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SIMILARITIES AND DICHOTOMIES BETWEEN NATURE-BASED SOLUTIONS AND GREEN INFRASTRUCTURE: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Objective: The study seeks to address the following question: What are the similarities and dichotomies between green infrastructure (GI) and nature-based solutions (NBS) from the perspective of Brazilian researchers, and how do the identified solutions mitigate the depletion of urban ecosystem services?

Method: A Systematic Literature Review (SLR) was conducted using the PRISMA protocol in research within the CAPES Journal database. The inclusion and exclusion criteria were original texts, peer-reviewed, published in national and international journals in Portuguese, covering the themes of NBS, GI, informal settlements, and public open space. After reviewing the 90 identified texts, a final selection of 41 texts was made for the SLR.

Originality/Value: These texts were analyzed from a novel perspective, bringing together the themes of GI, NBS, ecosystem services protection, and urban land use.

Results and Discussion: The study identified the authors' views on the pressures of urbanization on ecosystem services and the solutions for their protection. It was concluded that the concepts of NBS and GI are often conflated in most approaches and that adopting urbanization associated with nature faces conceptual, operational, and managerial challenges.

Research Implications: The research provides insights into the integration of GI and NBS in urban planning to address the challenges of uncontrolled urbanization and the degradation of ecosystem services.

Keywords: Nature-Based Solution (NBS), Green Infrastructure (GI), Systematic Literature Review (SLR), Urban Drainage.

SIMILARIDADES E DICOTOMIAS ENTRE SOLUÇÕES BASEADAS NA NATUREZA E INFRAESTRUTURA VERDE: UMA REVISÃO SISTEMÁTICA DE LITERATURA

RESUMO

Objetivo: Busca-se responder a seguinte indagação: Quais as similaridades e dicotômicas entre infraestrutura verde (IV) e soluções baseadas na natureza (SbN) na visão dos pesquisadores brasileiros e, como as soluções indentificadas mitigam a depleção dos serviços ecossistêmicos urbanos?.

Método: Adotou-se a Revisão Sistemática de Literatura (RSL) por meio do protocolo PRISMA em pesquisa na base do Periódicos CAPES. Os critérios de inclusão e exclusão foram texto originais, revisados por pares, publicados em revistas nacionais e internacionais em português, sobre os temas de SbN, IV, assentamentos informais e espaço livre público. Após a leitura dos 90 textos identificados se definiu um universo de 41 textos para integrar a RSL.

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Originalidade/Valor: Estes foram analisados sobre ótica inédita reunindo os temas IV, SbN, proteção de serviços ecossistêmicos e ocupação do solo urbano..

Resultados e Discussão: Foram identificadas as visões dos autores a respeito das pressões da urbanização sobre os serviços ecossistêmicos e as soluções para sua proteção. Conclui-se que os conceitos de SbN e IV se confundem na maioria das abordagens e que a adoção de uma urbanização associada a natureza enfrenta desafios conceituais, operacionais e gerenciais.

Implicações da Pesquisa: A pesquisa oferece informações sobre a integração da IV e das SbN no planejamento urbano para enfrentar os desafios da urbanização desordenada e a degradação dos serviços ecossistêmicos.

Palavras-chave: Solução Baseada na Natureza (SbN), Infraestrutura Verde (IV), Revisão Sistemática de Literatura (RSL), Drenagem Urbana.

SIMILARIDADES Y DICOTOMÍAS ENTRE SOLUCIONES BASADAS EN LA NATURALEZA E INFRAESTRUCTURA VERDE: UNA REVISIÓN SISTEMÁTICA DE LA LITERATURA

RESUMEN

Objetivo: El estudio busca responder a la siguiente pregunta: ¿Cuáles son las similitudes y dicotomías entre la infraestructura verde (IV) y las soluciones basadas en la naturaleza (SbN) desde la perspectiva de los investigadores brasileños, y cómo las soluciones identificadas mitigan la degradación de los servicios ecosistémicos urbanos?

Método: Se realizó una Revisión Sistemática de la Literatura (RSL) utilizando el protocolo PRISMA en la base de datos de Periódicos CAPES. Los criterios de inclusión y exclusión fueron textos originales, revisados por pares, publicados en revistas nacionales e internacionales en portugués, sobre los temas de SbN, IV, asentamientos informales y espacio público abierto. Tras la revisión de los 90 textos identificados, se seleccionó un total de 41 textos para integrar la RSL.

Originalidad/Valor: Estos textos fueron analizados desde una perspectiva novedosa, reuniendo los temas de IV, SbN, protección de servicios ecosistémicos y uso del suelo urbano.

Resultados y Discusión: El estudio identificó las opiniones de los autores respecto a las presiones de la urbanización sobre los servicios ecosistémicos y las soluciones para su protección. Se concluye que los conceptos de SbN e IV a menudo se confunden en la mayoría de las aproximaciones y que la adopción de una urbanización asociada a la naturaleza enfrenta desafíos conceptuales, operativos y de gestión.

Implicaciones de la investigación: La investigación ofrece información sobre la integración de la IV y las SbN en la planificación urbana para enfrentar los desafíos de la urbanización desordenada y la degradación de los servicios ecosistémicos.

Palabras clave: Solución Basada en la Naturaleza (SbN), Infraestructura Verde (IV), Revisión Sistemática de la Literatura (RSL), Drenaje Urbano.

1 INTRODUCTION

The different ways of managing the territory express patterns of occupation of the land that can both facilitate access to ecosystem services and make it difficult or even eliminate it.

Thus, the relationship between ecosystems and human occupation will have an impact on the quality of life of populations over time, constantly demanding the consideration of knowledge about their dynamics and actions of territorial management that take into account the logic of nature.

Ecosystem services comprise all the benefits and goods provided by nature to support human activities in a given territory. However, the perception of ecosystem services as conditions of nature, land occupation has been a relatively recent topic of study in urban landscape planning, constituting a disciplinary field, still under construction, though growing (Mooney; Ehrlich, 1997; Mea, 2005; Costanza, 2008; Potschin; Haines-Young, 2017).

While the initial human occupations were conditioned by the imperatives of the natural resources access site, especially the water and forest, what is happening over the years is a process of exploitation, which not only intensified, but also led to the loss of the protagonism of nature (MARSH, 1864). In the case of urban occupations, the concept of natural landscape has come closer to that of rural landscape, reinforcing the mentality in which nature is an obstacle to be overcome, used at best for aesthetic element, ignoring its essential role of support of the urban environment (Oliveira, 2017; Sant'anna, 2020). Urban occupation models over time have been increasingly distancing populations from the benefits received from their own ecosystem and as a result, urban planning and development practices have emerged that disregard the relationship of natural processes in the landscape (Hopkins, 2013; Costa; Gimmlernetto, 2015).

Today it is a consensus that many cities have become incapable of responding to contemporary pressures by adapting and resilient to the impacts arising from the distance between cities and the logic of their physical-biotic environment. As we know, these consequences are most strongly expressed in water scarcity, climate changes, floods and landslides, among other phenomena (Mcharg, 1969; Mea, 2005; Bonam, 2008; Waldheim, 2016; Bélanger, 2017).

Although they do not form part of the dominant practice in the way of producing cities, the first attempts to consider nature as part of urban space go back to the time of the Industrial Revolution, when green areas began to be introduced into cities. They were elements of separation of activities and/or connection of areas of the city with their expansions. Such initiatives of an intra-urban character had a common concern: bringing sun, fresh air and green into the urban environment in order to minimize the unhealthiness of cities (Oliveira, 2017).

2 THEORETICAL FRAME

In a quick overview of events parallel to the dominant practices, it can be highlighted that throughout the twentieth century initiatives such as those of urban environmental planning, from the 1960s onwards, present with conceptual and methodological support urban occupation practices that consider the river basins as a unit of study and intervention associated with the conditioning of the physical biotic environment (Mcharg, 1969; Forman; Godron, 1986; Dramstad; Olson; Forman, 1996; Oliveira, 2017).

More recently, from the 1990s, interdisciplinary approaches related to urban ecosystems have been developed aiming at increasing the resilience and adaptability of human occupations (Escobedo et al., 2019). Disciplinary approaches to Ecosystem Services (Mea, 2005; Costanza, 2008; Potschin; Haines-Young, 2017), Green Infrastructure (Bonzi, 2017; Meneguetti, 2017; Firehock; Walker, 2019), Urban Ecology (Forman, 2014), Landscape Infrastructure (Bélanger, 2017), Landscape Urbanism (Urbanism) stand out among them Waldheim, 2016), Restoration Ecology (Hobbs, 2007), Nature-Based Solutions (Scott et al., 2016).

However, Escobedo et al. (2019) warn of certain precautions in adopting such approaches in isolation, as they are inherently interdisciplinary. Thus, one must observe their complementarity in favor of an integral treatment of the landscape, always considering the local socioeconomic context, such as that of the Global South countries, where unequal access to the benefits of nature is a characteristic of urban arrangements.

It is within this perspective that the Systematic Review of Literature (RSL) carried out here is contextualized. His challenge was to understand the two most outstanding approaches disseminated in Brazil nowadays, namely, green infrastructure and nature-based solutions. The question that guided the research was: what are the similarities and dichotomies between green infrastructure and nature-based solutions and, in particular, how the solutions that they preach respond to the real problems of the depletion of the ecosystem services of our cities[4].

[4] This research is part of another broader study, also carried out in English, which comprises: a systematic review of literature, an urban diagnosis of ecosystems, a case study directed towards solutions based on nature, and participative processes with a community in vulnerability. It is sponsored by the Extension Decanto of the University of Brasilia/Brazil.

3 METHODOLOGICAL PROCEDURES

To undertake this systematic review of literature, the *Preferred Reporting Items for Systematic Reviews and Meta-Analyzes* procedures (PRISMA) were *used as a method* adopting a descriptive and critical perspective. The CAPES Journal Portal was used to select the texts, adopting as criteria: original, national and international articles, peer reviewed from 2010 to 2022. Another eligibility criterion refers to texts published in Portuguese with origin in any country.

To begin the codification, it was based on a conceptual understanding that made reference to the central question, which is how to plan and design cities in harmony with nature, preserving their ecosystem services. The understanding of Albert et al. was used for this. (2019, p. 12) that SbN are 'actions that alleviate a well-defined social challenge (challenge orientation), employ ecosystem processes of spatial, blue and green infrastructure networks (use of ecosystem processes) and are integrated into viable governance models for implementation (practical feasibility)'.[5]

Thus, it was based on a general term that would be Nature-based Solutions (SbN) but with descriptors that involved the other approaches that were subdivided into three groups, involving similar concepts related to SbN: problems and solutions associated with SbN; SbN applied to irregular settlements and SbN solutions applied to public free space (Table 1).

Table 1

Search strategy used in RSL

Subjects	Descriptors and Search Strategies
SbN	("nature-based solutions" OR "nature-based solution" OR "Green infrastructure" OR "Natural infrastructure" OR "Ecosystem-based adaptation" OR "sustainable drainage" OR "water-sensitive urbanism" OR "landscape architecture") AND
Problems and Solutions	("ecological transition" OR "transition" OR "social participation" OR "participatory management" OR "participation" OR "environmental justice" OR "climate change" OR "heat island" OR "ecosystem service" OR "sustainability" OR "adaptive management" OR "adaptation" OR "urban planning" OR "risk assessment" OR "waterproofing" OR "resilience" OR "risk area" OR "disaster" OR "land use" OR "urban infrastructure" OR "permeability" OR "vegetation" OR "metabolism"
Irregular settlements	OR "precarious settlement" OR "low income" OR "favela" OR "informal settlement" OR "subnormal settlement" OR "irregular settlement" OR "clandestine settlement" OR "precarious area" OR "land settlement" OR "regularization project" OR
Public Free Space	"Public Space" OR "Public Free Space" OR "Public Urban Free Space" OR "Urban Public Space" OR "Green Space")

[5] We define NBS as actions that alleviate a well-defined societal challenge (challenge-orientation), employ ecosystem processes of spatial, blue and green infrastructure networks (ecosystem processes utilization), and are embedded within viable governance or business models for implementation (practical viability).

The search was conducted in April 2023. Deduplication and/or dealing with the same case was carried out by automated tool. In the screening phase, the eligibility of the records was done by reading the titles and abstracts of the articles in the format of blind evaluation by 5 researchers linked to the Landscape Lab of the School of Architecture and Urbanism of the University of Brasilia. Finally, the codes were chosen to respond to the research problem, as described in Table 2. Six researchers, professors and students, codified the randomly distributed articles.

Table 2

Relationship of codes and correspondence to the search problem

Problem	**Code Book Reference**
1.1. When was the concept of SbN introduced into the political debate and the scientific community?	Adoption of the approach in the political frameworks in Brazil
	Adoption of the approach in the scientific community in Brazil
	Nature of scientific publications addressing the topic
1.2. What are the challenges addressed by the SbN that could be addressed by the SbN?	General challenges of SbN
	Social challenges addressed in studies on SbN
	Relationship with the Development Goals Sustainable (SDG)
1.3. How is the ecosystem process (SbN-related) used?	Types of SbN and their technical solutions
	Case Study Locations
	Intervention scale
	Urban ecosystem services provided
	Impacts of urbanization on ecosystem services
	Expectations of persons associated with nature
	Nature Values
1.4. What is the practical feasibility of implementing the SbN?	Policy frameworks
	Regulatory incentives or mechanisms
	Social participation
	Barriers
	Possibilities
	Gaps and future research

The methodological quality of the selected studies was evaluated qualitatively using criteria such as the scientific method used, use of primary data, conceptual basis aligned to the basic concept used, and conflict of interest between the author and the study. Periodic meetings were held for 3 months among the researchers for qualitative discussions and alignment of the analysis criteria used as: reasons for the selection of the study cases; correlation between cases; scientific method employed; use of the concept and use of similar terminologies for the same concept.

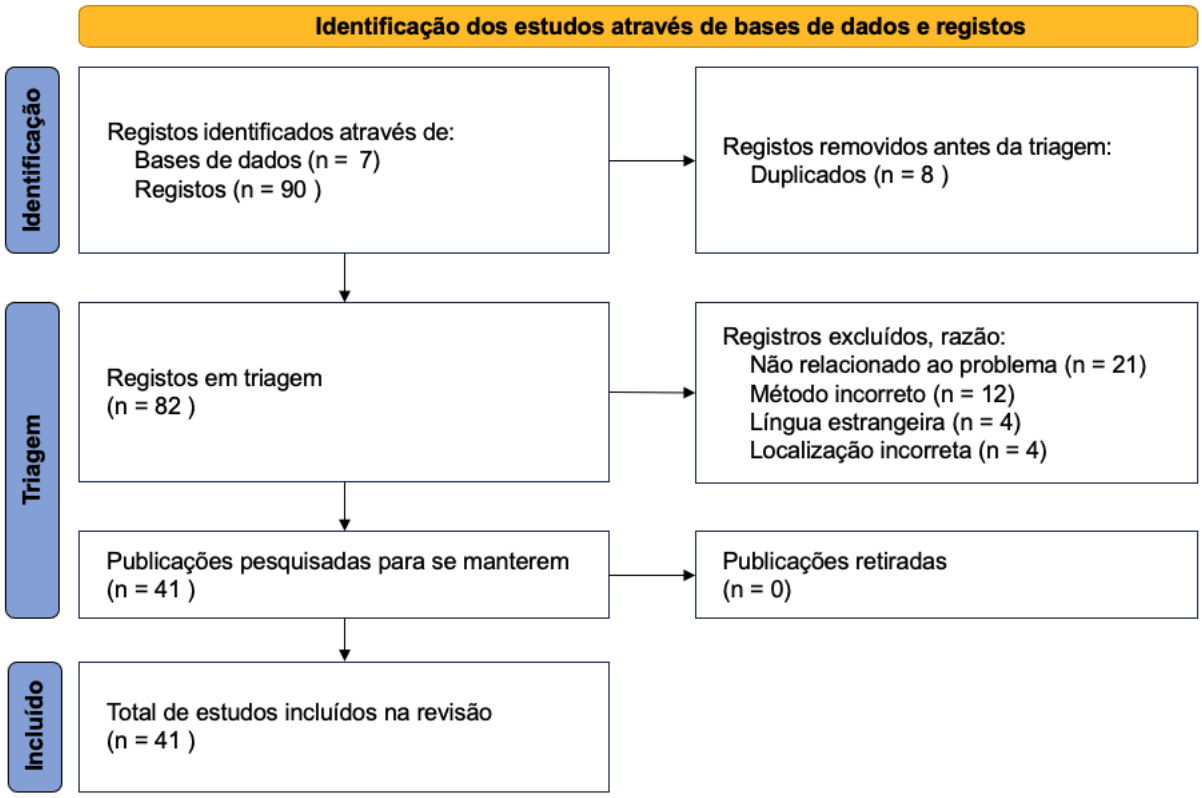
The synthesis procedure was carried out by bringing together all the direct quotations, codified in Table 2, in blocks of texts that were grouped together in common subjects. From

then on, the summarization of all the approaches by author was carried out in such a way that the vision of each one was clear and the convergences and divergences between the texts.

The search strategy resulted in 90 articles, located in 7 databases, namely: Directory of Open Access Journals, SCiELO, SCiELO Brazil, SciELO Public Health, SciELO Portugal, Elsevier ScienceDirect Journals and Social Sciences Citation Index (Web of Science), as described in Figure 1.

Figure 1

Systematic review flowchart and number of records found



Source: authors based on the translated version of the PRISMA (2020) flow diagram.

Of these, 8 duplicate records were located and resulted in 82 articles for the screening phase. At this stage, 41 records were removed and 41 remained. Of which 21 records were excluded because they were not related to the research problem, 12 were removed because they used research methods that were inappropriate for the research objective, 4 because they were in a foreign language and 4 because they dealt with different spatial contexts than those related to the research problem. All the articles were available for access and were analyzed in their entirety.

4 ANALYSIS OF RESULTS

As already mentioned initially, the initial motivation was a study about the thinking of Brazilian researchers, with publications in Portuguese, about solutions based on nature expanded to green infrastructure. This broad view considered approaches captured by the study descriptors of an urbanism that promotes the integrity of ecosystems and not exclusively studies that adopted the term SbN. This fact brought to the results the concept and term that has been most widespread in the country as solutions to improve resilience and protection and promotion of ecosystem services.

4.1 IMPACT OF URBANIZATION ON ECOSYSTEM SERVICES

A reading of what is understood as pressures of Brazilian urbanization on the integrity of ecosystem services indicated as the cause the unequal urbanization that characterizes the country, where a large part of the urban areas had their occupation of the land without any kind of planning, with absence of green areas and occupation of watercourses margins and other areas of environmental fragility. Also, the fact that the occupation model of the regular areas has been and is a promoter of significant losses of environmental benefits, in particular those that refer to water supply resulting from the high level of soil sealing, cannot be disregarded. Table 3 below summarizes the authors' approaches to the pressures that urbanization causes on ecosystems.

Table 3

Authors' approach to pressure from urbanization

Author	Approach taken
Ximenes (2022)	irregular urban land use in improper areas leading to flooding and landslides
Guimaraes (2018)	removal of vegetation cover, increased sealing and occupation of river banks.
Seraphim (2019)	modification of the hydrological regime due to increased soil sealing
Timmermann (2017)	increased soil sealing with urban sprawl
Nephew; Neves (2015)	soil sealing
Fernandes (2022)	lack of connection between green areas of Conservation Units and urban land use processes
Pereira (2021)	disorderly growth with deforestation and few green and free areas
Caiche (2021)	Soil sealing and few green and free areas
Fields (2021)	Lowering of the water table and land use, disregarding the rationale of river basins
Souza (2019)	Reduced green and free areas in cities
Soares (2022)	occupation of areas at risk and anthropic pressure in water sources
Pine (2015)	vegetation suppression and soil and water contamination

Franc (2013)	changes in the urban climate and increased flooding due to lack of integration between the natural landscape and urban occupation
Lotufo (2017)	lack of integration between landscape and building design
Herzog (2010);	Reduced free and green areas and their lack of connection
Author 2	Soil sealing, groundwater lowering and absence of drainage systems.
Olak (2020)	disconnection between natural and built landscape
Mattos (2020)	Low infiltration of water into soil, channeled and polluted watercourses, erosion, landslides and increased impermeable areas
Medeiros (2017)	urbanization with high waterproofing, increased surface runoff and leads to flooding, flooding and flooding
Ackermann (2021);	hydrological cycle of deforestation of high-mountain FPAs has been altered
Romero (2010)	Modification of the topography with the removal of the vegetation cover, creating islands of heat, erosions, lack of shading in public spaces, silting of the bodies of water and a reduction in biodiversity.
Baumgartner (2021);	soil waterproofing, deforestation. loading of soil and garbage for bodies of water, silting of rivers and lakes, heat islands
Ximenes (2020)	soil waterproofing and channeling of rivers leading to flooding, flooding, landslides and heat islands.

In general, the main aspects raised in relation to the type of urbanization of Brazilian cities that jeopardize ecosystem services refer to: (i) rapid and disorderly urbanization; (ii) suppression of green areas; (iii) channeling of rivers; (iv) soil sealing; (v) occupation of permanent preservation areas. The gray monofunctional infrastructure is highlighted by everyone as inadequate for the solution of problems and often as responsible for them. They almost always block natural dynamics, and therefore, even if it can provide some service of maintaining urban functions, they impair ecosystem services, reducing the resilience of cities.

On the other hand, lost services are associated with: (i) compromising the quantity of water by the low recharge of aquifers and the quality of water by silting, erosion, and ground and surface contamination; (ii) compromising the regulation of the hydrological cycle, resulting in soil loss and its destabilization generating floods, floods, floods and landslides that still jeopardize the lives of people; (iii) compromising the regulation of the climate with an increase in urban temperatures, besides the increase of the effect of heat islands.

4.2 URBAN PRACTICES IDENTIFIED AS SOLUTIONS FOR IMPROVING URBAN SPACES AND ECOSYSTEMS

In this topic, the reading of the selected bibliography took place with the aim of identifying the types of solutions adopted by the authors when making their recommendations and/or practice of the urban project. In this point a greater dialog with the real problems of Brazilian cities is highlighted, that is, if in the theoretical discussion there is reference to all the possibilities of solutions and protection of the most varied urban ecosystem services, in practice,

the authors emphasize solutions that are closer to the problems identified in our cities. In this way, we begin to make a synthesis, by author, about the solutions most used within the universe of his researches.

When analyzing this adherence, the specificities of the issues that are resorted to in Brazilian cities arouse a dichotomy: on the one hand, while in the theoretical discussions the approaches focused on the promotion of the creation of green areas and green corridors are highlighted, that is, the renaturalization of the cities by means of the presence of vegetation; on the other hand, when one observes the solutions indicated by the practice, more than two thirds of them make use of elements of urban water management that are closely linked to solutions that contribute to the ecosystems, but that are not understood as SBN, at least in the international literature. In any case, it cannot be said that the solutions are not interdependent, but one must take into account that if renaturalization supports water management, not every measure of water management is renaturalization. The propositions mostly advocate the creation of integrated green/blue infrastructure to enhance its effectiveness in promoting ecological integrity.

It could not be any other way in that a serious problem of our urbanization refers to the drainage with recurrence of floods, floods and landslides, especially of low income and irregular areas, these appear in the bibliography studied with a percentage of approximately 60% of solutions associated with compensatory drainage technique. In this case the proposed model is based on the Low Impact Development (LID) system of the American current, or Sustainable Drainage System (SuDs) term used in the UK. Thus, it is the theme of water management that predominates.

On the other hand, when discussing the renaturalization of cities with solutions for the implantation of parks, gardens, green/blue corridors, preservation areas and wooded public spaces, the conceptual recurrence always falls on the current of green infrastructure, also of American origin and that has been growing since the years 1994.

4.3 VIEWS ON SBN AND GREEN INFRASTRUCTURE

What can be highlighted is that in the researched literature the concept of SbNs appears as an "umbrella concept" that would incorporate the different approaches of preventive and reparative interventions of the use and occupation of the territory, encompassing those that come from various fields of knowledge, such as environmental sciences, landscape ecology, architecture and urbanism. This observation stems from definitions such as the one that

associates SbN with solutions that aim to protect, manage and restore natural or modified ecosystems, facing challenges such as climate change, food and water security, and natural disasters (UICN, 2016 apud Ximenes, 2022; Caiche, 2021). SbN is still mentioned as solutions derived from technologies and territorial interventions that seek to improve urban quality through strategies, tools and spaces that simulate the functioning of nature (LSBN, 2021 apud Costa; Sakurai, 2021; Pereira, 2021).

However, on the other hand, it can be verified that the same definitions are attributed to green infrastructure that received greater references among the studied authors. Green infrastructure is defined as an interconnected network of green and natural spaces that conserve ecosystem values and functions, providing benefits to the local population (Fernandes, 2022; Guimarães, 2018; Caiche, 2021). They are attributed their low ecological impact and high performance, following principles such as the use of multifunctional landscapes, flexibility and connectivity of systems (Guimarães, 2018; Herzog, 2010). As for the benefits, they go beyond ecological aspects, integrating social factors such as well-being, poverty eradication, socio-economic development and governance (Eggermont et al., 2015 apud Pereira, 2021).

The commonly cited strategies to implement green infrastructure include green corridors, connectivity, living areas, improvement in urban drainage, urban agriculture, biosphere reserves, conservation units, urban forests and afforestation (Guimarães, 2018; Fernandes, 2022; Caiche, 2021; Soares, 2022; Pinheiro, 2015; Herzog, 2010; Lotufo, 2017; Perim, 2019; Olak, 2 10). Most of these strategies are also referred to in texts dealing with SbN, although green infrastructure uses solutions that do not necessarily use elements of nature.

The articles analyzed include references to both green and blue infrastructure, the latter related to the management of the urban water system. The combination of both is often called "green-blue infrastructure," aimed at urban resilience and climate regulation (Guimarães, 2018; Soares, 2022; Herzog, 2010). In both cases, blue/green infrastructure and SbN are associated by the authors with sustainable urban drainage. There is an understanding that these approaches seek to integrate the hydrological cycle with the urban landscape, promoting more sustainable practices.[6]

[6] Two models synthesize this reading of urban space: linear and circular metabolism. The linear translates the traditional way of building cities into a continuous consumption of natural resources and production of waste, and the circular metabolism translates that the input (natural resources) and output of waste occurs in such a way as to maximize the processes of reuse and recycling, with solutions that are similar to the natural behavior of the environment. The logic of implementing a circular metabolism would be to reduce the ecological footprint. (AUTHOR2)

The authors agree that the SbNs and green infrastructure are fundamental for the generation of a series of Ecosystem Services, which benefit human beings (Guimarães, 2018; Pereira, 2021; Masquete; Chande, 2022). For this reason, AUTHOR 2 stresses that it should be taken into account that these solutions promote circular urban metabolism and are therefore at the service of promoting a resilient city.

Drawing a parallel between the predominant view in the Portuguese literature and the one used in the international context, one could say that unlike the SbN, green infrastructure does not seek to simulate the functioning of nature, but rather to use types of infrastructure that promote some kind of improvement of the ecosystem, not necessarily with elements of nature such as the use of permeable flooring to obtain more infiltration.

4.4 INCORPORATING NATURE-BASED SOLUTIONS IN THEIR BROAD SENSE INTO STANDARDS AND POLICIES

In the political sphere, the SbN are closely linked to the idea of environmental justice, which seeks to guarantee access to nature to all people through compliance with environmental laws and policies (Costa; Sakurai, 2021; Pereira, 2021). This concept becomes relevant as nature should but is not distributed equally and vulnerable communities face disproportionate impacts of environmental degradation (Costa; Sakurai, 2021).

The discussion about the need for a legal basis for the protection of ecosystem services is treated by the authors studied when the need to value environmental services as a means of transforming ecosystem services into natural capital is highlighted. This can occur at the city scale or at the regional and national level. This has occurred more frequently in climate change adaptation plans than in urban master plans. Thus, the legal basis emerges as a tool to ensure the consideration and protection of ecosystem services in political and business decision-making (Silva; Carvalho, 2018).

In this sense one can identify references to initiatives in several cities such as São Carlos (SP), São Paulo (SP), Belo Horizonte (MG) and Fortaleza (CE), where legislation and public policies incorporate principles related to SbN (Caiche, 2021; Perim, 2019; Soares, 2022). In São Carlos, for example, municipal legislation seeks to integrate biodiversity into urban planning, promoting the maintenance and restoration of natural ecosystems (Caiche, 2021).

At the national level, the National Plan for Adapting to Climate Change and the National Program for the Revitalization of River Basins are pointed out, as instruments that align with the principles of the SbN (Brazil, 2016 apud Campos, 2021). The National Adaptation Plan

highlights the need for actions that promote the sustainable management of water resources and the adaptation of land uses and physical environment weaknesses, while the National Program for River Basin Revitalization seeks the recovery and conservation of aquatic ecosystems.

Despite general advances in the protection of ecosystem services, when considering urban land use practice, significant challenges are identified. The fragmentation of knowledge and the lack of integration between disciplinary fields affected to territorial planning are pointed out as a limiting the application of nature-based solutions (Caiche, 2021). Another aspect refers to resistance to changes by some sectors of society for lack of understanding about the long-term benefits that SbN can propositional, which leads to non-acceptance of the change of their practices (Pereira, 2021). Finally, among the challenges is social inclusion and active community participation. The lack of involvement of the local population in decisions affecting their spaces can result in ill-adapted strategies and in the perpetuation of socio-environmental inequalities (Costa; Sakurai, 2021; Lotufo, 2017).

However, although it has been found that the Master Plan has been absent in the definition of guidelines promoting interaction between city and nature, it is shown to be a key instrument for the application of Nature-based Solutions and/or green infrastructure, i.e. solutions that add resilience to urban space. As highlighted in the literature, the SbN could provide guidance to be incorporated into legislation and urban plans (Cortez, 2019).

5 CONCLUSION

It can be concluded that the adoption of the concept of SbN is present in the Brazilian academic universe as a holistic approach to face the challenges arising from the transformations in the urban and natural environment of Brazilian cities. At the same time, from the perspective of the authors studied, it turns out that the relevant thing is to state a position on how to incorporate resilience into the urban environment. In the background is the origin of the solutions or their differences that, in the end, can be applied in accordance with what the problem requires without necessarily having a conceptual alignment, whether of SbN or green infrastructure. From this perspective, Brazilian researchers are more open to the various solutions and about their necessary adaptation to the conditions of our cities than, very often, can be observed on the international scene.

Concerning Brazilian urbanization, there is a recurrent concern with the degradation of ecosystem services due to the lack of urban planning, the suppression of green areas, the soil sealing and the inadequate occupation of permanent preservation zones. The convergence of

studies points to the urgency of rethinking the relationship between cities and their ecosystems, especially in the face of contemporary challenges such as climate change, floods and the scarcity of natural resources.

The solutions indicated include the need to rethink urban design in general, but with an emphasis on urban water management as a priority. The implementation of sustainable drainage strategies, such as LID or SuDs, is emphasized as a way to deal with recurrent flooding and flooding. Still, in this sense, the studies highlight the importance of the integration of architectural design with landscape planning, always involving the community to ensure its preservation and proper use of spaces.

Finally, the discussion about solutions based on nature and green infrastructure demands an interconnection between various fields of knowledge and solutions inserted into public policies, in order to attain the objetive of promoting resilient cities.

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