creek continues to deteriorate, exhibiting signs of degradation that range from the rural zone—in stretches adjacent to residential settlements and irrigated agriculture areas—to its mouth in the urban zone. There, water pollution is intensified by the discharge of untreated effluents originating from the channels of the Jardim Petrópolis neighborhood and Tapuio Avenue, which ultimately flow into the São Francisco River.

It is worth noting that, despite the increasing demand for structural solutions, the municipality of Petrolina currently lacks a consolidated macrodrainage plan. Since 2020, public hearings have been conducted to formulate this plan, with completion expected in 2026 (Brasil, 2020).

Another aspect that exacerbates the environmental vulnerability of the Vitória Creek in its urban reach is the irregular occupation of its floodplain by private lots and buildings. According to preliminary data from the Draft Technical Report of the Petrolina Macrodrainage Plan (2025), 109 informally constructed properties were identified in areas exercising direct influence over the creek. This contributes to the narrowing of its active channel, reduces flow capacity, and increases susceptibility to flooding, particularly during high-water periods of the São Francisco River.

In 2024, a year in which the National Institute of Meteorology (INMET) recorded the highest rainfall levels of the past fifteen years in the city, the debate surrounding Vitória Creek gained significant prominence. Conversely, in 2025, rainfall volumes were primarily concentrated in January, which contributed to the absence of public complaints regarding the creek's water quality and, consequently, led to a lack of interest from local public

authorities regarding the issue.

Despite its widely recognized issues, the Vitória Creek continues to suffer the adverse effects of Petrolina's urban development, which disregards the degraded condition of its water bodies. This dynamic perpetuates a critical problem that has transcended environmental and aesthetic concerns, evolving into a public health issue that continuously affects the population through the city's public water supply.

5 FINAL CONSIDERATIONS

The discussions about the environmental condition of Petrolina's urban streams have become more frequent due to the rapid growth of the urban network. This context reveals the paradox of a municipality whose development has historically been linked to the waters of the São Francisco River, but whose tributaries have been negatively affected by the transformations resulting from urban occupation.

In this scenario, Vitória Creek emblematically represents the consequences of these interventions on watercourses, constituting an important element for understanding the local environmental dynamics and the challenges related to conserving urban water resources.

It is evident that the environmental conditions observed in the urban stretch of the stream show that its degradation is not solely the result of episodic factors associated with rainfall periods, but of a set of ongoing pressures, among which stand out the discharge of untreated domestic effluents, clandestine sewer connections, irrigated fruit farming activities, insufficient sanitation coverage, and the absence of effective macrodrainage actions.

This reality highlights vulnerabilities in the municipal management of sanitation and urban drainage, as well as the challenges faced by public authorities in mitigating long-standing issues. In light of this context, it is necessary to adopt integrated planning and environmental management strategies that go beyond the emergency measures implemented during rainy periods. Such strategies must encompass investments in basic sanitation, drainage infrastructure, and continuous monitoring of environmental quality.

Thus, the revitalization of Vitória Creek and other urban streams in Petrolina represents not only a demand resulting from environmental impacts, but also an opportunity to promote higher quality of life, urban landscape enhancement, and water sustainability. In this manner, these watercourses can reassume their role as natural elements, contributing to the conservation of the São Francisco River and the sustainable development of the

municipality.

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