



**Urban densification, legal aspects and potential environmental impacts
of cemeteries in the municipality of São Paulo, SP**

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ABSTRACT

The **objective** of this articles is to verify and analyze urban density data and their correlation with the legal aspects that regulate cemeteries, in order to understand the environmental impacts that these spaces can generate. The **methodological approach** combines qualitative, quantitative and descriptive elements to provide a comprehensive analysis. The **methodology** adopted includes a case study of burial spaces in the city, exploring qualitative data and bibliographic research techniques and a documentary analysis of the relevant legislation. The **results** of this study allow for a deeper understanding of the complex interactions between population growth, legal regulation of cemeteries, and associated environmental impacts. The analysis sought to address the socio-environmental implications of urban cemeteries and their relationship with urban planning, public health and environmental preservation/conservation. Through an interdisciplinary approach, the expectation is for this study to expand the understanding of the importance of urban policies that consider socio-environmental impacts when planning the location and operation of cemeteries in densely populated urban areas.

KEYWORDS: Burial spaces. Urban management. Environment.

1 INTRODUCTION

Characterized by the intensification of population density and construction in urban areas, urban densification is a phenomenon that reflects both demographic growth and the relentless pursuit for space and infrastructure. Oftentimes inevitable, this process leads to a significant transformation in the urban fabric, marked by gradual relocation of cemeteries from urban centers, the focus of this paper, and consequently, the homes of the loved ones of the deceased. Over time, this mismatch between residential areas and burial sites has led to abandoned cemeteries and neglected areas, suggesting an image of apparent neglect and disinterest. This phenomenon is not only a result of urban transformations; it carries along implications related to public health and the environment, as emphasized by Pacheco (2012). The environmental and health ramifications arising from the establishment and operation of cemeteries in urban environments become more pronounced as population density increases and environmental control regulations strengthen.

Therefore, urban planning assumes an intrinsic connection with the consideration of long-term cemetery needs, incorporating elements of territorial and urban development. A regulatory approach emerges in response to these complexities. The 1978 Sanitary Code, updated in 1990, establishes guidelines that guide cemeteries, emphasizing the imperative of isolation and sanitary measures to safeguard public health and water resources (Section II - Cemeteries). However, many public cemeteries predate enactment of this code, partially explaining the discrepancy in adherence (PACHECO, 2012).

A forward-looking approach to the cemetery issue, as advocated by urban and environmental management experts, supports the location of new cemeteries in urban peripheries and the transformation of existing ones into urban parks. However, the challenge lies in the lack of suitable spaces for establishing new horizontal cemeteries in large cities, exacerbated by the disorderly growth of urban areas and the appreciation of land value (PACHECO, 2012).

Thus, legislation plays a crucial role in the harmonious coexistence between cemeteries and the environment, minimizing potential environmental and sanitary risks. The inclusion of details in the guidelines aims at ensuring a comprehensive and cohesive approach to the establishment of cemeteries, considering legal, regulatory and environmental dimensions (SILVA and MALAGUTTI FILHO, 2008). It is acknowledged that the construction and operation of

cemeteries are examples of activities capable of causing environmental impacts, especially when adequate protective measures are not implemented. While the creation of cemeteries itself may not be a direct cause of environmental impacts, lack of precautions can result in adverse effects on the environment and on public health, especially in densely populated cities like São Paulo, where challenges related to quality of life and environmental impacts are intricately intertwined (SANTOS et al., 2015).

To mitigate such risks, the National Council for the Environment (*Conselho Nacional do Meio Ambiente*, CONAMA) has established specific regulations for the implementation of cemeteries. CONAMA Resolution No. 335/2003 addresses the necessary criteria for environmental licensing of cemeteries, whereas CONAMA Resolution No. 368/2006 provides guidelines for their implementation, with an emphasis on location restrictions. These regulations aim at harmonizing urban development with environmental preservation, establishing criteria for site selection, contamination prevention measures and waste management, with the goal of minimizing environmental impacts (BRAZIL 2003; 2006).

In the context of São Paulo, the Environmental Company of the State of São Paulo (*Companhia Ambiental do Estado de São Paulo*, CETESB) plays a crucial role by establishing Technical Standard CETESB/L1.040, with the objective of regulating the implementation of cemeteries. This standard establishes criteria for the selection of suitable sites, considering factors such as soil permeability, distance from water bodies, and permanent preservation areas. These guidelines highlight the importance of a comprehensive and coherent approach to the implementation of cemeteries, encompassing environmental and regulatory aspects (CETESB, 1999; SILVA; MALAGUTTI FILHO, 2008).

In this context, the interdisciplinary analysis of these phenomena proves to be of great relevance, aiming to understand the relationship between urbanization, environmental protection, public health and legal regulations. This study seeks to address the complexity of socio-environmental impacts resulting from the implementation of cemeteries in urban areas, exploring the intersection between legal aspects, management challenges and environmental protection, as well as implications for the well-being of the urban population.

2 OBJECTIVES

To verify and analyze data on urban densification and correlate them with legal aspects and potential environmental impacts of cemeteries located in the municipality of São Paulo, SP.

3 METHODOLOGY

The current research falls within the field of qualitative-quantitative and descriptive approaches, aiming to provide a better theoretical foundation to enhance comprehensive understanding of the “object/phenomenon” under study and enrich the analysis (KNECHTEL, 2014).

This is a case study (YIN, 2001) of burial spaces in the municipality of São Paulo, SP. Its methodological procedures for data production are grounded on literature research in electronic databases such as Scientific Electronic Library Online and EBSCO Information Services, as well as on a documentary analysis of the current legislation.

The descriptive analysis of the data collected through the literature review and documents took place jointly and was based on the following research question: How does the relationship between population density, presence of cemetery spaces and potential environmental impacts take place in the municipality of São Paulo, SP, based on legal aspects?

4 RESULTS AND DISCUSSION

4.1 Urban densification

Urban densification refers to the increase in population and construction density in existing urban areas. This occurs when there is greater utilization of the available space, whether through the construction of taller buildings, the occupation of vacant land, or the redevelopment of previously underused areas. Generally, it is associated with population growth and with the demand for housing, services and infrastructure in urban areas. It can take place in a planned manner as part of an urban development project or in an unplanned way, when it happens spontaneously and without proper planning (VITTE, 2009).

Therefore, with the increase in population and construction density in urban areas, urban planning becomes necessary to ensure that densification is carried out in a balanced and sustainable manner, promoting better quality of life for the residents. For this, both urban planning and territorial management should comprehensively consider the multidimensional elements of sustainability, with a focus on the spatial dimension. It is understood that not only economic aspects can influence different social realities and configurations of urban spaces, but also that cultural, environmental and political agents play a fundamental role in shaping this environment (VITTE, 2009).

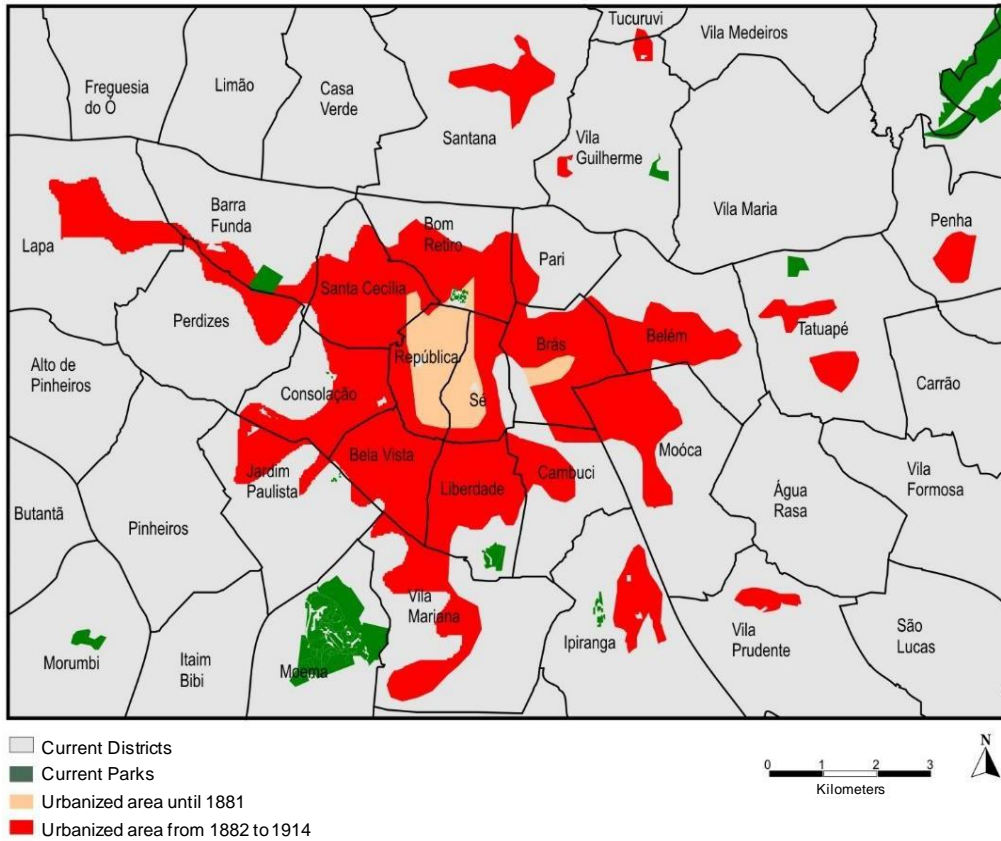
The city of São Paulo, focus of this research, has faced challenges stemming from population growth, as it has historically been one of the main hubs attracting internal migration in Brazil since approximately 1882 (Figures 1 and 2). The search for better job opportunities and quality of life leads many people from various regions of the country to settle in the city. This constant migratory flow is one of the main factors responsible for the population increase in São Paulo (VITTE, 2009).

According to preliminary data from the 2022 population census of the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística*, IBGE), the population of the city of São Paulo was 12,200,180 inhabitants, with a density of 7,527.76 people/km² (IBGE, 2022).

Thus, it is indisputable that this high population contingent poses challenges to the city, such as the demand for public services that need to keep pace with this demographic increase. Among these challenges is the need for burial spaces, given that, according to the Informatics Department of the Unified Health System (DATASUS), in 2019, the mortality rate in the city of São Paulo was around 78,670 deaths (DATASUS, 2019). This points to the need to adapt to the increasing number of deaths in the city of São Paulo.

Figure 1: Urban densification in the municipality of São Paulo, 1882-1914.

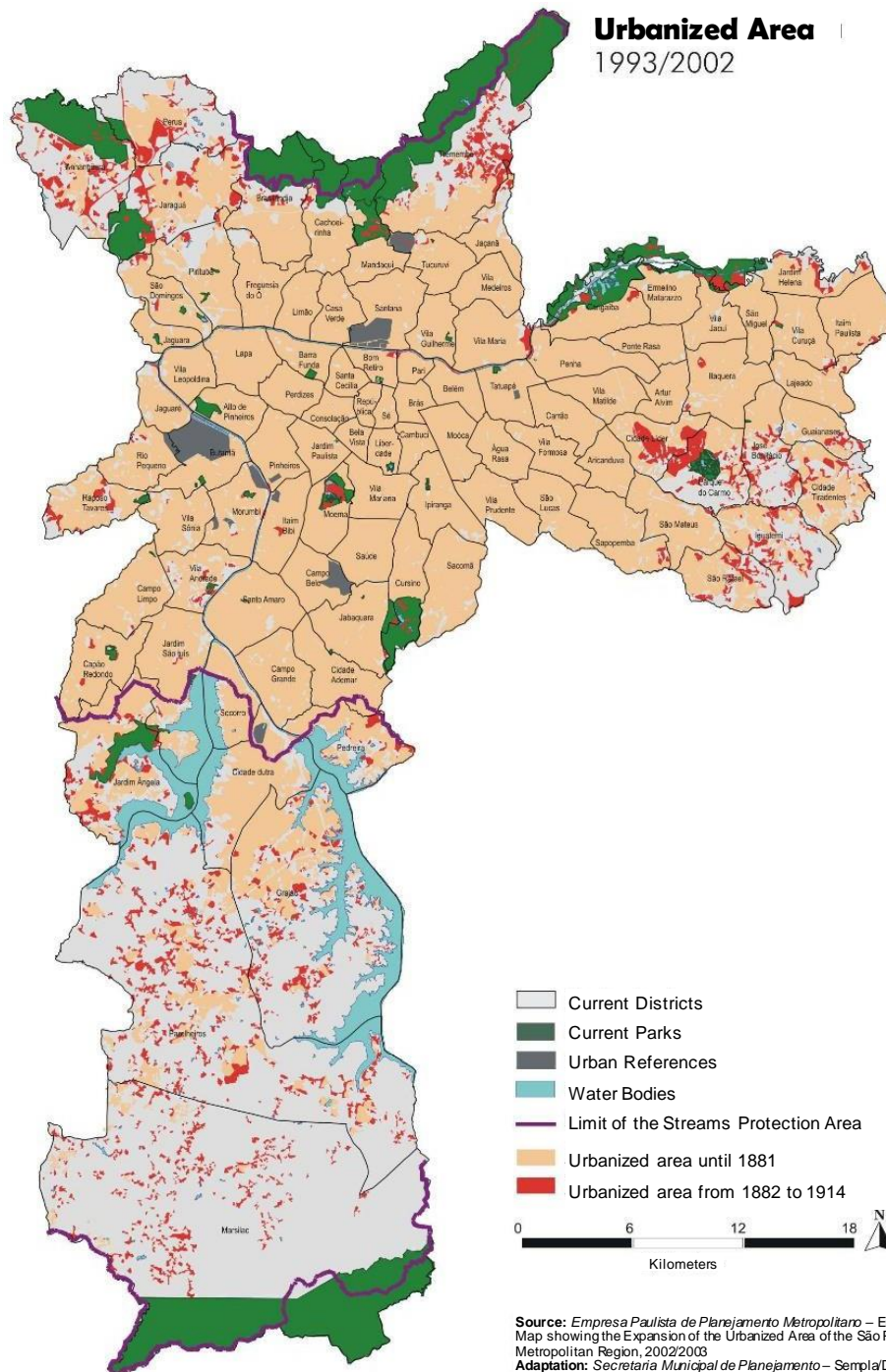
Urbanized Area
 1882/1914



Source: *Empresa Paulista de Planejamento Metropolitano – Emplasa*
 Map showing the Expansion of the Urbanized Area of the São Paulo Metropolitan Region, 2002/2003
 Adaptation: *Secretaria Municipal de Planejamento – Sempla/Dipro*

Source: São Paulo Urban Planning Company, 2002-2003

Figure 2: Urban densification in the municipality of São Paulo, 1993-2002.



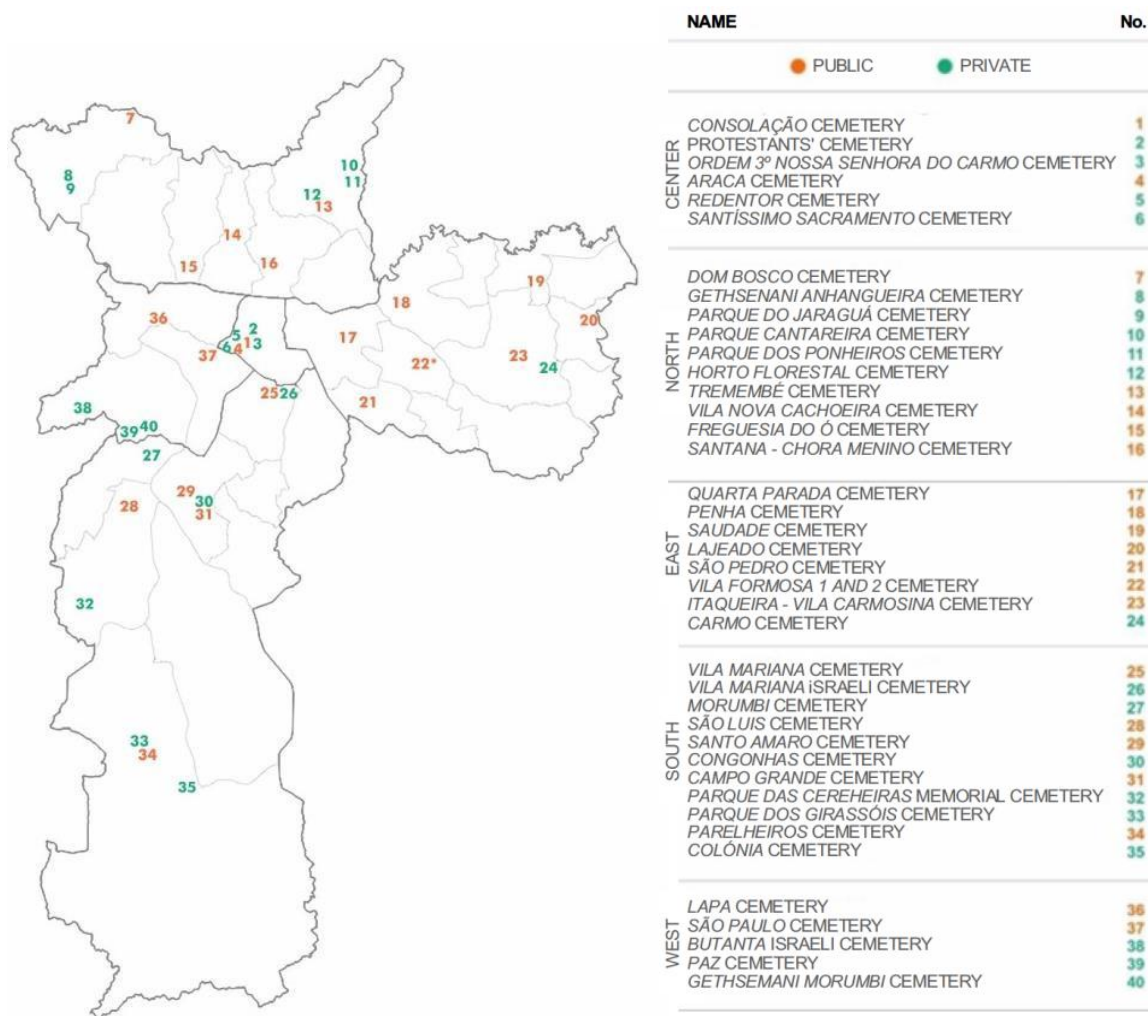
Source: São Paulo Urban Planning Company, 2002-2003.

4.2 Cemeteries in the city of São Paulo

In the municipality of São Paulo, a survey conducted in 2019 identified 40 cemeteries (Figure 3). There is varied distribution of these cemeteries in the city, with an increase over time and a tendency for private cemeteries to occupy areas farther away from urban centers. The

smaller cemeteries emerged through the allocation of land parcels within public cemeteries (FUCHS, 2019).

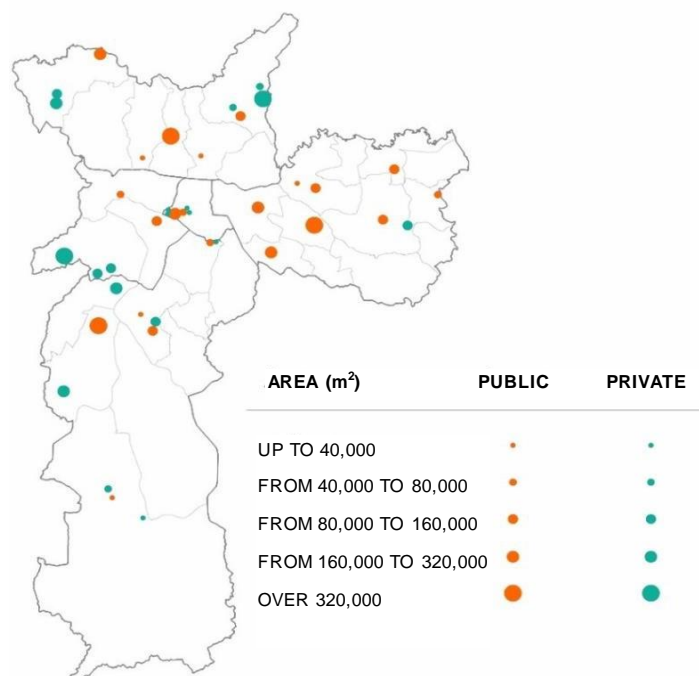
Figure 3 - Map showing the number and location of public and private cemeteries in the city of São Paulo in 2019.



Source: FUCHS, 2019.

The size of the cemeteries in the city of São Paulo varies considerably (Figure 4). This diversity in size and location reflects the city's demand and urban evolution over time (FUCHS, 2019).

Figure 4 - Map showing the location and extension of public and private cemeteries in the city of São Paulo in 2019.



Source: FUCHS, 2019.

Cemeteries are generally established in locations distant from urban centers and oftentimes difficult to access, due to the search for available areas with lower urban density, especially in more peripheral regions. However, it can be observed that, over time, some cemeteries ended up remaining in central areas of the city.

Even so, coupled with the frequent changes in the dynamics of an extensive city like São Paulo, the distancing from the cemeteries to the houses of the deceased's family members and friends has intensified over the years. This has led to graves being abandoned and unprotected. As a result, the spaces of many cemeteries have been neglected, taking on an appearance of abandonment.

According to Pacheco (2012), when dealing with the construction of a cemetery, especially in urban areas, it is crucial to know the resulting environmental impacts and potential health hazards. This not only affects quality of life for nearby residents but also for those exposed and susceptible to possible contaminations, a topic that will be further explored later on.

In accordance with Article 152 (Section II - Cemeteries) of the 1978 Sanitary Code (revised and updated in 1990 - 4th edition, São Paulo, IMESP, 1991), cemeteries should be isolated along their entire perimeter by public streets or other open areas, with a minimum width of 15 meters in areas served by a water supply network and 30 meters in areas without access to water networks. In other words, areas where the watercourse is more susceptible to direct contamination and, consequently, to public health risks. However, most public cemeteries emerged before publication of the Sanitary Code, justifying non-compliance with Article 152 (PACHECO, 2012).

According to experts in urban and environmental management, new cemeteries should be located outside the limits of large cities, in their peripheries, whereas existing ones should be transformed into urban parks. As already mentioned, in the metropolitan region of São Paulo there is a variety of public and private cemeteries, some located outside the cities and others integrated into the urban fabric (PACHECO, 2012).

Currently, in large cities there is no adequate space for the construction of new horizontal cemeteries, nor for the expansion of existing ones, due to chaotic urban growth and high land costs. On the other hand, population growth in cities overwhelms cemeteries, generating problems both in terms of housing shortage and burial spaces, which is inherent to large metropolises (PACHECO, 2012).

When planning occupation and use of urban spaces, it is necessary to consider the establishment of new cemeteries in the long term, taking into account various aspects of urban life development, both from a territorial and human perspective. This practice should be considered by municipal master plans as a way to meet the communities' needs (PACHECO, 2012).

As urban structures, cemeteries should be responsibility of architects for the design and/or execution of the project, as they play a fundamental role in terms of Architecture and Public Health.

4.3 Legal Aspects

Among other aspects, legal regulations regarding cemetery spaces aim at preventing negative environmental impacts, controlling proper waste management, and ensuring the protection of soils and groundwaters. They also aim at establishing sanitary measures to protect public health, regulate urban planning and preserve social rights and safety. The regulations assign responsibilities to cemetery owners and administrators, as well as to governmental agencies, promoting transparency, accountability and compliance with the established legal requirements. Legal aspects are fundamental to ensure safe and sustainable operation of cemeteries, considering the social, environmental and urbanistic aspects involved.

Regarding the environmental aspects, according to CONAMA Resolution No. 001/86, environmental impact refers to any activity that poses a risk to the environment and to human health, either directly or indirectly (BRAZIL, 1986).

Ferrari *et al.* (2015) emphasize that, when classified as activities generating environmental impact, cemeteries are subjected to the need for conducting an Environmental Impact Assessment (EIA) and preparing an Environmental Impact Report (EIR). These instruments are essential to establish criteria and guidelines aimed at preventing or minimizing the negative effects on the environment resulting from the implementation and operation of these ventures.

In the current Brazilian context, CONAMA resolutions No. 335/03 and 368/06 address the licensing process for a cemetery. This latter resolution made changes to Articles 3 and 5 of Resolution No. 335/03, particularly regarding the installation area, protecting Permanent Preservation Areas (PPAs), as well as depth and distances of the graves, taking into account the proximity of water bodies. On the other hand, CONAMA Resolution No. 402/2008 assigns to

state and municipal agencies the responsibility to adapt cemeteries to current regulations (BRAZIL, 2003; 2006; 2008).

For the establishment and operation of cemeteries, it is indispensable to analyze legal aspects to avoid environmental contamination risks and sanitary problems detrimental to public health. Therefore, it is necessary to establish basic criteria for their construction and implementation.

Regarding vertical cemeteries, which have been constructed more recently, the guidelines for determining the most appropriate use of the environment, through CONAMA Resolution No. 335/2003, establish that:

Article 6. The following requirements must be met for vertical cemeteries: I - The Niches should consist of: a) materials that prevent passage of gases to areas where visitors and workers circulate; b) accessories or construction features that prevent leakage of liquids resulting from decay; c) a device that allows gas exchange in all niches, providing suitable conditions for decomposition of the bodies, except in specific cases provided by the legislation; and d) environmentally appropriate treatment for any gaseous effluents.

Article 8. The buried bodies can be wrapped in blankets or urns made of biodegradable materials, and the use of plastics, paints, varnishes, heavy metals or any material harmful to the environment is not recommended. Single paragraph. The use of impermeable material that prevents gas exchange of the buried body with the surrounding environment is prohibited, except in specific cases provided by legislation.

Article 9. Solid, non-human waste resulting from the exhumation of bodies should have environmentally and sanitary appropriate disposal.

Article 10. The procedure of this Resolution may be simplified, at the discretion of the competent environmental agency, if all the following conditions are met: I - Cemeteries located in municipalities with a population of less than thirty thousand inhabitants; II - Cemeteries located in isolated municipalities, not part of a built-up area or metropolitan region; and III - Cemeteries with a maximum capacity of five hundred graves (BRAZIL, art. 6, 8, 9, and 10). Of Resolution No. 335, 2003.

CONAMA Resolution No. 368/2006 establishes guidelines for the implementation of cemeteries, highlighting restrictions regarding their location. As already mentioned, according to the aforementioned Resolution, it is prohibited to install cemeteries in Permanent Preservation Areas (PPAs) or other conservation units, areas requiring deforestation or vegetation removal and areas with geological and hydrogeological restrictions, as well as in violation of applicable legal provisions. Regardless of the specific context, construction of a cemetery must consider studies conducted in the implementation region, as well as the criteria established by the competent authority (BRAZIL, 2006).

In the state of São Paulo, there are also technical standards integrated into environmental policies that aim at preserving the soil and surface and underground water resources when implementing projects with polluting potential, such as cemeteries. As the agency responsible for environmental control in the state, the Environmental Company of the State of São Paulo (*Companhia Ambiental do Estado de São Paulo*, CETESB) issued Technical Standard CETESB/L1.040 in January 1999 with the purpose of regulating the implementation of cemeteries for underground burials. This standard establishes the requirements and technical conditions that should be observed to ensure protection and preservation of the environment, especially concerning soils and groundwaters (CETESB, 1999).

Application of this standard aims at ensuring minimization of the environmental impacts resulting from the implementation and operation of cemeteries. It establishes guidelines for proper selection of the place, considering aspects such as soil permeability, minimum distance from water bodies, existence of aquifer recharge areas, and presence of permanent preservation areas. These considerations should be taken into account both during the construction and operation of cemeteries, encompassing measures for preventing soil and groundwater contamination, proper management of generated solid and liquid waste, and adoption of environmental control and monitoring measures (CETESB, 1999).

The inclusion of additional references and definitions in the CETESB/L1.040 standard aims at ensuring a comprehensive and consistent approach to the implementation of cemeteries. It contemplates the requirements of various laws and addresses specific aspects related to environmental protection, such as preservation of water resources, proper waste management, and a detailed characterization of the area in question (SILVA; MALAGUTTI FILHO, 2008).

Regarding the implementation of cemeteries, another important law in the municipality of São Paulo is Law No. 16,050, dated July 31st, 2014¹¹, known as the Strategic Master Plan (SMP). This law establishes guidelines for land division, use and occupation in the city. The SMP contains specific provisions to regulate not only the implementation of cemeteries but also their operation (PMSP, 2014).

According to the 2014 SMP, new cemeteries should be implemented in accordance with established environmental and urbanistic criteria. Compliance with technical and legal standards related to environmental protection is required, including the preservation of soil and water resources, as well as meeting public health and safety requirements (PMSP, 2014).

The SMP also stipulates that cemeteries must comply with the federal, state and municipal legislation related to the management of solid and liquid waste generated in the burial process. This law requires the need for environmental impact assessments and the elaboration of environmental impact reports for the implementation of cemeteries to assess potential negative effects and propose mitigating measures (PMSP, 2014).

For their construction, cemeteries are considered high-impact buildings. Therefore, mitigating measures should be implemented for proper land use and compliance with the legislation. In São Paulo, licensing projects with significant environmental impact is foreseen, such as the construction and operation of cemeteries, and it is indispensable for them to be carried out in accordance with established legislation and regulations.

4.4 Cemeteries and possible environmental impacts

When talking about environmental impact, many people seem to associate it only with the negative impacts on the environment. However, there are two important aspects to consider in understanding it. In the first place, it refers to the effects, whether positive or negative, caused to the environment. And secondly, they are always caused by human activities. Therefore, it is

¹ The articles used have not been altered during the mid-term review of the Strategic Master Plan of the Municipality of São Paulo, now established by Law No. 17,975 of July 8th, 2023.

based on the idea that human activities have the potential to affect ecosystems, natural resources, biodiversity and people's quality of life (SANCHEZ, 2013).

According to CONAMA Resolution 001/86, environmental impact is defined as any alteration in the physical, chemical and biological properties of the environment caused by any form of matter and energy resulting from human activities that, whether directly or indirectly, affect the health, safety and well-being of populations; social and economic activities; biota; aesthetic conditions; and the quality of environmental resources (BRAZIL, 1986). Here, it is also important to clarify that although they are terms that can be associated, environmental impact, environmental degradation, pollution and contamination have different definitions.

Environmental degradation refers to any adverse alteration of environmental processes, functions or components, or any adverse alteration of environmental quality, which can result from human action or occur naturally, in this case also called environmental disaster (SANCHEZ, 2013).

In the case of pollution, it refers to the introduction into the environment of any substance or energy that may negatively affect humans, other organisms or the ecosystem, which can be measured based on certain physicochemical parameters, using reference values known as environmental standards (SANCHEZ, 2013). Examples of pollutants include chemical compounds present in water and soil, particulate matter or harmful gases in the atmosphere, noise and vibrations and ionizing radiation, among others, which in turn contaminate the environment. Consequently, environmental impact is broader than pollution because several human activities can cause impacts without emitting pollutants. In other words, environmental impact is the result of a human action, which is its cause (SANCHEZ, 2013).

The construction of a hydroelectric plant, for example, is not an environmental impact; it causes environmental impacts. Similarly, the construction of cemeteries, scope of this research, is not an environmental impact in itself but can cause environmental impacts if necessary and appropriate socio-environmental protection measures are not adopted. From a positive perspective, for example, reforestation with native species is not an environmental impact; it can cause positive environmental impacts. And in the case of emitting a pollutant, it is not an environmental impact. The impact is the change in environmental quality that results from this emission (SANCHEZ, 2013).

In a city like São Paulo, with high population growth and density as already mentioned earlier, challenges to quality of life are constant, and the environmental impacts to which it is subjected are countless. Pasqualotto and Sena (2018) relate environmental problems to human activities, as these inadequate practices in the use of natural resources aim only at economic development, demanding awareness from society regarding the already existing environmental impacts, especially in urban centers, where growth takes place in an unorganized manner.

In the case of this research, it is important to understand and emphasize that the construction and operation of a cemetery are not environmental impacts in themselves, but they can cause various environmental impacts when protective measures for natural resources are not adopted.

Various burial modalities have been adopted throughout human history, taking into account cultural, social, geographical and economic aspects. With population growth and the subsequent development of urban areas, the need to establish open-air cemeteries arose as a solution to environmental challenges and to the lack of space in churches and chapels, which

were commonly used for burials. However, these conventional, horizontal and open-air cemeteries, while playing a crucial role in society, especially in cultural aspects, can also represent enterprises that pose a risk to the environment and the general population (SANTOS et al., 2015).

When built without contamination prevention measures in urban areas, cemeteries are considered pollution sources for the environment, as well as for public health. Lack of proper prevention can lead to risks arising from the improper operation of these places, including contamination of the soil, air and groundwater near the facility (CARNEIRO, 2008).

As already mentioned, the vast majority of existing cemetery constructions in urban areas, particularly those in large centers, were implemented before the legal regulations established for this process. Faced with this situation, proper studies were not conducted and preventive measures were not adopted to mitigate potential environmental impacts. Currently, the establishment of new cemeteries requires compliance with the regulations stipulated by CONAMA Resolution No. 335/03, which deals with the necessary criteria for obtaining environmental licensing for the implementation of cemeteries (MOTA JÚNIOR, 2012).

In cemeteries where inhumation occurs, where bodies are placed in graves or directly in the ground, there is a negative environmental impact from necrochorume, a liquid released by the body during the decomposition process. This liquid contains a variety of toxic and pathogenic chemical substances from the decomposition of organic tissues, which can cause various environmental and public health problems if not properly treated or contained (SANTOS, 2013).

Therefore, necrochorume consists of an aqueous solution composed of a variety of mineral salts and degradable organic substances, and its formation occurs over a period of approximately six months or more, depending on the environmental conditions. This process takes place after the gaseous phase and during the colligative phase of decomposition (CAMPOS, 2007).

Furthermore, according to Campos (2007), when cemeteries are established in inappropriate conditions, in areas that have not undergone proper geotechnical analysis, they become unhealthy environments characterized by unpleasant odors and can lead to infiltrations. These infiltrations result in necrochorume spread, making it a pollutant, especially for groundwater resources and soil quality. Groundwater faces challenges in its accurate mapping. It is crucial to evaluate the environmental impact in cemeteries.

Kemerich, Ucker and Borba (2012) explain:

Like any other facility that affects the natural conditions of soil and groundwater, cemeteries are classified as an activity with environmental contamination risk. The reason for this is that the soil in which they are installed acts as a filter for impurities deposited on it. The decomposition process of the corpses releases various metals that are part of the human body, not to mention the different utensils that accompany the body and the coffin in which it is buried. The main contaminant in the decomposition of bodies is a liquid known as necrochorume, of viscous appearance and brownish-gray in color, containing approximately 60% water, 30% mineral salts and 10% degradable organic substances (KEMERICH; UCKER; BORBA, 2012, p.78-81).

In addition, according to Kemerich, Ucker and Borba (2012), the structural problems of cemeteries and polluting agents, along with the poor maintenance of tombs, exacerbate

environmental problems when located in areas of greater vulnerability where the population directly uses water resources.

It is also important to note that necrochorume can affect those who work in cemeteries when Personal Protective Equipment (PPE) is not used. In the process of maintaining cleanliness in tombs, when in contact with the urns' materials, employees get contaminated, which can lead to a series of infectious diseases (SILVA, 2008).

Lack of planning in land use and natural resource management in areas where cemeteries are located can lead to complex and varied environmental problems. To avoid the negative effects of this human activity, it is necessary to use environmental impact assessment techniques and adopt preventive measures.

According to the case study conducted by Liliane Folli Trindade at the *Vila Formosa* Cemetery in the city of São Paulo, soil contamination in cemeteries due to decomposition processes is common, particularly when adequate environmental protection measures are not implemented, such as burials in open soil trenches. The soil composition influences the body decomposition speed, filtration of liquids resulting from decomposition, and transport of microorganisms to the groundwater (TRINDADE, 2022).

The study addresses the hydrographic location of the *Vila Formosa* Cemetery and its implications. The cemetery is located in the *Aricanduva* River Basin, a region that covers more than 100 km². Channeling of the *Aricanduva* River and occupation of the floodplains have led to an increase in floods, surface runoff and sedimentation processes. This is evident in the cemetery, where rains have washed away bones, despite the construction of a retention basin to mitigate floods (TRINDADE, 2022).

The *Água Rasa* Stream, which runs through the cemetery and flows into the *Aricanduva* River, was channelized, and an environmental trail was created along it. The stream's source is protected, but it is not clear how the channelization works to guard against contaminations. In relation to the groundwater level, some studies indicated the presence of a suspended aquifer in the region, with depths ranging from 4 to 12 meters. Therefore, the cemetery presents risks of groundwater contamination by necrochorume, although it has lower contamination than other cemeteries (TRINDADE, 2022).

The author also highlights the influence of the cemetery on the concentrations of ions, nitrogen compounds and heavy metals in groundwater, possibly arising from the organic decomposition of bodies and coffin materials. The study area is in the São Paulo aquifer, which is vulnerable to contamination due to infiltration through the unsaturated zone. The groundwater flow likely heads towards the *Água Rasa* Stream and the *Aricanduva* River, impacting their quality.

While cemeteries are essential and indispensable, the potential impact of necrochorume from horizontal cemeteries highlights the need to explore more ecological burial alternatives. One of these alternatives are vertical cemeteries, which stand out for preventing groundwater contamination and the interference of necrochorume, as the corpses do not come into direct contact with the soil. This method offers ease during the burial process and optimizes urban space, becoming an option to address the growing scarcity of available areas for funeral activities (SILVA, 2008).

5 CONCLUSIONS

In an interdisciplinary manner, the study sought to address the complexity inherent to some of the challenges and impacts associated with the implementation of cemeteries in urban areas characterized by increased population and construction density, which have driven significant transformations in the urban landscape, including how burial sites are configured and operated.

The gradual relocation of cemeteries from central urban areas, leading to neglected areas and abandoned graves, reflects the ongoing urban expansion demands and the maintenance of significant spaces for memory and mourning. However, this disconnection is not merely a manifestation of urban transformations; it also has implications for public health and the environment. The risks associated with the construction and operation of cemeteries in urban areas become particularly pronounced in densely populated cities, where quality of life and environmental impacts are intertwined. In this context, regulation emerges as a crucial tool to oversee cemetery activities, environmental concerns and public health. The guidelines established by the legal aspects outline criteria for the location, operation and management of cemeteries, aiming to mitigate adverse environmental impacts and ensure regulatory compliance. This regulatory approach emphasizes the importance of considering legal, environmental and social aspects in the implementation of urban cemeteries.

The interdisciplinary analysis presented in this study revealed the complexity and the relationship of the variables involved in the issue of urban cemeteries, calling for further research studies and a deeper exploration of the reflections and discussions herein proposed. The study also highlights the need to consider both practical and cultural aspects as well as environmental and public health implications when dealing with the development and operation of urban cemeteries. It becomes necessary to understand these aspects in order to find solutions that respect both cultural memory and values and the protection of the environment and public health.

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