

**Considerations about the sociocultural and environmental landscape of
the Jaú River**

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ABSTRACT

Despite fundamental roles of rivers in the history and evolution of urban centers, city design has often disregarded water networks in the midst of accelerated urban expansion. The lack of connection between rivers and the urban landscape has over time contributed to the exacerbation of socio-environmental problems. This research aims at understanding the relationship between the Jaú River and Jaú's cityscape through the following perspectives proposed by Jean-Marc Besse (2014): historical, sociocultural and socio-environmental landscapes. The river landscape of Jaú is characterized based on information taken from scientific and documentary sources (textual, iconographic and cartographic). The results of analysis are then presented to systematically characterize challenges to landscape planning in this case study. This research pertains to the contemporary effort aiming at understanding landscapes by analyzing historical and current perspectives allowing us to restore connections between a city and its natural environment. In conclusion, it is argued that the neglect of the Jaú River valley throughout urban expansion contributed to the disconnection between the river landscape, the city and its inhabitants' daily lives. As an alternative, we propose a landscape planning process that integrates the river's environmental and social dimensions.

KEYWORDS: Landscape. Urban rivers. Urban resilience.

1 INTRODUCTION

According to the United Nations (UN, 2022), the world's population increased from 2.5 billion people in 1950 to 6 billion in the 2000s and has now reached approximately 8 billion people. Accelerated population growth has contributed to increased urbanization, which in turn has constrained the natural environment to the outskirts of cities and constrained it to marginal spaces within urban areas. Rivers and green areas have been neglected in city planning and are still not seen as fundamentals for urban infrastructure and urban planning. Thus, the landscape currently occupies "a crucial place in social and political concerns due to the quality of the life frameworks offered to populations, in relation to questions about the identity of places, about the governance of territories or, even, about the protection of natural environments" (Besse, 2014, p.7, our translation).

In this sense, problems of urban space configuration and appropriation of the natural environment refer to landscapes, which are composed of relationships between man and nature (Gorski, 2010). Thus, issues commonly conflicting in urban development and involving natural and human processes are the objects of this investigation focusing on Jaú's urban landscape and its relationship with the Jaú River.

According to Besse (2014), the reading of a landscape can be carried out through different viewpoints, presented as "doors" helping understand coexisting contemporary landscape problems. Among the proposed perspectives Besse (2014) presents the landscape as a "fabricated and inhabited territory" and the landscape as natural environment.

Understanding the landscape as a manufactured territory resulting from collective works of societies is the basis of the "Jacksonian" theory of landscape. The American John Brinckerhoff Jackson (1909-1996), a historian and theorist, is known to be one of the main thinkers on landscapes. His studies, based on human geography, conceive landscapes as a cultural production, based on the conception of space organized by society (Jackson, 1997). In this sense, Besse (2014, p.30) observes that "every landscape is cultural [...] essentially because

it was produced by a set of practices (economic, political, social), and according to values that, in a certain way, it symbolizes.”

While the understanding of a landscape as a material and living environment of human societies, another reading key proposed by Besse presents the environment as its starting point; the landscape is deemed to be “above all, a dynamic, evolutionary totality, crossed by flows of quite variable nature, intensity and direction” (Besse, 2014, p. 43). The author observes that landscape reality, from this perspective, can be understood as a system ordered by flows of matter and energy between its spaces.

This research aims at understanding, through these two perspectives, the landscape in the sub-watersheds composing Jaú’s urban area, providing inputs for future public policies that promote improvements in local socio-environmental conditions.

This analytical exercise thus fits into contemporary efforts aiming to understand the landscape by analyzing historical and current keys that could restore connections between the city and the Jaú River.

2 MATERIALS AND METHODS

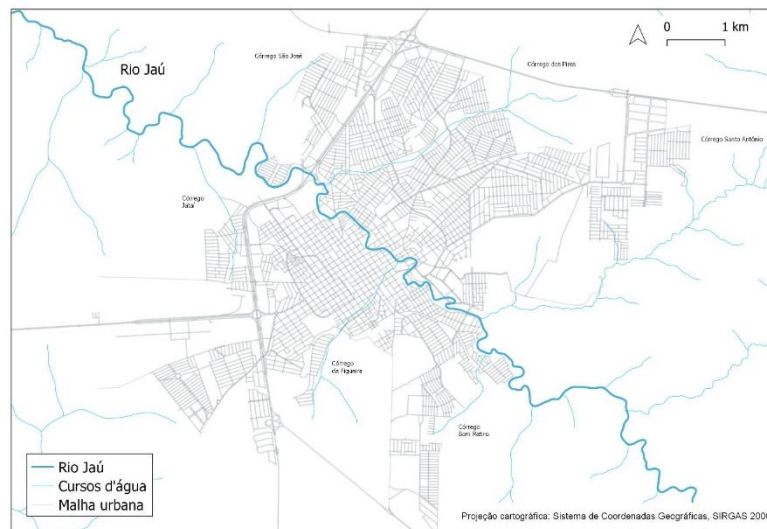
2.1 Study Area

The present work focuses on the sub-basins that compose the urban area of Jaú, located under the Jaú River valley in the center of the State of São Paulo. The municipality of Jaú is inhabited by approximately 133,497 people (IBGE, 2022) and its urban area covers 81.12 km².

The Jaú River is a 5th-order watercourse according to Strahler's criteria (1957), and its basin is part of the Tietê-Jacaré Water Resources Management Unit (UGRHI TJ or UGRHI 13). The Jaú River Basin spreads over 752.25 km² and its drainage network measures 745.8 km. Its territory encompasses seven municipalities, including the municipality of Jaú (Rezende, Pires, Veniziani, 2011).

The urban area of Jaú, which is territory covered by this research, comprises six of the twenty-four sub-basins of the Jaú River (Souza; Sammarco; Cremonesi, 2014). Flowing from the southeast to the northwest towards the Tietê River, within the urban area of Jaú, the river receives water from the Santo Antônio, Pires and São José streams on its right side, and from the Bom Retiro, Figueira, and Jatay streams on its left side, as shown in Figure 1.

Figure 1. Jaú, SP – Urban network and watercourses



Sources: IBGE, 2020. Prepared by the author.

2.2 Methodology

Based on scientific bibliographic and documentary sources (textual, iconographic and cartographic), this case study (the sub-basins in the urban area) involves analyzing information on socio-environmental issues and their relationship to the urban landscape through research in municipal archives, newspapers and other media. Additionally, as a part of the methodological strategy, field visits allow for a comparison between maps and reality, and capture photographic records relevant to this research. The final phase of this research involves the analysis of results to systematically outline challenges to landscape planning in the case study.

3 RESULTS

3.1 The Territory of Jaú

The territory of Jaú is part of the Arenito-Basáltico Plateau in the State of São Paulo, located on the reverse slopes of the 'cuesta', regionally known as Serra de Brotas and Serra de São Pedro. Formed on the edges of the Plateau, the top of the 'cuesta' has altitudes exceeding 800 meters, decreasing to the west towards the Tietê River where its banks are around 400 meters above sea level (Perides, 1981).

The area of the Arenito-Basáltico Plateau is roughly bound in the south and west by the Tietê River, and in the north by the Jacaré-Pepira River, which originates on the immediate reverse slope of the 'cuesta' and flows towards the Tietê. Between these two rivers is a large plateau aligned in a southeast-northwest axis, divided in two by the Jaú River, which is also a tributary of the Tietê (Perides, 1981).

Perides (1981, p. 7) highlights that it was along these plateaus that the first settlers from the East entered, after overcoming the escarpment of the "cuesta." One of the striking features of this part of the Arenito-Basáltico Plateau is a significant area of purple soils, that have resulted from the decomposition of basalt, and provide good quality soils for agriculture. Thus, Perides (1981) observes:

Besides the high soil fertility, the lush Tropical Broadleaf Forest that covered much of the plateaus contributed to characterizing this area as highly suitable for establishing an export crop (Perides, 1981, p.7, our translation).

Topography was not a limiting factor for the use of Jaú's natural setting for agriculture (Perides, 1981).

In the book "Jaú – Sons and Images of a River!", Souza, Sammarco, and Cremonesi (2014) describe the vegetation of the Jaú River Basin where, before an intense deforestation effort, was dominated by the Atlantic Forest of the Interior in the valley of the basin, followed by patches of Cerrado located in the headwaters of the rivers. The few remaining fragments of native forest are characterized as Seasonal Semideciduous Forest and are found in depressed areas of the basin valley where rugged terrain is not particularly suitable for agriculture.

3.2 The Growth of the Jaú Village

The settlement of the Jaú territory began in the mid-1830s, fueled by the establishment of an export economy in its hinterland (Perides, 1981). This movement was part of the so-called 'São Paulo sugarcane cycle,' which occurred between 1765 and 1851.

Perides (1981) notes that in 1822 the government ceased the granting of lands ("sesmarias") and instituted legal recognition of land holdings to occupants who could prove their agricultural cultivation. This encouraged appropriation of public lands, such as those in the Jaú territory. According to Perides, the first pioneers who arrived in the territory took possession of lands near the Jaú River.

After the arrival of the first white settlers, additional land claims were made. The region was quickly populated due to the fertile soil and waters rich with jaú, a Tupi name for one of the largest freshwater fish in Brazil (Teixeira, 1900; Perides, 1981).

From the 1850s onwards, due to the increasing external demand and the high price of coffee in the global market, sugarcane crops began to be replaced by coffee cultivation throughout the Jaú territory. In the 1850s, development of coffee crops experienced significant expansion, contributing to the influx of new settlers in Jaú.

In 1853, inhabitants of Jaú gathered to record the founding of the city (Santos, 2021). In that year, a simple chapel was built on an elevated point of land in the city. The construction of the Jaú Parish Church began on that same site in 1888 and was completed in 1905 (Livorato, 2004). As noted by Marx (1980), in his description of cities founded on a religious heritage, we can see that Jaú's street layout began with the donation of land for the church. The church, located on high grounds, serves as the nucleus from which the urban street network radiates outwards in a sequence of straight alignments.

Facing the Jaú River, the parish church is located between the upper part of the city and the valley bottom. The typical layout that characterized the usual landscape in western São

Paulo can be observed in the city plan of Jaú, drawn by civil engineer Luiz Gomes dos Reis on February 20, 1912.

Over time, the city grew on both sides of the river. Today, the valley bottom cuts through the urban area, as illustrated in Figure 3, where the alignment of the 1912 city plan remains evident in the current urban layout of the city.

Figure 3 – Jahu Plan, 1912, adapted

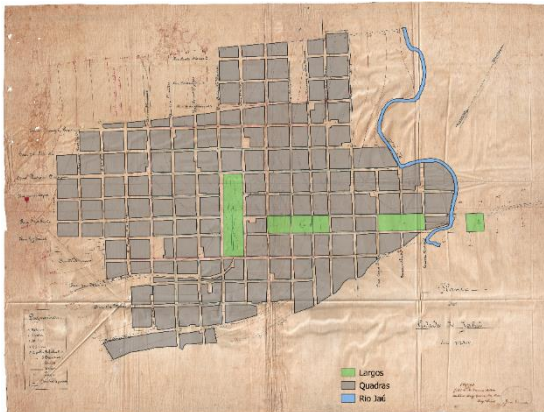
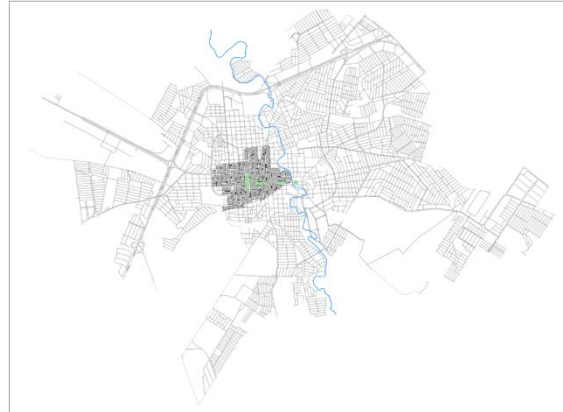


Figure 2 - Jahu Plan in 1912 and current urban layout



Source: Jaú Municipal Archive, adapted by the author.

Coffee production in Jaú continued to expand and reached its peak in the 1880s with the construction of the railroad in 1887. Sebastião Teixeira (1900) highlights that the arrival of the train contributed to Jaú's economic growth and facilitated the arrival of foreign immigrants, increasing population growth and the city's expansion.

Junior and Rezende (2021) observe that, especially in the second half of the 19th century, changes in land use intensified with the expansion of coffee cultivation in the Jaú River Basin region, resulting in increased deforestation of riparian forests.

Coffee cultivation, affected by the 1929 economic crisis, began to be replaced by sugarcane in the 1950s. Sugarcane has been predominant from the 1980s to the present day. According to Junior and Rezende (2021), sugarcane cultivation also contributed to land use changes and to the degradation and deforestation of riparian forests in the Jaú River Basin.

3.3 The City and the Jaú River

Throughout the city's history, the Jaú River and its tributaries have been fundamental water supplies and sources of livelihood for its inhabitants. Besides being an essential natural resource sustaining life, the river offered contact with nature and marked the childhood of Jaú's past residents, who played on its banks and swam in its waters, as observed in Figure 4.

Figure 4 – Boys on the bank of the Jaú River around 1960



Source: Archive of Ítalo Poli Júnior (1960)

In the past, fishing was also a part of childhood. Along its course, the river's fish were an abundant source of food. In the following images, we can see a fisherman with four 'jaú' fish in the 1930s and two boys holding fishing rods around 1974 (Figures 5 and 6).

Figure 5 - "Jaú" fishing in the 1930s



Figure 6 - Boys fishing in the 1970s



Source: Jaú Municipal Collection (2023)

The Jaú River also played a significant role in the city's development. For example, it was the source of energy for ice production. In 1910, an ice factory was established, becoming one of the oldest businesses in the municipality. The factory was built by a German entrepreneur of the Doring family, who brought the equipment from Dresden, Germany (Cestari, 2015).

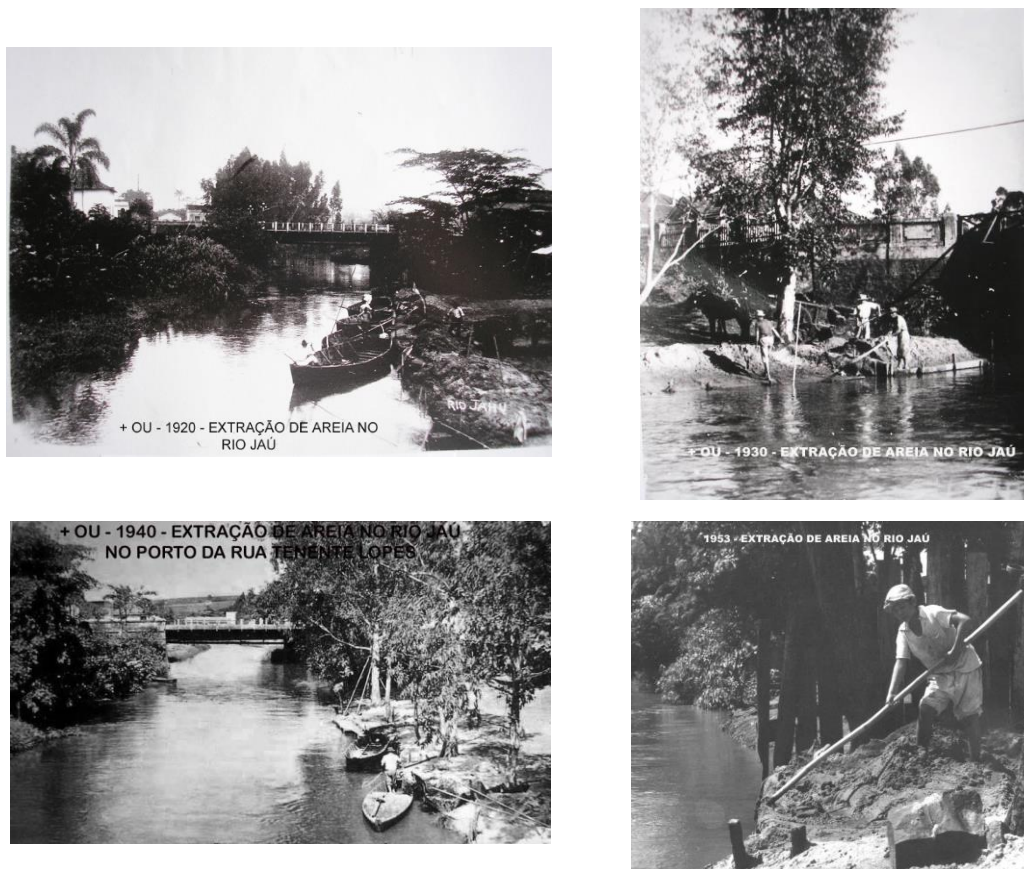
The manufactured ice was sold to households to cool the primitive refrigerators, mostly made of wood [...]. Ice blocks were also widely used by the Santa Casa de Jaú

to keep medicines and other hospital products at ideal temperatures, in the air conditioning units of the Companhia Paulista de Estrada de Ferro (which operated with ice), as well as in bakeries and cold storage facilities. (Cestari, 2015, w/p, our translation).

Located in the city center on General Galvão Street, near the corner with Quintino Bocaiuva Street, the factory was powered by a branch of the Jaú River. The water wheel drove the piston that operated the compressor for ice production. The water from the 'branch' then flowed back into the Jaú River.

The Jaú River also marked the city's history throughout the 20th century as a source of sand extraction used for construction. As shown in the following images (Figure 7), this practice was common in the city center for decades during the past century. The population was likely unaware of the erosive and negative environmental impacts that extraction could cause.

Figure 7 - Images of sand extraction in Jaú throughout the 20th century



Source: Archive of Ítalo Poli Júnior (1970)

Despite the importance of the Jaú River and its tributaries to the residents of Jaú, its waters were polluted and its banks completely deforested. As described by Levorato (2003):

[...] Our river knows man and approaches his city, quenches his thirst, and works for him – powers his factories and plants, cleans his filth, transports his vessels, quenches the thirst of his herds and crops, offers him its fish – and despite all this, sometimes tastes the bitter flavor of his ingratitude (Levorato, 2003, p.130, our translation).

Throughout its history, the city of Jaú, located in the river valley, has faced significant flooding problems common during the rainy season (from October to March). Many of these floods had catastrophic proportions, such as the one that occurred on February 12, 1922, when the overflowing of the Jaú River resulted in collapsed bridges and destroyed buildings. After a storm lasting about two hours in Mineiros do Tietê, Dois Córregos, and Torrinha, the rain was even more violent, and all the streams flowing into the Jaú River received an enormous amount of water, which channeled into Jaú.” (Prado, 2011, p. 33).

In 1929, a major flood was also recorded in the city and over time, other significant catastrophic floods have marked Jaú's history, such as those of January 1965, November 2011, and more recently, January 2022.

With expansion of the city and urban land speculation, the pressure of urbanization on the river and its tributaries continued to intensify throughout the 20th century. Thus, interventions in the urban section of the Jaú River led to changes in its course such as the straightening of its meanders carried out in the 1960s, a common practice at the time, to facilitate the urbanization of valley bottoms and 'eliminate' river overflow in urban areas. However, the alteration of the Jaú River's course led to changes in its flow, exacerbating existing flooding in the downstream area, which were also worsened by the intense soil impermeabilization caused by urbanization (Junior; Rezende, 2021).

In Figure 8, we can observe the alteration made to the river's course, as well as some historical photos of the section showing the relationship between the Jaú River, the city and its inhabitants.

Figure 8 - Map of Jaú, central occupation, Rio Jaú and old archived photos



Source: Google Earth and photos from the Jahu Municipal Library collection, altered by the author.

Preservation of the Jaú River and its natural resources was overlooked throughout the city's growth. Its banks have been deforested, diminished and degraded; natural processes have been disregarded by urban planners.

Meanwhile, environmentalists fought for the river's cleanup and managed to promote restoration of a significant portion of the riparian forests along its urban section. As Prado (2011) notes, in the 1980s:

[...] a group of young people decided to draw the attention of citizens and public authorities to important but previously shallowly discussed issues, such as the cleanup of the Jaú River, tree planting, and the preservation of historical buildings in the municipality. Thus, the Apuã Environmental and Cultural Association was born, one of the first non-governmental organizations (NGOs) in the interior of São Paulo, which awakened the city to discussions about historical and environmental heritage. (Prado, 2011, p. 153, our translation).

Prado (2011, p.153) reports that this organization managed to plant around 800 native tree seedlings along the Jaú River's riparian area, "over a distance extending from the Fazenda Santo Antônio dos Ipês, owned by the Botelho family, to the vicinity of the Forum." Also noteworthy is the work of the Pró-Terra Institute. Established in the 1990s and still active today, it emerged from the voluntary efforts of young people who organized additional tree-planting campaigns along the banks of the Jaú River.

With the participation of society and partnerships between public authorities and non-governmental organizations, the riparian forest has been partially restored and now protects stretches through which the waters of the Jaú River flow, as demonstrated in the following images (Figures 9 and 10).

Figure 9 - Jaú River in Vila XV in 1970



Source: Archive of Ítalo Poli Júnior

Figure 10 - Jaú River in Vila XV in 2024



Source: archive of author

3.4 Route along the Jaú River

According to the Forest Restoration Master Plan of the Tietê-Jacaré Water Resources Management Unit, which includes the Jaú River Basin, the remaining vegetation in the upstream sub-basins of the urban area of Jaú accounts for just over 5% of the total area, and more than

70% of the Permanent Preservation Areas are degraded, meaning there is a lack of riparian forests (Rezende; Helene, 2023).

In the city of Jaú, the Jaú River supplies water to more than 57,000 residents, which corresponds to almost one third of the municipality's population. Throughout 2022, 5,768,180 m³ (658 m³/h) of its water were extracted for public supply (Rezende; Helene, 2023).

As mentioned, the riparian forests of the Jaú River and its tributaries were deforested at the beginning of Jaú's urbanization and have been partially restored in the more recent history of the city. However, there is noticeable degradation of the existing riparian forest. As highlighted in the Municipal Basic Sanitation Plan (JAÚ, 2013), the Permanent Preservation Areas (APPs) in general are not preserved according to what is stipulated in the Forest Code – Law 12.651 of May 25, 2012.

According to the Plan, it was observed that the APPs in urban areas were partially occupied by urbanization, an ongoing process. There are also sections of eroded banks due to lack of protection and excessive soil impermeabilization in adjacent areas (JAÚ, 2013).

Walking along the banks of the Jaú River and its tributaries, one observes a significant amount of trash and debris left by residents (Figure 11). According to the Technical Report conducted by the Technological Research Institute (IPT) (2014) in Jaú, waste that is discarded occasionally in watercourses exacerbates flooding, particularly in channelized sections where the water lacks proper flow and overflows through storm drains and sewers.

Figure 11 – Sofa and waste discarded next to Córrego da Figueira



Source: Archive of the author

According to IPT (2014), the riparian settlement in Jaú is subject to the impact of its waters during the rainy periods in its watershed. The report indicates that, based on historical data, floods can reach a larger area than estimated because the water levels rise more rapidly.

In the Municipal Basic Sanitation Plan (JAÚ, 2013), the main issues of urban drainage and stormwater management in the city were identified. According to the Plan, the primary deficiencies in Jaú's drainage are related to the urbanization of the Jardim Sempre Verde neighborhood, the channelization of the Figueira Stream, and the impermeabilization of the Pires Stream basin.

Upon entering the city, the Jaú River has, on its right side, the Amadeu Botelho Private Natural Reserve (RPPN), which is the largest fragment of the basin, covers 143 hectares and connects to the ecological corridor formed by the river's Permanent Preservation Areas; on its left side stands the João Ballan II neighborhood (Figure 11). The next neighborhood, on the left bank of the river, is Jardim Sempre Verde, where the Jaú River receives the waters from the Bom Retiro Stream.

The neighborhood area is frequently affected by river floods. According to information from the Civil Defense, more than ten flooding events have been observed in the neighborhood in less than a year. The Municipal Basic Sanitation Plan (JAÚ, 2013) mentions that floods occur because the neighborhood is located in the river's floodplain which, as stipulated by the Municipality's Master Plan, should not have been urbanized.

Along its urban stretch, the Jaú River receives water from the Figueira Stream on the left side and water from the Pires Stream on its right side. Both streams are major watercourses with significant influence in urban areas of Jaú.

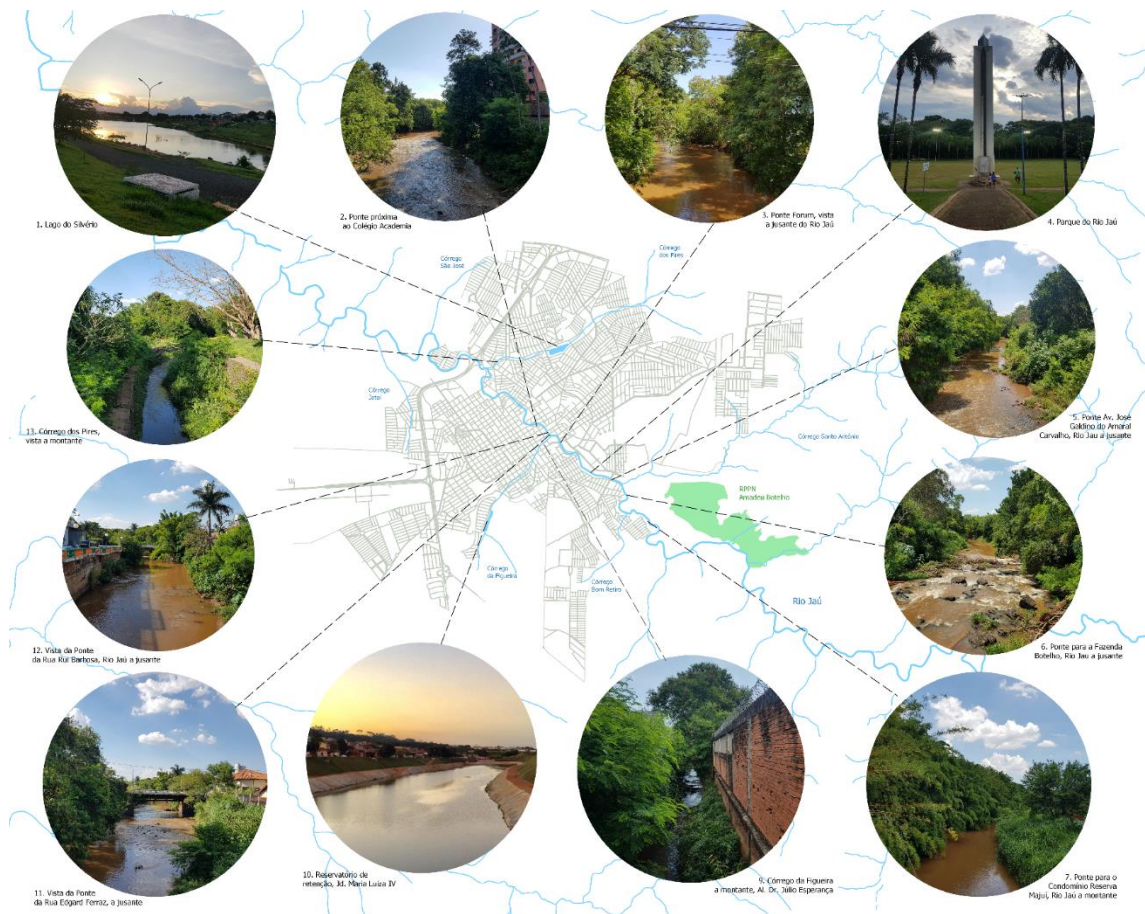
The Figueira Stream, after crossing the railway, continues in a culverted canal below Avenida Francisco Canhos until it reaches the Jaú River, with its banks occupied by buildings that constrict its course (Figure 11, Photo 9). Due to historical flooding issues and lack of drainage in the Avenida Francisco

Figura 12 – Imagens do Rio Jaú e afluentes na área urbana de Jaú

Canhos area, the city hall began constructing a retention reservoir upstream of the avenue in 2014 as part of the Growth Acceleration Program (PAC) works. The reservoir was built in Jardim Maria Luiza IV, with the aim of controlling the water flow entering in the canal (Figure 11, Photo 10).

The Pires Stream also has the Silvério Lake as a reservoir (Figure 11, Photo 1). Built in 2006 for leisure and recreation purposes, the lake, which was completely silted up by 2013, also underwent PAC works in 2014. The proposed redesign aimed at giving the lake not only a recreational function but also a role in retaining rainwater. As part of the basin's works, the Pires Stream, downstream of Silvério Lake, continues in a canal to the Jaú River (Figure 12, Photo 13).

Figure 12 - Images of the Jaú River and tributaries in the urban area of Jaú



Source: Prepared by the author

3.5 The flood of 2022

Between January 29 and 30 2022, the residents of Jaú experienced the largest flood ever observed in the city (Figures 13, 14, 15, 16). During these two days, approximately 320 mm of rainfall was recorded across the watershed, upstream of Jaú's urban area (Rezende; Helene, 2023). According to the authors:

The Jaú River overflowed from its usual channel and occupied, in addition to its larger seasonal channel, its larger exceptional channel, causing two deaths and directly affecting, according to the Jaú Civil Defense, 864 homes and 139 commercial establishments. This caused disruptions to the daily lives of approximately 5,000 people and compromised mobility in the city, impacting virtually all residents. (Rezende; Helene, 2023, p. 292, our translation).

Figure 13– Residences affected in January 2022



Source: Robson Manganhato

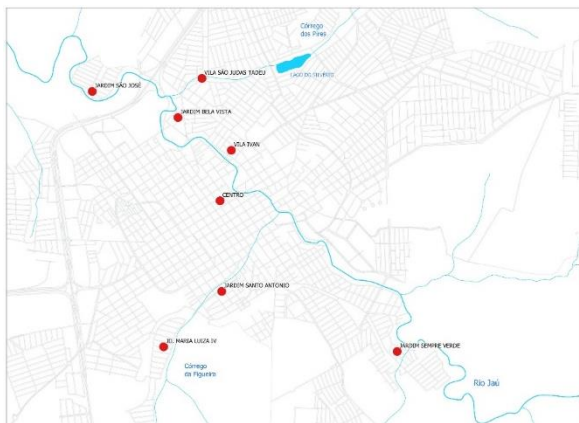
Figure 14– Quintino Bocaiúva Street in January 2022



Source: Robson Manganhato

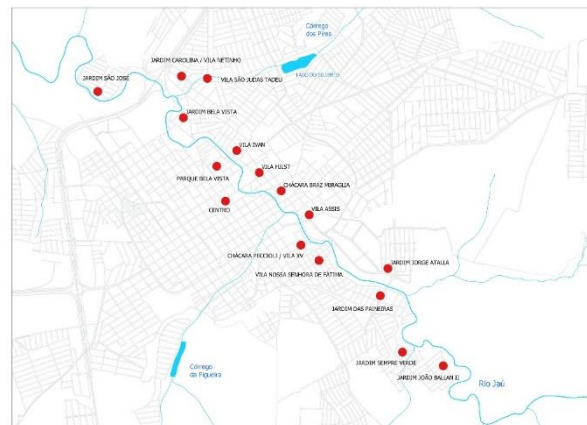
Based on a report provided by the Jaú Civil Defense Protection Secretariat (2024) and using information about areas affected by the river's flood based on recorded occurrences, it was possible to map the neighborhoods impacted by the January 2022 flood and the November 2011 flood in the urban area of Jaú for comparison purposes. The maps identifying the neighborhoods are presented below.

Figure 15– Neighborhoods affected by the flood of 11/2011



Source: Prepared by the author based on incidents recorded by Civil Defense

Figure 16– Neighborhoods affected by the flood of 01/2022



These maps illustrate that the neighborhoods Jd. Maria Luiza IV and Jd. Santo Antônio, which are part of the Figueira Stream basin, were affected only by the 2011 flood. This indicates the likely effectiveness of the flow control provided by the reservoir built in Jd. Maria Luiza IV in 2014.

On the other hand, the extent of the areas affected by the Jaú River flood in 2022 is considered significant. We can observe that the November 2011 flood affected eight neighborhoods in the urban area of Jaú, while the January 2022 flood impacted sixteen neighborhoods, twice the number of areas compared to the largest previously recorded flood.

4 CONCLUSIONS

Since the beginning of the territory's occupation, the Jaú River and its tributaries have provided essential resources to its inhabitants and the city's development. However, despite its importance to the city, the Jaú River has suffered from sewage pollution, had its banks deforested, its surroundings occupied, and its meanders straightened. Similarly, important tributaries of the Jaú River in the urban area have been constricted by urbanization and canalized.

Thus, the neglect of the Jaú River valley and its tributaries throughout the urban expansion process has contributed to the disconnection between the river landscape, the city and its inhabitants' daily lives. The city of Jaú has been experiencing floods for over a century and its population suffers the consequences of the disregard for the river and its tributaries in urban planning.

It is therefore necessary to urgently implement integrated urban and environmental planning actions, including the adoption of green infrastructure measures and planning of open spaces, based on technical and scientific studies.

Authors Rezende and Helene (2023) note that actions taken to mitigate the floods of the Jaú River should consist of strategies based on Nature-Based Solutions (NbS), and highlight the need:

[...]To mimic natural processes, adopting as basic principles the maintenance of the natural properties of riverbeds (meanders), the maximum permeability of rainwater on the basin surfaces, both in rural and urban areas, banks along watercourses occupied by riparian forests, and the alignment of land use and soil conservation with the environmental carrying capacity of each hydrogeodynamic zone [...] (Rezende; Helene, 2023, p. 296).

In summary, integrated planning between the municipalities comprised in the Jaú River Basin, as well as planning within its sub-basins, is essential to mitigate negative flooding impacts. In this sense, planning of green spaces, which contributes to increasing soil permeability and creating recreational spaces, should be considered. Furthermore, preserving APPs and careful planning of open spaces near the river is emphasized. Both APPs and carefully planned riparian open spaces could provide residents greater contact with the natural environment of the Jaú River.

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