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Urban rivers and channelization policies

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Abstract
Most of the watercourses in the city of Presidente Prudente, state of São Paulo, Brazil, are channeled, and many others are inaccessible to the population. The city's watercourses are degraded with silted beds, intense erosive processes, garbage accumulation on their banks and alongside the streams. Therefore, this study aimed to investigate how the interventions and actions of public authorities have affected the urban streams of Presidente Prudente over time, as well as the relevant protection laws and their enforcement during the urban expansion process. The study comprised fieldwork, interviews with city dwellers, Google Earth satellite image analysis, research on environmental issues and on urban space production, as well as the examination of various documents. The results showed that the city's urban planning favored the real estate sector, without consideration of the legal framework protecting the city's watercourses. In structuring the city, its waters were led to flow through concrete channels, with subsequent construction of public leisure spaces as an immediate solution to the environmental problems caused in the valley floors. This process, coupled with a lack of urban spaces valuing the presence of waters in the landscape, contributed to the population accepting channelization as the final fate of urban waters.

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INTRODUCTION

The city of Presidente Prudente, state of São Paulo, Brazil, was founded from the substitution, over time, of "natural objects" by "manufactured objects, technical objects" (SANTOS, 2002), which ensured the arrival and permanence of pioneers and integrated this space into the coffee economy. In this process, the urban space was produced, with inherited forms "reconstructed under a new organization, with new forms under construction" (SUERTEGARAY, 2000, p. 18). This "material system" based on technique mastery, which in "different historical moments" (SANTOS, 2002) extended over the waters, produced the actual urban landscape.

The urban landscape of Presidente Prudente has few environments with waters, for instance, fountains, streams or lakes. This is noteworthy, since the city has settled on a dense hydrographic system consisting of small watercourses, i.e. several streams within the Santo Anastácio and Do Peixe river basins –the main rivers of the municipality. Most of the watercourses in the city are channeled, and those which are not nearly all of them are inaccessible to the population.

The present study aimed to investigate how the interventions and actions of the public authorities have affected the urban streams of Presidente Prudente over time, and whether the relevant protection laws and their enforcement were contemplated during the urban expansion process. Thus, the study sought to understand how the local urban policies considered and have been considering the city's streams in the urban fabric, and examined the conservation status of these valley floor areas.

METHOD

We examined the city's channelization approval requests archived in the Department of Water and Electric Energy (DAEE, in Portuguese) of Presidente Prudente. These documents allowed an overview of the city's watercourses from 2002, when the channelization approval requests were prepared by the City Hall and submitted to the DAEE. Prior to this date, no records of watercourse channelization were found, only cartographic projects from the city's historical archive.

Therefore, to understand how interventions were carried out in the streams prior to 2002, the study examined various researches on urban space production and environmental issues that resulted in the degradation, straightening and channelization of the watercourses within the Presidente Prudente's urban area. We consulted the 1969 Municipal Master Plan (PLANO ..., 1969); the Technical Report on stream channelization in the city of Presidente Prudente, issued by the Public Prosecution Service of the State of São Paulo - Case No. 439/05 (SÃO PAULO, 2005a); the São Paulo State Water Resources Policy - Law No. 7,663/1991 (SÃO PAULO, 1991); and the Brazilian Forest Code (BRASIL, 1965), among other documents.

Satellite images directly from Google Earth 2017-2018 were used to locate the watercourses and identify the urban occupancy in the valley floor areas. These places were then visited to confirm and collect data on their conservation status. In addition, interviews were conducted to understand the residents' social representations in those environments.

We conducted a systematic observation of the streams and their surroundings to analyze the situation of the stream – with open or culverted channels, or no channelization; land use – houses, leisure areas (squares, equipment, soccer fields, sports courts etc.); waste disposal on site – household waste, rubble, dead animals, gardening waste and tree pruning, etc.; presence or absence of vegetation – forest or riparian forest; whether the area is maintained by the public administration and how the space is used by the population.

THE CITY OF PRESIDENTE PRUDENTE AND ITS WATERS

The emergence of neighborhoods Goulart (1917) and Marcondes (1919), which gave rise to Presidente Prudente, occurred differently from of many villages, that chose regions near rivers as their reference point of foundation. The Sorocabana Railway was the main reference for the creation of the city and for the other urban cores that sprang up along this railway line.

The initial urban core aimed to support the commercialization of rural lands, at a time when "land had already been transmuted into a commodity" (SPOSITO, 1983). The lack of resources and the need to attract new land buyers drove the city's founders, and the residents themselves, into urban upgrading services. Thus, the expansion process followed the allotment policy implemented by the founding colonels back then, leading to the rapid

settlement of the city (SPOSITO, 1983).

However, the urban expansion of the place, whether planned or not, which disregarded its natural elements (headwaters, streams, vegetation), entailed negative consequences for the watercourses.

In the central core, erosions commonly affected the streets and the banks of the streams, which had already been impacted by riparian vegetation removal, thus causing the place to lose its natural characteristics. Moreover, as the government attempted to solve the city's water supply "problem", the streams became increasingly degraded and were used as waste sewers. Consequently, valley floors were not incorporated into the urban expansion, thus becoming uninhabited places, with waste disposal and open sewage (SUDO; LEAL, 1996).

Even after various administrations, the city still needed urban elements to beautify it. Thus, it is evident that Presidente Prudente was designed to support coffee farms and serve as a point of arrival for traders. Despite the coffee crisis of the 1930s, Presidente Prudente did not stop growing thanks to the cotton, the new culture implemented in the region. Over time, new objects were placed in the urban area and the city started taking new forms: administrative, religious and service institutions; the center for cottonseed phytosanitary treatment; and constant street gutter and pavement services. The vegetation gave way to this materiality, which, after the occupancy of the high areas near the railway line, gradually took the slopes and valley floors.

Barros (2009) points out that Presidente Prudente, in 1950, still did not have full coverage of piped drinking water. Back then, environmental problems were on the rise and, according to Amorim (2000, p. 18), stemmed from the "accelerated and disordered growth" of the city,

> [...] which is the result of both the rural exodus caused by changes in the countryside, mainly the replacement of agricultural products by livestock in 1960, and the migration of people from neighboring small towns, which became even smaller over the years due to population decline i.e. inhabitants who headed to Presidente Prudente in pursuit of better living and working conditions (AMORIM, 2000, p. 18-19).

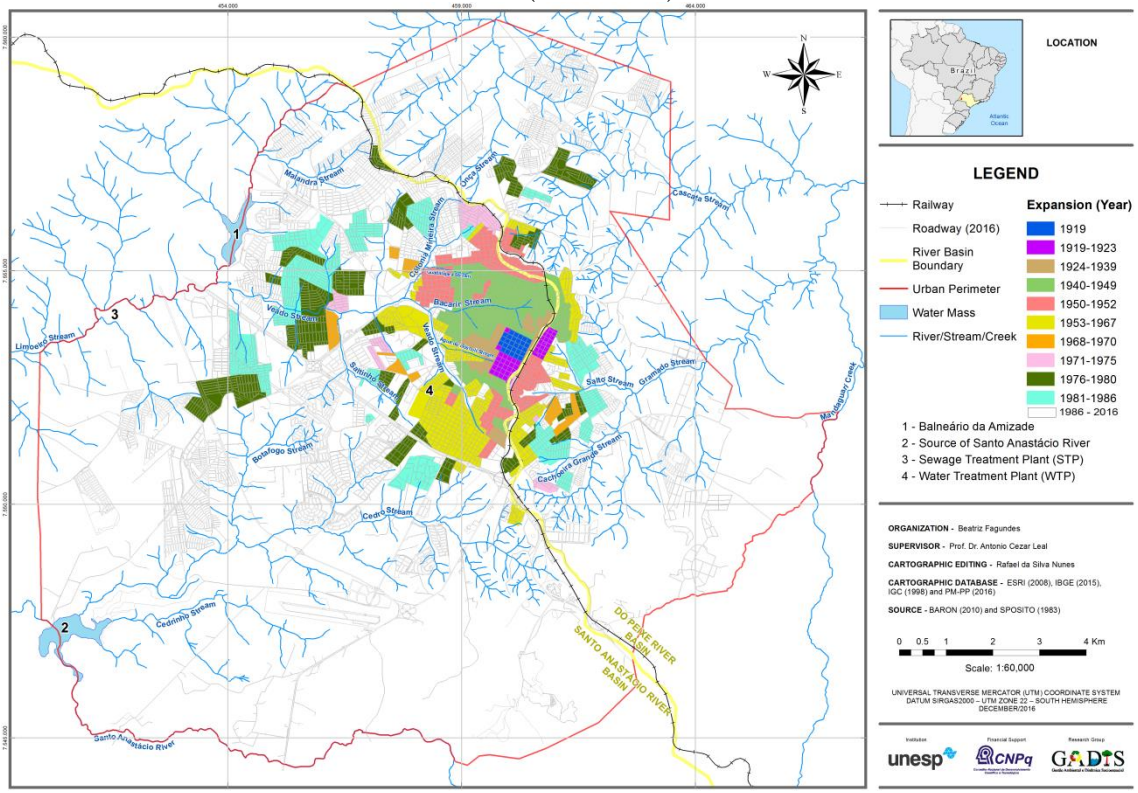
Between the 1950s and the 1970s, cattle-related industries (e.g. slaughterhouses and tanneries) were installed in the valley floors, thus attracting the countryside population. On that occasion, Presidente Prudente was already recognized as the "Regional Capital of Alta Sorocabana", at which time the city extended its influence to a wider area, becoming the seat of the "10th administrative region, covering 50 municipalities and offering a variety of services which, associated with its expressive commerce, eventually attracted a large contingent of inhabitants" (AMORIM, 2000).

Therefore, the city's watercourses lost their natural characteristics and were increasingly used as conduits of rainwater and wastewater from various origins (homes and industries), and the valley floor areas were chosen by the public administration for the disposal of the city's garbage. Additionally, the watercourses were considered physical barriers to the urban expansion.

From the early 1970s, new subdivisions began to emerge, away from the urban fabric, without basic urban services, such as paved streets, sewage systems, and running water in the households (SPOSITO, 1983). Thus, with the "tendency towards the peripheralization of the low-income population" (AMORIM, 2000, p. 58), large housing projects were implemented, reaching the valleys floors. The Ana Jacinta Housing Estate was the largest housing complex located in areas of stream springs flowing into the Santo Anastácio dam, which accounts for 30% of the water supply of Presidente Prundente's population. This was how the urban expansion process of Presidente Prudente extended along the streams of the Santo Anastácio and Do Peixe river basins (Figure 1).

The lack of a proper planning, in which watercourses were an integral part of the urban landscape, the valley floors of Presidente Prudente were gradually occupied as the city's structuring process advanced, with engineering works emerging as an immediate response to the problems in those areas.

Figure 1 - Hydrographic network and urban territorial expansion of Presidente Prudente, SP, Brazil (1919–2016).



Source: Fagundes (2018, p. 144).

WATERCOURSES AND CHANNELIZATION POLICIES

In Brazil, there are a number of federal, state and municipal bodies that, empowered by law, are responsible for the protection and improvement of environmental quality on various scales. Among those public bodies is the National Environment System (SISNAMA, in Portuguese), which includes the National Environment Council (CONAMA, in Portuguese) and the Ministry of the Environment (MMA, in Portuguese). Several laws, decrees and resolutions form the Brazilian legal framework for environmental protection, to which the municipal public administration should resort for the planning, organization and expansion of the city in a way to guarantee quality of life in line with environmental protection –, with special attention to urban streams.

Presidente Prudente adopted an urban expansion model that favored the real estate sector, with urban constructions focused on sanitary and aesthetic aspects for the beautification of the city and expansion of the road system (SPOSITO, 1983; MARISCO, 1997). Since the approval of the first national Building Code in 1949, new laws have been created, and "between ordinary and complementary, over six laws are created each year in an attempt to plan, organize and regulate the urban space" in balance with natural elements, however not prioritized (MELAZZO; SPOSITO, 2002, p. 129).

According to Ikuta (2003), there has always been a gap between what is stated by law and what the reality of Presidente Prudente, mainly because the city's planning did not resort to environmental laws to safeguard its waters.

The first Master Plan of Presidente Prudente was created between 1968 and 1969. At that time, Brazil was going through an industrialization process, and the cities were likewise experiencing a growing urbanization, hence urban planning was fundamental. The Master Plan envisaged stimulating and favoring the development of the municipality, making the city an industrial development center. Prioritized the compact model of the city, in continuity with the existing urban fabric, that started from the top areas towards the valley floors (PLANO..., 1969).

Godoy (1989, p. 1) criticizes this Master Plan by pointing the unimportance given to "geological-geotechnical constraints in

establishing guidelines for implementating the urban fabric and for the predictions of urban expansion". The author states that the occupancy of the watershed ridges and the advancement of the urban fabric over the areas of springs and valley floors characterize cities whose initial core emerged according to the layout of the railways. The author also argues that the lack of attention given to the behavior of the physical environment in this type of occupancy has generated economic damages, environmental deterioration, and social issues. Thus, this form of occupancy led to the channeling of some streams and drastically affected valleys and canals due to the clogging of headwaters as a result of erosion.

The Master Plan of Presidente Prudente, as an instrument for planning and regulating urban activities, was supposed to support the city's administration, but at no time the Master Plan was important to the city's urban development policy. This is clear because, even with the Integrated Development Master Plan ready, the administrative authority in office (1969-1973 term) did not implement the document (MARISCO, 1997, p. 71).

It was only in the following term (1973-1977) that the city's Plan, however outdated, was implanted (MARISCO, 1997), to request funds from the Federal Government for a project for the "recovery of valley floors", which would only be granted to the municipalities with approved and operational Master Plans. The funds allowed channeling the streams through culverts in the central area, integrating problematic areas by means of circulation paths to the other occupied spaces.

Thus, in 1976, the municipality, with the resources from federal government, started to implement the "Fundo de Vale" [Valley Floor] project, whose objective was the environmental sanitation of the area where the initial stretch of the Veado Stream is located, providing for the construction of an extensive green area for leisure and sports called "Parque do Povo" [People's Park], thus "recovering" that valley floor area which was in an advanced degradation process (Figure 2).

Figure 2 - Parque do Povo – channelization of the initial stretch of the Veado Stream.

Source: Fagundes (2018, p. 170).

However, Parque do Povo, the time one of the city's main public leisure spaces, was built disobeying the 1965 Forest Code (SAWADA et al., 2007). Later, in 1978, with more funds from the Federal Government, new works were implemented in areas a little further from the central urban core. Always with the objective of "recovering the valley floors" and improving the road system, culverted channels were built with subsequent construction of public leisure spaces (HORA, 1997).

As a result, several watercourses were channeled through culverts before and even after 1965, when Federal Law No. 4,771/65 (BRASIL, 1965) was approved, regulating the protection of watercourses and respective permanent preservation areas. These channelization works began to be overseen only from when legal approval began to be required for the channeling of the city's streams. In the early 1990s, Law No. 7,663/1991 establishing the Water Resources Policy of the State of São Paulo was approved, which in 1997 was reinforced by Federal Law No. 9,433/1997

providing for water resources management on a national scale. The DAEE is in charge of "registering users and granting the right to use water resources", regarding qualitative and quantitative aspects, as well as applying the sanctions provided by law (SÃO PAULO, 1991).

However, even though the submission of an approval request is mandatory, the practice of channelization through culverts continues in the urban space of Presidente Prudente. For this reason, the State Prosecutor's Office, through the Environmental Attorney General's Office, decided to intervene, recommending that the DAEE no longer authorized channelization through culverts. The technical report finalized and issued in November 2005 considered that, to preserve the environment, the landscape, nature's reference to the population, as well as to avoid possible risks and damages, the best technical alternative addressing the environment and the public interest would be to construct open channels for the watercourses (SÃO PAULO, 2005a).

However, even after that recommendation, the Presidente Prudente City Hall persisted in submitting approval requests for channelization of the streams through culverts. In this sense, the DAEE created a regulation grounded on the State Prosecutor's recommendation, determining that all the DAEE's local and regional offices no longer authorize channelization through culverts. The recommendation came from the Presidente Prudente Environmental Attorney General's Office and became a general rule, prohibiting channelization of watercourses through culverts in the entire state of São Paulo (SÃO PAULO, 2005b).

Thus, when analyzing the channelization approvals, it is clear that the city, through its technical team, deals with the waters in the urban area as a "systemic element" (SAHR, 2015, p. 11) that must circulate in channeled networks of sanitation and sewage. Besides, in preparing request forms, this technical team follows the protocol required by the DAEE and continues to implement valley-floor urbanization projects, which follow a standard model, regardless of the target area – streams channeled through culverts with public leisure spaces built above them – as in several request forms where only the location and name of the stream is changed but the text as a whole remains the same.

The DAEE alsoexamines, with its technical team, such approval requests according to the granting rules and norms in effect, with a major focus on the planning and execution of the work and to avoid floods in the urban area.

In this vein, when the approval presents itself as a mere bureaucratic instrument, it does not fulfill its main objective, namely "to control the quality and quantity of water uses and to ensure the right of access to water resources for all citizens". (SÃO PAULO, 1991). Moreover, this clears the way for the public administration to legally perform channelization, repeating the malpractice of remedying the consequences rather than mitigating the causes, thus further damaging the watersheds in urban areas and consequently in the countryside. Therefore, the public administration has the role of "controlling" the waters of streams through channeling, often considered or disclosed as an alternative to solve an existing problem resulted from poor urban planning that ignored the waters in the urban space.

There is, therefore, a vicious circle in which the city submits approval requests for channelization that are granted by the DAEE without major environmental concerns. Hence, the valley-floor urbanization projects copy the old model used for Parque do Povo, which is well accepted by most of the population, as of the public space "Parque do Povo da Vila Geni" (Figure 3), built in a degraded area, above the culverted channel of the Colônia Mineira Stream.

In this sense, the projects for the recovery of valley floor areas resulted in several channelization works in various neighborhoods of the city. The execution of those works, over time, coupled with the relentless advertisement that pictures channeling as the solution to the environmental problems in the valley floors contributed to the creation of social representations that do not value the waters in the urban landscape. Hora (1997) points out that these actions help mayors to gain in popularity, just as happened with the works of Parque do Povo that served as the flagship in political campaigns to elect the candidate of the same party as the mayor who started the works in the park.

There is a "culture of stream channeling", articulating political interests with the urbanization process that did not regard the city's streams as an integral part of the landscape. This culture affected the downstream parts of the river basins and watercourses and was perceived by the public eye as a problem to be solved.

Figure 3 - Parque do Povo da Vila Geni – stretch of the Colônia Mineira Stream.

Source: Fagundes (2018, p. 230).

In the words of Caetano (2011), channelization is part of the "Brazilian political tradition" that assumes that preserving a river, without concrete works, is a type of action that "the governments do not like to carry out because they give low visibility". Silva (2002) highlights that the figure of politicians who carried out works materialized in the landscape are "conceived in popular memory",

> [...] as men who loved the city and did everything for its "progress". This association occurs because they were careful to petrify their works in space, that is, to make sure that they were above all tangible. Such works are first and foremost some materialities of the "dream of an ideal city", they are desires that the city's eye wants to satisfy concretely in the city. The material artifacts in space dignify the name of those who built them. The practice of materializing them, taking advantage of the favorable historical context, of the alliances and of a whole series of political devices, guarantees the memory of such "good doers" in the future. This is a practice, by the way, that acquired many roots in Brazil and was no different in this city. The other issues on the political agenda, materially less visible, were left to the palliative charity of philanthropic institutions or other politicians, perhaps (SILVA, 2002, p. 55).

The local urban policy insisted on this predatory relationship with urban rivers, without visualizing alternatives, as if this were the natural, unique and intentional path to follow, to "petrify their works in space" (SILVA, 2002, p. 55).

The Environmental Attorney General's action in banning streams through culverts channels was somewhat positive, but only for the protection of the valley-floor vegetation. Regarding the watercourses, this measure turns out to be inefficient. However, this all evinces that when authorities are willing and the public agencies created to protect the environment play their role, the laws are enforced indeed.

On the other hand, as the interviews pointed out, there are "conflicts" raised by the population against environmental actions by the public administration and the Environmental Attorney General's Office. Nevertheless, these "conflicts" only appear when the area reaches an advanced stage of degradation, due to poor planning and unlimited urban expansion. Moreover, new housing estate allotments in Presidente Prudente often disobey urban and environmental laws.

The most degraded environments in this study, included areas adjacent to unchanneled watercourses, with garbage on stream banks and stream beds, disposal of debris, remnants of tree pruning and gardening, furniture, and even electronic waste (Figure 4).

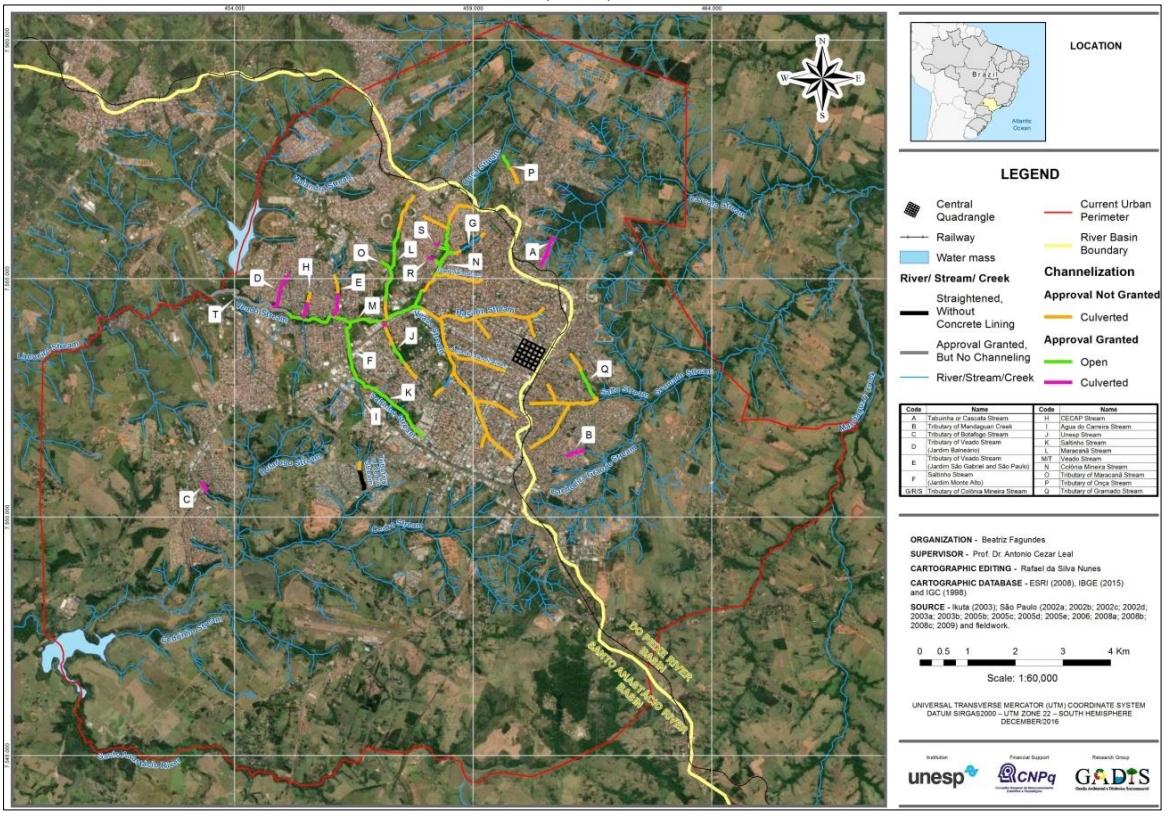
In addition, various irregularities were found in the streams belonging to the relevant river basins: holes in the protection fences for the disposal of gardening remains, debris, and dead animals. A considerable amount of garbage was found in the areas adjacent to the Permanent Protection Areas.

Figure 4 - Area adjacent to the Veado Stream – Jardim Servantes.

Source: Fagundes (2018, p. 254).

Figure 5 shows the hydrographic network in the urban fabric of Presidente Prudente. The watercourses were impacted by the urban expansion, and engineering works became the solution to the resulting problems, including floods. The watershed of the Veado Stream was the most affected by the interventions in the watercourses because the urban expansion was more significant to the west of the railway.

Figure 5 - Map of the hydrographic network in the urban fabric of Presidente Prudente, SP, Brazil (2018).



Source: Fagundes (2018, p. 186).

In a city of so many waters like Presidente Prudente, it is quite rare to find environments in which they were valued as a landscape element; such as Balneário da Amizade, Cidade da Criança, Lagoa dos Patos Municipal Park (Figure 6) and some residential condominiums, such as the Damha I, which valued the watercourses and springs in its project; however, it is a private condominium with restricted access.

Figure 6 - Lagoa dos Patos Municipal Park.

Source: Fagundes (2018, p. 211)

Therefore, the population rarely sees the city's waters in linear parks not circulating through concrete galleries. These environments, through which the waters in Presidente Prudente circulate, have not and have not been preserved.

Furthermore, of alternative solutions, creativity or political interest in providing new routes to these waters lack, valuing and including them in valley floor environmental projects.

CONCLUDING REMARKS

The small streams running through Presidente Prudente's urban fabric were seen by the public administration as part of an artificial system of river channelization, as rainwater and wastewater clearance and as a barrier to urban expansion.

Presidente Prudente followed a planning model focused on the real estate sector and often did not consider the city's waters as an integral element of the urban landscape.

The urban expansion of Presidente Prudente extended over the city's streams in a process that overlooked the legal framework protecting the watercourses. This process, coupled with a lack of urban spaces valuing the presence of waters in the landscape, contributed to the population accepting channelization as the final fate of urban waters.

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