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CHALLENGES OF URBAN SANITATION: BIOPHILIA AS A SUSTAINABLE SOLUTION AND ALLY OF URBAN WELL-BEING

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ABSTRACT

The article investigates the challenges of urban sanitation, proposing biophilia as a sustainable solution that promotes well-being in contemporary cities. This is a literature review, with the objective of analyzing the main obstacles faced by urban sanitation and exploring how the integration of biophilic elements can improve the efficiency of these systems, while improving the quality of life in urban areas. The research adopts a qualitative approach, focused on the identification and interpretation of concepts related to biophilia and sustainability. The results show that the adoption of nature-inspired solutions, such as green areas and natural spaces integrated with urban infrastructure, can mitigate environmental and social issues, contributing to the creation of healthier and more balanced cities. The conclusion highlights the need for public policies that encourage the incorporation of biophilic practices, promoting a more sustainable and resilient future for urban centers.

Keywords: Biophilia, Urban sanitation, Sustainability, Nature-based solutions.

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INTRODUCTION

Since the beginning of civilizations, the relations between humanity and the environment have been indispensable for survival, with both elements affecting each other, based on a series of interrelations whose modification has occurred historically and considering the different contexts. In summary, nature affects human beings, demanding adaptability and shaping the ways in which people live in various regions and, concomitantly, human beings have always intervened in nature so that it molds itself to their desires, which can be summarized from the perspective of Tuan (2012), who emphasizes the broad connection between all factors (socioeconomic, technological, attitudinal, architectural and urban changes, among others) in the promotion of changes, in a "cyclical" way.

The idea of "cycle" is reinforced with regard to the economy and development criteria and, in several places in the world, including Brazil, where urban growth has often occurred in an intense and disorderly way, leaving aspects related to the environment in the background, there are currently serious consequences of this, being one of the problems of the current century (Blau; Light; Panagopoulos, 2018).

In this panorama, it can be seen that many of the urban modifications adopted, especially in cities built spontaneously and without planning, are of high impact, causing problems such as flooding, pollution and, consequently, several challenges in the face of urban sanitation and quality of life. Examples include soil waterproofing to prioritize spaces for vehicles and disorderly constructions and, in addition, channeling, which are also pointed out by Blau, Luz and Panagopoulos (2018).

Based on this, Baptista and Cardoso (2013, p. 126) point out that "[...] the environmental damage and severe socioeconomic damage resulting from floods call into question the current urbanization and sanitary models". This statement allows us to debate the fact that the non-adoption of preventive measures causes the demand for corrective measures in the face of related situations.

The new paradigm for more conscious development consists of the search for sustainable urbanism strategies, considering its socio-environmental dimensions together with technological innovations, seeking more integrated and respectful interventions (Baptista; Cardoso, 2013). Among these strategies, the integration of principles and elements of nature in interventions consists of a potential for urban improvement and

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quality of life, characterizing the concept of Nature-based Solutions (NbS), which includes biophilia, biomimicry, biouse and others (Butt; Dimitrijević, 2022).

Based on the first of the strategies mentioned above and the question of "how can biophilia be integrated into urban sanitation to solve challenges related to sustainability and well-being in contemporary cities?", the main objective of this work is to investigate how the integration of biophilic elements into urban sanitation can answer this question. To this end, the specific objectives include: (a) to analyze the main current challenges in urban sanitation related to sustainability and quality of life in cities; (b) to examine the biophilic approaches already existing in different urban contexts that promote sustainable solutions and (c) to propose strategies to integrate biophilic principles into urban sanitation systems, aiming to improve environmental efficiency and the well-being of the population, envisioning the hypothesis that such propositions can bring more efficiency to sanitation services, promoting greater sustainability and contributing significantly to the physical and psychological well-being of the population. residents in contemporary cities.

THEORETICAL FRAMEWORK

Perceiving the demand for public policies and strategies of management and urban planning that are more respectful of the natural environment, this stage of the present work sought to understand how research on this type of solution has been developed so far, focusing on the theme of "biophilia" and its intersection with the mitigation of problems related to urban issues, especially those related to sanitation.

SUSTAINABLE URBANIZATION BASED ON SOLUTIONS THAT CONSIDER NATURE

Documentedly, many cities have developed extremely quickly and uncontrollably, prioritizing "gray infrastructure" over respect for the natural. By proposing nature-based solutions (NbS), it is envisaged to reduce the high impacts of these practices, since, with regard to the use of this type of solution, Butt and Dimitrijević (2022) point out that buildings and nature are largely integrated, that is, urban expansion will not overlap with the ecosystem, and natural aspects stand out due to their ability to consciously deal with frequent challenges in cities. Furthermore, these authors also emphasize the interdisciplinarity of the theme by conceptualizing that:

> Nature-based solutions [...] are defined as actions to protect, sustainably manage, and restore natural and modified ecosystems, which address societal challenges (e.g., climate change, food and water security, or natural disasters) in an effective

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> and adaptive manner, while promoting human well-being and providing benefits to biodiversity (Butt; Dimitrijević, 2022, p. 2).

From this, the evidently positive character regarding urban resilience is corroborated, understanding that this type of technique has prospects of meeting current global demands, with characteristics of preservation, restoration and environmental improvements in all dimensions (Bianciardi; Becattini; Cascini, 2023), involving professionals, government and all interested agents in search of sustainable design cycles, including promoting the mix between "gray" and "green" and the effects from this relationship.

The aforementioned type of solution has been the subject of research in the most varied areas, considering that it is a concept with an emerging character, with increasingly robust research, and the growing demand for more integrated approaches (Johnson *et al*., 2022; Sowińska-Świerkosz; García, 2022).

The assertion regarding the number of scientific studies on the subject and the rapid evolution of research is visualized from studies such as the one by Johnson *et al*. (2022), who, after having made considerations about climate change and challenges, highlighted that the number of publications in this area has grown exponentially in the last decade.

Sowińska-Świerkosz and García (2022) point to NBS as a key theme to deal with the problems brought up so far, validating the arguments brought, adding to them the idea of the need for convergence between theory and practice, that is, considering the interdisciplinarity of the theme and the possibilities of implementing these concepts. Such multiplicity therefore promises a series of benefits, which can be illustrated in Figure 1, which compiles and correlates several terms pertinent to the construction of concepts.

Figure 1 - Summary of processes and keywords for describing NBS.

Source: Adapted from Sowińska-Świerkosz and García (2022).

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Given this, it is noted that this type of system can bring, therefore, benefits that go beyond the urban scale and promote general quality of life, optimizing environmental parameters and the entire ecosystem in general, fulfilling a role of vitality in a reality in which it is urgent that integrated management prioritize strategies that promote greater permeability and "green" strategies that connect with the subdivision and use of land and resources. mitigating water, climate and sanitation problems, in addition to being something interesting in terms of urban planning projects (Fink, 2016).

INTEGRATION OF BIOPHILIC ELEMENTS IN CITIES

Based on these considerations, it is essential to highlight the role of nature-based solutions (NbS) as part of an integrated, multidisciplinary strategy that involves both urban planning and green infrastructure. Faced with the complexity of contemporary challenges, such as population growth, resource scarcity, and the intensification of climate change, NBS emerge as effective alternatives to promote urban resilience and environmental sustainability.

The Final Report of the Horizon 2020 Expert Group, which established a European Union (EU) research and innovation policy for nature-based solutions and the rewilding of cities, highlights the transformative potential of these approaches to solve urban challenges. This document, produced from stakeholder consultations and workshops, suggests that NBS can not only respond to environmental, social and economic challenges in a sustainable way, but also position Europe as a leader in innovation and green growth (Faivre *et al.*, 2017). Such a strategy goes beyond traditional infrastructure by incorporating natural elements that offer multiple co-benefits for society and the environment, especially in urban areas.

NBS are defined as interventions inspired, supported or replicated from nature, designed to address urban challenges with greater efficiency, lower energy consumption and greater resilience to change (Faivre *et al.*, 2017). These solutions must be adapted to the local context, ensuring synergistic integration with ecosystems. In addition, NBS promotes an integrated approach to sustainable urbanization, restoring degraded ecosystems, improving risk management, and raising well-being in cities (Faivre *et al.*, 2017).

By addressing contemporary challenges, such as rapid population growth and inequality in access to sanitation, biophilic solutions, such as green roofs, urban forests,

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and sustainable drainage systems, have been shown to be effective in alleviating the burden on urban infrastructure and improving quality of life (Faivre *et al.*, 2017). Examples such as storm gardens and bioditches not only optimize stormwater management, but also revitalize neglected areas, increasing biodiversity and creating green spaces that benefit the health and well-being of residents (Faivre *et al.*, 2017).

In the face of these strategies, the implementation of biophilic cities, which integrate natural elements into the urban environment, appears as a complementary approach that not only promotes aesthetics and quality of life, but also provides a closer connection between inhabitants and nature (Beatley & Newman, 2013). By adopting NbS in biophilic cities, the benefits are amplified, especially in tackling problems such as flooding and air pollution. Strategically placed vegetation can mitigate the effects of urban heat islands and significantly improve stormwater management (Parivar *et al.*, 2022).

The integration of natural systems, such as constructed wetlands and bioretention techniques, offers a more sustainable alternative to wastewater treatment, contributing to the efficiency of urban sanitation systems and promoting an ecological balance in cities (Parivar *et al*., 2022). By harmonizing urban infrastructure with nature, biophilic cities create healthy environments, connected to the environment, and a more balanced and resilient form of urbanization (Beatley & Newman, 2013).

Therefore, nature-based solutions (NbS) and biophilic approaches converge to create more resilient cities, capable of addressing contemporary environmental and social challenges. In the context of Brazilian cities, where poor basic sanitation, accelerated urbanization and social inequality are critical issues, there is an urgent need for innovative and sustainable solutions. Biophilia, understood as the innate connection of humans with nature, facilitates the reconnection of citizens with the natural environment, encouraging preservation and sustainability practices. When incorporated into urban planning, NBS and biophilic elements have the potential to promote lasting and positive transformation in urban centers, for example, aligning city growth with the principles of sustainability and well-being (Fink, 2016).

NATURAL SOLUTIONS FOR URBAN WELL-BEING AND SUSTAINABILITY

The concept of biophilia, first proposed by biologist Edward O. Wilson, refers to the inherent human inclination to affiliate with nature and natural systems (Wilson, 1984). This affinity between humans and the natural world has been shown to have implications for

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health, productivity, and overall well-being. Biophilic design seeks to leverage this innate relationship between man and nature by incorporating natural elements and processes into the built environment.

In this way, in the urban context, biophilic design is applied to promote environments that rescue this connection between man and nature. It incorporates natural elements into the built space, transforming cities into healthier and more enjoyable places to live. The use of greenery, natural light, water, and other natural resources in urban architectural designs is an effective strategy for meeting people's physical and mental health needs. As highlighted by Sabaa *et al.* (2022), the presence of natural elements in urban spaces positively impacts not only the physical health, but also the productivity and well-being of residents.

The integration of biophilic elements not only improves the quality of life in cities, but also contributes to urban sustainability. According to Butt and Dimitrijević (2022), the application of nature-based solutions (NbS), which includes biophilia, is one of the most promising strategies to address contemporary challenges, such as urban sanitation, stormwater management, and climate change. Green roofs, living walls, and the insertion of trees and vegetation around buildings are practical examples of how NBS can be implemented, creating a more resilient infrastructure adapted to environmental and urban challenges.

Reeve's (2015) research corroborates the effectiveness of biophilia, demonstrating that contact with nature brings a series of benefits to mental and physical health, such as reducing stress, depression, and anxiety, in addition to improving the recovery of patients in hospitals and increasing job satisfaction. In addition, urban experiences that involve access to green areas promote greater social connection, reducing crime and improving public safety. These factors are especially relevant in densely populated urban environments, where the presence of nature is limited.

Recent literature has emphasized the multiple benefits of biophilic solutions. Reeve (2015) highlights that these solutions not only improve human well-being, but also play a determining role in stormwater management, urban heat island mitigation, and reducing energy demand in cities. In addition, these strategies raise the value of properties, encourage the practice of physical activities and extend the useful life of urban infrastructure, promoting a more connected and sustainable city.

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In this way, biophilia, as an integral part of NBS, offers a decisive approach to face contemporary urban challenges. By promoting greater interaction between nature and urban infrastructure, it enables healthier, more sustainable, and more resilient cities, contributing to the improvement of the quality of life and well-being of citizens. Access to parks, urban farms, green roofs, and vegetated community spaces are examples of how these biophilic elements can be implemented to transform the urban environment, creating a positive impact on both the physical and emotional levels of residents (Reeve, 2015).

In summary, biophilia and NBS are effective responses to urban problems, integrating nature into the city's sanitation systems and infrastructures. By prioritizing the connection between humans and nature, this strategy promotes not only environmental sustainability, but also the psychological and physical well-being of urban populations, consolidating itself as one of the main approaches to urban planning in the twenty-first century (Reeve, 2015; Butt; Dimitrijević, 2022; Sabaa *et al.*, 2022).

BIOPHILIA AND NBS AS RESPONSES TO CONTEMPORARY URBAN DEMANDS

In sustainable urban planning, it is essential to incorporate green spaces in urban areas, based on the concept of biophilia, which is premised on human well-being through interaction with nature, according to Pieve (2024). Making cities an inclusive public space that offers more quality of life for their inhabitants goes beyond having accessible buildings. It is about considering the quality of human and social life of all citizens in the urban environment. In addition to creating sustainable environments that aim to improve the quality of urban life, either by expanding green areas or ensuring accessibility, it is essential that all individuals, regardless of their physical or intellectual conditions, can enjoy urban space in an equitable way.

Cities have urban parks as integrated green spaces, which play an essential role in providing opportunities for direct interaction with nature. In recent years, the use of these spaces as a leisure alternative has increased substantially (Fan; Luo, 2020 *apud* Melo, 2023). Such parks are important for the development of a healthy lifestyle among the inhabitants of a city, since contact with nature is one of the main demands of residents of urban areas. In addition, urban parks offer a variety of ecosystem services, such as reducing noise and air pollution, saving energy, and regulating the microclimate. Therefore, the incorporation of these green areas in urban planning is fundamental for the composition of sustainable and healthy cities.

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According to Trevisa (2024), the environmental dimension is recognized as one of the pillars of sustainable development. Concern for ecological issues is fundamental to life in cities, as highlighted by the UN:

> The depletion of natural resources and the negative impacts of soil degradation, freshwater scarcity and biodiversity loss, add to and aggravate the list of challenges facing humanity (UN, 2016, p. 6).

In this context, biophilia plays an important role in promoting sustainable urban development, contributing to reverse the adverse effects of disorderly expansion of metropolises. Native forests have an intrinsic value, promoting a concrete communion between humanity and nature in urban daily life.

Currently, we have Singapore as one of the most notable examples of biophilic urbanism, being a global reference in the integration of green infrastructure and sustainable urban planning, according to Fayad (2020). Public policies have been implemented in the city that promote coexistence with the built environment and nature, resulting in significant benefits for the health, economy, and quality of life of its inhabitants. Singapore is the fourth best city in the world in terms of life expectancy of its inhabitants, and has one of the lowest infant mortality rates, which reflects the positive impact of biophilia on public health and general well-being of the population (Beatley, 2012 *apud* Fayad, 2020).

The South American city of Medellín, Colombia, is also an example of urban transformation based on the restructuring and revitalization of public spaces. The capital has adopted strategies that prioritize social inclusion and the equitable development of its green areas, promoting coexistence between different social classes. The process of modernization and investment in green infrastructure in Medellín has contributed to the creation of accessible and healthy public spaces, directly benefiting the quality of life of its inhabitants (Dias, 2017 *apud* Fayad, 2020).

METHODOLOGY

The methodology adopted in this study followed a qualitative approach with the objective of investigating and analyzing the concepts and theories related to the theme of biophilia as a sustainable solution and ally of urban well-being. To this end, a literature review was carried out with a descriptive, exploratory character and including bibliographic/documentary research, as emphasized by Gil (2022). This type of approach allows for a broad exploration of the theme, facilitating the construction of a solid theoretical

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basis on the subject. The main focus of the analysis was the identification and interpretation of concepts that contribute to the discussion about biophilia, its impact on urban sustainability and the promotion of well-being.

The instruments used for data collection consisted of scientific articles, academic theses, legislation, and data pertinent to the topic (Gil, 2022). The selection of these sources followed criteria of relevance and proximity to the biophilia approach applied to the urban context, ensuring that the data collected were representative of the current theoretical discussions on sustainability and quality of life in cities.

The procedure adopted in data collection was based on the selective and reflective reading of the sources, which allowed the survey of the main concepts and theories that structure the discussion. The reflective reading made it possible not only to identify the central ideas, but also a critical analysis of the convergences and divergences between the different authors and perspectives addressed. Thus, the study sought to build a comprehensive and grounded view of the contributions of biophilia as a sustainable strategy in the urban context.

RESULTS AND DISCUSSIONS

The research developed investigating the implementation of NBS in the city, together with its technical aspects and benefits, corroborates the vitality of this type of strategy for sustainable urbanism, with great potential for improving spaces and urban resilience in the face of water and sanitation challenges. In order to verify and contextualize these applications, we seek to understand the Brazilian panorama.

THE BRAZILIAN SCENARIO AND THE ANALYSES OF URBAN SANITATION

Sanitation is a problem and challenge present in several countries and regions. In the national context, the relevance of the topic is proven by the existence of public policies that deal with the subject, such as Law No. 14,026, of July 15, 2020, which "updates the legal framework for basic sanitation [...]" (Brasil, 2020), and others, and their respective updates, which prove the changes in the subject over time and the continuity of the theme as relevant and current, which is reinforced by correlating such a statement with the fact that the universalization of basic sanitation and water resources correspond to integral objectives for the UN, with regard to the 2030 Agenda and sustainable development (Amaral *et al.*, 2023).

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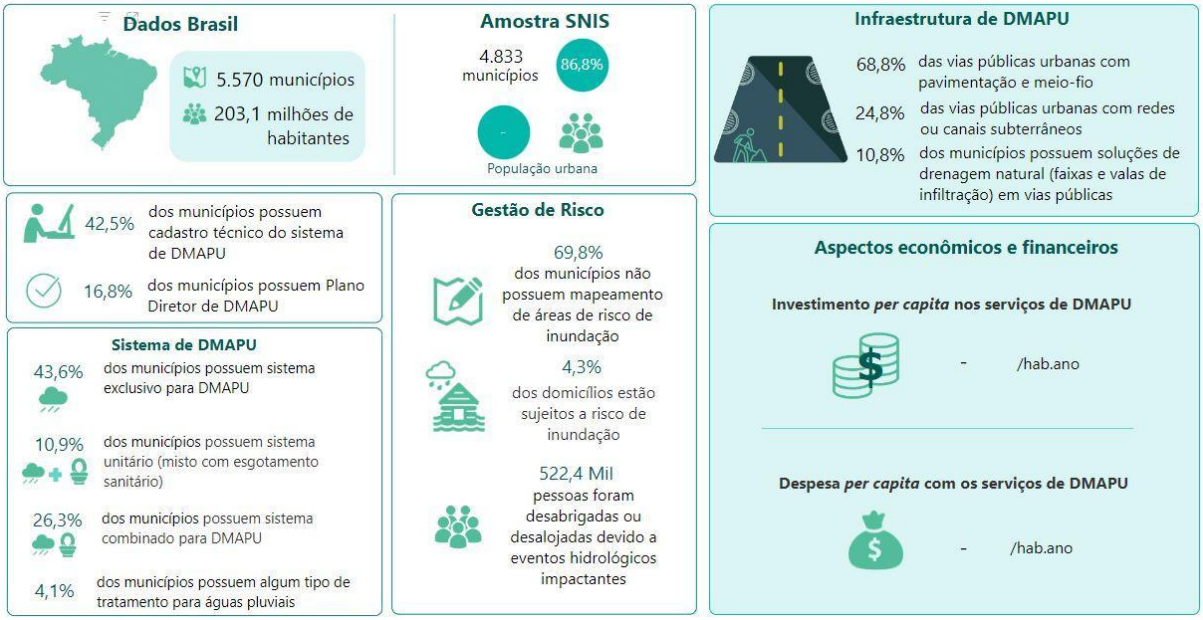
Briefly analyzing the legislation mentioned in the previous paragraph, some of its main points are pointed out as the search for the integration of the performance of the different stakeholders and infrastructures in management, in line with the objective of exponentially amplifying the service with the services, in a more comprehensive way, by the year 2033 (Brasil, 2020).

Amaral *et al.* (2023), when addressing the view regarding the performance of the National Water Agency (ANA), point out that:

> [...] an ideal scenario for water security is possible where the infrastructure is planned, dimensioned, and properly implemented and managed, to meet the supply and demand of water, in a balanced way, thinking about contingency situations, arising from vulnerability to extreme weather events (Amaral *et al.*, 2023, p. 3).

This idea reinforces the idea of the importance of integrated and careful management, emphasizing the preventive nature and corroborating the search for the implementation of NbS in cities, which will be addressed in more detail in the course of this work. Quantitatively, it is possible to perceive from the analysis of the results of the National Sanitation Information System (SNIS) (Brasil, 2023), especially in the panel referring to the subject "Drainage and Management of Urban Rainwater" (DMAPU), the national panorama regarding the theme in its most recent version (considering that the SNIS 2023 has the year 2022 as a reference for the data presented), illustrated in Figure 2.

Figure 2 - Results on DMAPU in 2022 presented in the form of a panel.



Source: Brazil (2023).

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The indicators listed in the Figure above provoke the discussion about the type of measures adopted so far and allow us to perceive the importance of taking measures to optimize the sanitation of conscious urban growth, considering the importance of thinking in a preventive way, which often does not occur, see the low percentage of areas with care related to the DMAPU system, and the infrastructure parameters demonstrating the strong presence of "gray infrastructures" and impermeable, while few municipalities opt for drainage that respects and values the environment (Brasil, 2022).

POTENTIAL FOR INTEGRATING BIOPHILIC PRINCIPLES INTO URBAN SANITATION SYSTEMS

In addition to the research treated in the bibliographic reference, the critical analysis of the documentary data corroborates the idea that the adoption of a solution that respects and integrates nature into urban planning has a positive character, grounding and giving robustness to the proposal to integrate the principles of biophilia in cities.

Biophilic urbanism is addressed by Daniels *et al.* (2020), explaining the benefits of this relationship to meet the multidimensions of sustainability, since the consideration for nature in development goes beyond the perspective of spatial aspects and well-being, including also proven technical benefits, in a functional way.

The complex and disorderly way in which the development of many cities occurred corresponds to a challenge for the implementation of this type of measure. However, this challenge does not correspond to an impediment to the search for the integration of NBS and biophilic principles in urban areas, since such action can occur at different scales, such as the scale of buildings, the scale of the neighborhood, and the scale of the city (Daniels *et al*., 2020).

Thus, discussing again what was scored by Daniels *et al.* (2020), the possibility of adopting gradual and punctual measures, initially, proves the possibility that this occurs gradually, starting with strategies such as green roofs or even vegetation and greater permeability in buildings, to, over time and possibilities, gradually incorporate larger measures, such as green corridors and parks that value the natural environment in the city and in the regions, expanding its operations, in an integrated way.

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CONCLUSION

In general, during all stages of the present work, the relevance of thinking of urban space as a space of integration between "gray" and "green" elements was noticeable, and from this, the potential of nature-based solutions to mitigate water and urban sanitation challenges. In addition to the perspective of sustainable development, biophilia was found to be a multidisciplinary strategy and promoter of co-benefits for people and the urban environment.

Finally, it is seen that this type of strategy has great potential to overcome the challenges, supporting the idea of a proposition for greater diffusion of biophilic urbanism among the different actors and those involved, optimizing environmental efficiency and the experience of the population in cities. To this end, it is valid that biophilic practices are encouraged through public policies, in view of the relevance and timeliness of this type of strategy.

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