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Just cities and nature-based solutions in the Global South: A diagnostic approach to move beyond panaceas in Brazil

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ABSTRACT

Within the context of climate change and the quest for more sustainable cities, greener urban solutions are gaining traction through emerging concepts that have been orienting municipalities' regeneration and development agendas, including the so-called nature-based solutions (NbS), which have been discussed, planned, and proposed worldwide by academics, NGOs, and policymakers. Comprising different scales and typologies, NbS makes up a modern toolkit of actions towards decarbonized, climate-resilient, and ecologically healthy cities, claiming ample ecological, social, and economic benefits. A literature analysis indicates a greater presence of research and projects focused on NbS in countries in the Global North than in the South; however, given their accelerated urban growth, lack of green areas, and degradation of local environments, cities of the South urgently need such solutions. Nonetheless, research on the effects of urban greening agendas in the Global North has demonstrated that solutions may be entangled with neoliberal practices of space production that exacerbate inequalities, resulting in harmful social impacts such as displacement of people and increases in land and housing costs. This study seeks to build an anticipatory understanding of practices that articulate NbS in the Global South from a Brazilian viewpoint. Given Brazil's reality of social and environmental injustices, we focus on whether implementing NbS could amplify such problems. Our objective is to contribute to the debate by (1) understanding how the NbS concept is being appropriated, in practice, in Brazil, and (2) reflecting and pointing out paths and recommendations on how to plan NbS through a justice lens.

1. Introduction

The discourse on nature-based solutions (NbS) is gaining ground in meetings, reports from agencies and multilateral organizations (United Nations Environment Programme, 2021; International Union for Conservation of Nature IUCN, 2018; Global Commission on Adaptation, 2019; World Economic Forum, 2019), international NGOs (Local Governments for Sustainability [ICLEI], 2018, 2020), and influential groups of scientists (Intergovernmental science-policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019; Intergovernmental Panel on Climate Change [IPCC], 2019). The widespread, worldwide application of this concept may appear to indicate that it is becoming a generic panacea for socio-environmental problems faced in cities (Haase et al., 2017; Kotsila et al., 2020); however, as Ostrom (2007) notes, there are no universal solutions, and we must "move beyond panaceas." This exploratory study seeks to emphasize that there is no universal solution to all problems, especially those of high complexity.

Our main goal is to help determine how to move towards just cities by understanding how the NbS concept is being appropriated, in practice, in a Global South country: Brazil. We aim to identify pathways and develop recommendations for NbS planning through a justice lens in the Brazilian context. There are many barriers to adopting these strategies in Brazil: lack of large-scale experience, need to improve knowledge base and professional competencies in NbS, and particularities of Brazilian contexts (Marques et al., 2021).

To this end, we examine scholarly literature highlighting important issues with NbS and the practical side-effects of NbS projects (Ali et al., 2020; Cousins, 2021; Tozer et al., 2020; van der Jagt et al., 2021). For mitigation of and adaptation to climate change, NbS needs to be implemented appropriately; for example, for "ambitious reductions in

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all human-caused greenhouse gas emissions," NbS will be more effective when "planned for longevity and not narrowly focused on rapid carbon sequestration" (Pörtner et al., 2021, p.16).

The IPCC AR6 Report (WG II) recognizes and alerts readers to the "unintended consequences" of NBS, in particular, that "it may contribute to gentrification" (IPCC, p.41, 2022). The IPCC also exposes solutions that could lead to "maladaptation," in particular reinforcing inequalities by privileging elites. This is precisely what needs to be avoided, mainly in contexts like Brazil, with an emerging and growing agenda of NbS implementation.

Brazil has high inequality in its cities and, therefore, has the opportunity to address NbS and the problems of inequalities that afflict most of the population. In this context, such an emerging agenda may represent an opportunity to create pathways to be paved by public policies and projects toward just cities in this specific reality of the Global South. We understand that if NbS projects and plans serve only a portion - already privileged - of society, we will have an increase in environmental inequalities, which might generate even more conflicts in the territory. It is noteworthy that approaching this topic from the perspective of the Global South adds complexity to this research as the concept is still nascent in this context (Souza and Torres, 2021; Marques et al., 2021). NbS impacts – such as displacement, privatization of spaces and green areas, and green infrastructure for elite groups – are still unmapped in Brazil (Torres et al., 2021); making this study's diagnostic contribution timely.

Although adopting Brazil as a case may limit the study's potential for replicability, it might inspire an exploratory approach to this research agenda in other countries with their own lineaments. Therefore, this study does not present the best practices or denounce cases of environmental injustices from the implementation of NbS projects. Its specific objective is to contribute to a science–policy dialogue. We believe in cyclical processes in which scientific production can shape political processes and decision-making. Contributing to the Science and Policy dialogue, in the first place, is to admit that this dialogue does not exist a priori. Otherwise, either Science will speak only to its peers, or politics will take its actions only from partisan/ideological convictions and interests. Contributing to and using the best-produced science available can help shape more effective policies (Xavier et al., 2022).

This study presents a three-level contribution to interdisciplinary field of research on NbS, as follows: (1) at global level, it offers reflections from a Global South country (Mabon, Shih, 2021) toward "robust impact evaluation frameworks for nature-based solutions in cities" (Dumitru et al., 2020); (2) at regional level, it addresses the knowledge gap concerning justice and NbS in the Global South by providing insights and empirical material based on a subnational reality; and (3) at local level, it provides specific inputs for a justice lens in the emerging NbS agenda in Brazilian context to include a just lens in present in future projects. To this end, we address the topic at stake by using contemporary diagnostics that should be taken into account by decision-makers, academics, civil society, and NGOs to anticipate the side effects and green privileges related to NbS projects. This work is pertinent given the rapid growth of NbS on the policy agenda and the need to prevent it from becoming a panacea or merely a "green narrative."

The findings indicate an emerging avenue with enormous potential to engage the public policy agenda in the debate on NbS in the Global South. An analysis of the current scenario helps understand the entry of NbS in the Global South as part of a worldwide agenda that does not recognize local specificities. It also helps understand the desirable rise in the nature–society connection (Twohig-Bennett and Jones, 2018; Zhang et al., 2019) that is not reflected in the hegemonic narrative of political and economic elites (Rigolon, 2016), reinforcing green privileges (Park and Pellow, 2011), green gentrification (Anguelovski, Irazábal-Zurita, Connolly, 2019), and other forms of appropriation of space to benefit a few (Torres et al., 2021).

Below, Section 2 discusses the theoretical framework necessary to address NbS through a justice and equity lens in a Global South country. Section 3 describes the methods and materials applied in this survey-based research. Section 4 presents and discusses survey outcomes. Section 5 provides recommendations. Finally, Section 6 provides concluding remarks and directions for future research.

2. Theoretical framework

Greater connection and interaction between society and nature are indispensable for better quality of life in cities. Cities that are better integrated and in balance with local ecosystems through NbS projects might constitute a step toward more resilient, adaptive territories that can better cope with climate change and social challenges (Oke et al., 2021). Recognizing the benefits and limitations of NbS (Pörtner et al., 2021; Seddon et al., 2020) vis-à-vis social justice in the Global South thus leads us to contemplate environmental justice.

Our study engages in dialogue with classic and contemporary environmental justice literature dealing with urban planning and governance (Schlosberg, 2007; Ernstson, 2013; Wolch et al., 2014; Agyeman et al., 2016; Pellow, 2016; Coolsaet, 2020; Travassos et al., 2020; Calderón-Argelich et al., 2021; Travassos and Momm, 2022). Through the lens of justice and equity, it is imperative to consider these problems in the Global South, in terms of questions such as "who would the solution benefit?" and "what are the purpose, method, time, and place of solution implementation?" This is the key to avoiding increasingly unequal environmental privileges, such as access to and benefit from nature and green infrastructure for elites, while others lack basic infrastructure.

Pineda-Pinto et al. (2021) find co-construction, co-design, co-participation, social capital, inclusivity, participatory planning methods, and social-ecological capabilities to be keys to planning and designing NbS through a justice lens. As Calderón-Argelich et al. (2021), p.2) argue, "environmental amenities and greening policies in urban planning are not exempt from trade-offs and potential social and racial inequities in the way new green infrastructure is being deployed." Environmental justice perspective has the potential to make NbS assessments more effective for a better quality of life in that it can influence urban policy and practices for social equity and justice.

Concerning environmental justice and equality, Pineda-Pinto et al. (2021) frame three categories related to contemporary NbS research: 1) "Nature-based solutions are framed and evaluated through an anthropocentric lens"; 2) "Nature-based solutions do not explicitly relate to ecological justice or to its justice dimensions: participation, recognition, distribution, and capabilities"; and 3) "Current research on nature-based solutions recognizes the need for inclusive governance and the need to include justice considerations to planning of and with nature-based solutions in cities"(Pineda-Pinto et al., 2021, p.6). As Souza and Torres (2021) demonstrate, however, empirical work on NbS and dimensions of justice in the Global South is lacking.

Marques et al. (2021) analyzes the applicability of nature-based solutions in the Latin American context (Peru and Brazil). They note the large gap in climate and socioeconomic, environmental, and political realities between the Latin American context and the European context in which NbS was developed, noting in particular that the social factor "hardly finds representation in [European] NbS projects" (p.24). According to the authors, "even though it is still little known in Brazil, with few publications and no direct mention of NbS in documents, plans or national policies, the concept of NbS has gained prominence in recent years'' (Marques, p. 36, 2021) mainly, according to the study, related to water management. In that field, Travassos and Momm (2022) reveal a lack of consideration for dimensions of justice in river revitalization projects, especially the descriptor *favelas/housing* present in these territories. As the authors show, the growth of academic research on this theme has been accompanied by a reduction in studies on precariousness and vulnerability related to urban rivers, building a discourse of river revitalization that gives support to public policies that prioritize upper and upper-middle-class neighborhoods.

An environmental-justice-oriented policy approach might empower local communities in the co-production of NbS to create greener and more just cities. To plan NbS at local level through a justice lens that empowers communities, Pineda-Pinto et al. (2021) finds co-construction, co-design and co-participation, social capital, inclusivity, participatory planning methods, and social-ecological capabilities to be the key. Regarding NbS projects in the context of the Global South, this argument seems fundamental since it would contribute to greater involvement of the social actors, and to the creation of projects and plans that meet aspirations and demands at the local and community level. In this way, a space for the production of NbS is opened at the community and non-state levels, contributing to new and more just pathways to creating more sustainable cities. This point remains critical in NbS plans and projects in Brazil, as unpacked in the next sections and indicated in the literature that analyzes the implementation of these infrastructures in the country, save for rare exceptions.

Co-design is vital in NbS projects (IUCN, 2018; Frantzeskaki, 2019; Mahmoud et al., 2021), but requires going beyond formal strictures or business-as-usual. Calderón-Argelich et al. (2021) propose three guidelines to go beyond business-as-usual planning for such contexts: 1) incorporating environmental justice considerations with clear operational definitions; 2) incorporating "new methodologies and intersectoral collaboration"; and 3) considering "trade-offs, conflicts, and deep inequalities across different dimensions of justice and ecosystem services" (Calderón-Argelich et al., 2021., p.11). The third guideline in particular will be a challenge for Brazil.

The objectives for researchers formulated here are twofold: (1) to recognize the lessons learned from other contexts and (2) reflect on the construction of a mutual South–North dialog. This is because the production of critical analysis, lessons, and recommendations on the deployment of NbS projects is significantly greater for illustrative cases in the North (Calderón-Argelich et al., 2021; Frantzeskaki et al., 2020; Ignatieva et al., 2020; Souza and Torres, 2021; van der Jagt et al., 2021). Nevertheless, these lessons are crucial starting points for reflective practice in the South (Frantzeskaki, 2019). However, this study's objective is not to test whether the lessons and recommendations related to the North would apply to the South, but to test how lessons for the South can be established by learning from the differences and reorienting the policies and recommendations considered universal. Furthermore, the works that have critically stimulated a more careful consideration of the composing of global hegemonic agendas and narratives in the Global North enable establishing connections between NbS and justice. Thus, providing an important instrumental framework, not to be simply imported to the South's reality, but to critically reflect on key elements and particularities to devise recommendations on how to deploy NbS through a justice lens.

Therefore, the following section describes a procedure aligned with the three dimensions of justice (Schlosberg, 2013), present in most approaches for environmental justice, connected to NbS projects (Walker, 2012; Urkidi and Walter, 2011; Anguelovski et al., 2020; Coolsaet, 2020; Enssle and Kabisch, 2020), namely: procedural justice (PJ), recognition justice (RJ), and distributive justice (DJ). According to Schlosberg (2013), *Procedural justice* is characterized by the various aspects of participation processes. For this study, it is connected to the level and form of societies in decision-making processes in the design and implementation of urban green areas, and the extent to which NbS projects provide space for citizen input. *Recognition justice*, in turn, acknowledges the different values, needs, and preferences related to the identity and characteristics of a given social group, according to gender, race, age, and ethnicity (Schlosberg, 2013). Finally, *distributive justice* (Schlosberg, 2013) deals with the extent to which the implementation of green areas in cities is done equitably and the extent to which marginalized communities in situations of socio-environmental vulnerability are prioritized (or not) in the process.

Fig. 1 graphically illustrates these dimensions for the analysis carried out in this study. To avoid unintended social effects, and to plan NbS through a justice lens in this Southern context, we argue that these three dimensions of justice need to be articulated, to prevent green gentrification and maladaptive responses (IPCC, 2022) triggered by the creation of a green amenity or green renewal in an urban area that which results in changes in the income and demographic patterns of the neighborhood residents – namely, richening and whitening – due to increased land prices and cost of living (Gould and Lewis, 2012). Green gentrification is a territorial process that occurs when green luxury resilient buildings or condominiums, greenwash projects, privatization, or restored shorelines, cause displacement, removal, and economic and cultural changes in a neighborhood (Anguelovski, Irazábal-Zurita, Connolly, 2019; Torres et al., 2021). It need not always be luxurious. For example, in a context of low presence and distribution of green areas, if the process does not safeguard the price of land, it could also cause gentrification.

All three dimensions of justice, as well as actions aimed at avoiding green gentrification processes, structure the recommendations presented in this study. We carry out the integration between the theoretical background and the research results, generating a set of recommendations that articulate theory and practice, to demonstrate particular interrelations of NbS design, planning, and governance toward just city transitions. The justice dimensions contemplate considerations that can be understood as more universal, while the results obtained from the analysis of local practices add site-specific nuances. Fig. 1 represents the proposed framework, derived from the literature review, that will guide the recommendations, addressing structural aspects such as geopolitics and disparities between countries (especially in financing the transition). Considering local practices and governance makes it possible to articulate recommendations at the NbS implementation scale. Next are the processes for the elaboration of projects and instruments, based on which NbS initiatives can be developed that reflect the dimensions of justice to promote Just City and NbS projects in line with environmental justice concerns.

3. Material and methods

The study was conducted in five interlinked steps (see Fig. 2). First, a questionnaire was prepared based on the key NbS elements proposed by Frantzeskaki (2019), Haase et al. (2017), Kabisch et al. (2016), and Anguelovski et al. (2020), related to the dimensions of justice as well as green gentrification processes. The questionnaire was administered to practitioners from local Brazilian municipalities selected for experience with application of NbS solutions. All respondents were already involved in NbS in Brazil, which was an inclusion criterion.

The questionnaire comprised 14 questions. Six were open-ended and allowed the assessment of respondents' perceptions and level of knowledge about the topic. These questions sought to diagnose the stage of development of the NbS concept among practitioners, how they understood the concept, what references they used in their practice, and what concrete examples, if any, they could share. The practitioners were asked to elaborate NbS concepts from their own context, and to relate how they had already dealt with NbS in practice in their respective municipalities. The remaining eight questions were multiple-choice, aimed at understanding how the dimensions of justice (as explained in the theoretical section) are related to and could be integrated into NbS design and implementation.

The data thus reflect what practitioners from each municipality understand NbS is or could be. They were not asked about NbS concepts or ideas but how they had already dealt with NbS in their respective municipalities. In the second step, the survey was administered, from

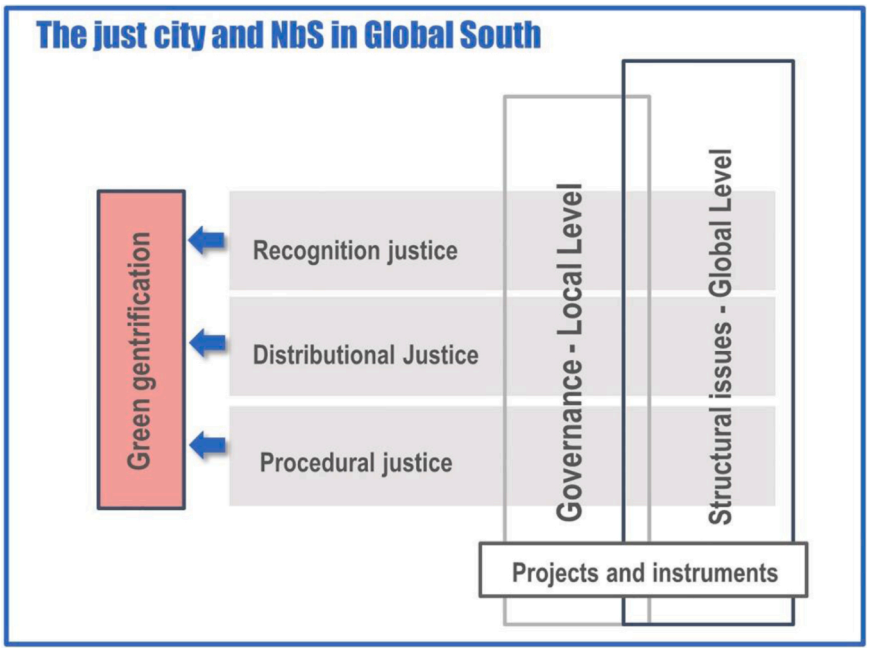

Fig. 1. Structural analysis for recommendations from the theoretical framework.

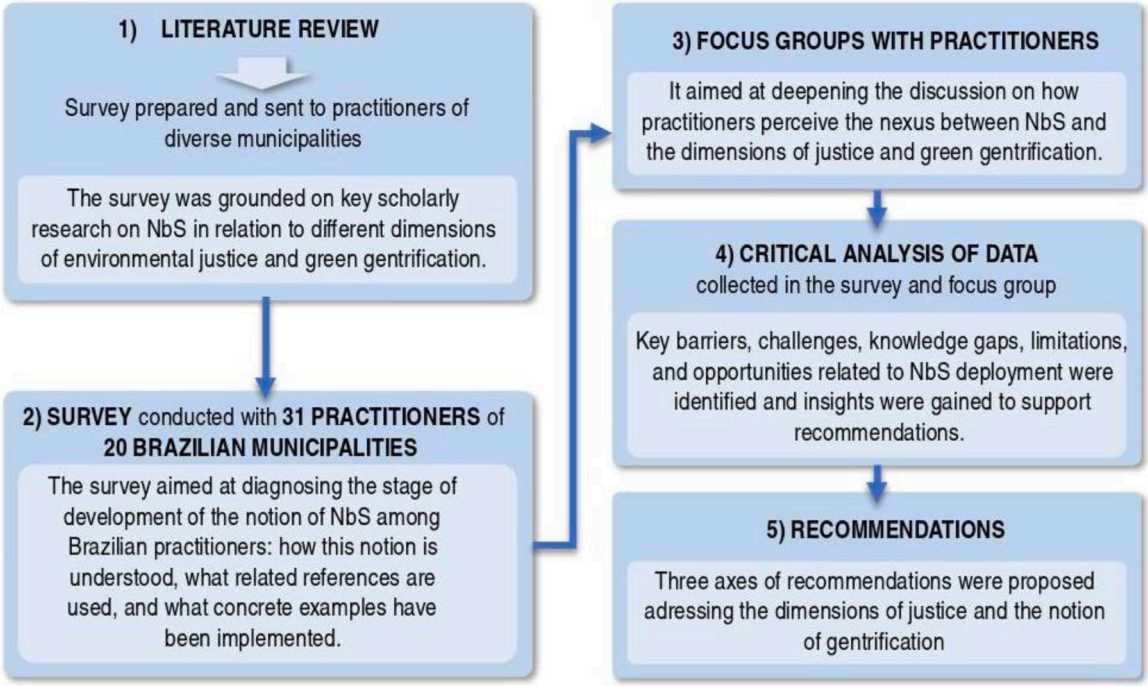

Fig. 2. Methodological steps.

November 9–27, 2020, to 31 practitioners from 20 municipalities[1] across Brazil. Most of the surveyed municipalities are members of the ICLEI - Local Governments for Sustainability, which facilitated access to the respondents. However, it is important to highlight that the city being part of a network like ICLEI does not mean that its practitioners are from ICLEI or reproduce the institutional arguments of the institution. They continue to be practitioners linked to the municipalities and answer to their respective line managers in the local government structure.

ICLEI had a role in presenting the concept to local governments in Brazil. However, as it is a broad approach, where various measures and actions can be planned and implemented, according to reality, context, and local needs, it presents itself as a possibility, without specifically defining what should be done where. It brings examples of cities, lessons learned, and general guidelines for step-by-step planning and implementation, in a broad way and adaptable to different contexts. Most of

[1] The cities are: Nova Iguaçu (RJ), Boituva (SP), Campinas (SP), Rio de Janeiro (RJ), Sorocaba (SP), Suzano (SP), São Paulo (SP), Santo André (SP), Mogi das Cruzes (SP), Niterói (RJ), Ribeirão Pires (SP), Belo Horizonte (MG) São Leopoldo (RS), Joinville (SC), Lindóia do Sul (SC), Curitiba (PR), Porto Alegre (RS) Fortaleza (CE) Macapa (AP) Cuiabá (MT).

this content is made available to actors beyond the ICLEI network, for example through events, webinars, and materials on the institutional website and specific projects. ICLEI may have started this process with cities in the Brazilian context, however always in a collaborative way with other institutions that also have this view that SbNs can present more integrated possibilities for solving challenges.[2]

On December 21, 2020, after the survey was completed, a focus group discussion was conducted with one practitioner from each Brazilian region. The objective was to present key survey outcomes, explore responses in-depth, check the existence of possible regional disparities along responses, and collect further practical examples.

In the third step, the survey and focus group data were critically analyzed to identify the main barriers, challenges, gaps, and limitations as well as the opportunities raised by the deployment of NbS in Brazilian municipalities. Respondents represented large, medium, and small municipalities in all five regions of Brazil, albeit with greater concentration in the southeast. However, the sample is merely illustrative of a large, complex, multicultural, and heterogeneous country, and the results are not intended to be a full representation.

Although including more southeastern municipalities (see Section 4) could result in bias, the survey data are meant to be empirically representative not necessarily of the national reality, but of municipalities already influenced by the NbS agenda. In the Brazilian federative structure, the 5570 municipalities in 26 states and the federal district manage land use and occupation, and often have low technical and institutional capacity, restricting their intervention capacity.

Fig. 2 summarizes the methodological steps applied in this study.

4. Results and discussion

Of the 31 respondents, 59.38% were women, 37.50% were men, and 3.23% were non-binary. About 40% (n = 13) had 20 or more years of experience as a practitioner at municipal level, seven had been working for five years or more, three for more than 30 years, and only two for less than a year.

Most of the respondents were from Brazil's southeast region due to the strong ICLEI partner network, the authors' connections, and the requirement that projects be NbS related in this region. The southeast region of Brazil is the richest region, with the most significant institutional capacity. But it is also a region of inequalities, with a lack of infrastructure (e.g., sewage, housing, water), criminality, poverty, and vulnerability. It is also important to note that most NbS projects are located in this region. Outside the southeast, examples were collected from the northeast (Fortaleza), north (Macapa), center-west (Cuiaba), and south regions.

Regarding the respondents' source of knowledge about NbS, academia was the most cited place (28.57%), followed by articles or books (22%), external courses (10%), or partnerships with NGOs (10%). The open responses on what the participants understood about NbS were heterogeneous but showed a tendency to comprehend it as an applied policy deriving its primary definition from the IUCN. Another recurring feature was the association of NbS with actions that seek to offer solutions using sustainable practices. Sometimes, generic words such as "in the same way that nature would do," "planning guidelines based on what is found in nature," or "adopt measures in cities based on respect for nature," were used by the respondents to define NbS. This seems to be aligned with the European Commission's description of NbS as a "successfully tested tool protecting and enhancing nature and natural processes, and the many benefits human society gains from nature, through its conscious integration into spatial planning and territorial development" (EC, 2013).

Overall, practitioners seem to have more biocentric values in their understanding of NbS, rather than infrastructure, urbanism, engineering, or social focus. Specific themes often mentioned included reforestation, in terms of focus, the theme of reforestation was often connected to NbS. Which reinforces this understanding of a more biocentric/ecological value. The idea of innovative solutions also came up frequently in the responses, as did climate change. Fig. 3 represents the respondents' understanding of NbS; the word cloud shows that "solutions" and "restore" were the most-cited words, demonstrating a more technical and solution-driven than social aspect–driven understanding of the concept.

Asked if they could mention a municipal NbS project, 18 of the 31 respondents were able to identify a project typology but unable to name individual projects. The following types were mentioned: a) reforestation for a hydrographic basin recovery; b) rain garden; c) park implementation with reforestation; d) linear park; e) remediation of contaminated toxic areas; f) park roads built in an "ecological way"; and, g) planting trees to combat heat islands. This result indicates the practitioners' difficulty calling up examples of concrete NbS projects already installed in the cities.

Concerning finance, the practitioners were asked, "What are the main financing mechanisms that could promote more projects, programs, and works for nature-based solutions?" Most chose the Municipal Environmental Fund (38%), followed by public–private partnerships (26%) and parliamentary allotments (10%, individual congressman quota). Other financing mechanisms cited by the respondents included the State Environmental Conservation Fund, State Water Resources Fund (Basin Committees – Guandu and Guanabara), Global Environment Facility (GEF), and municipal budgets.

Regarding the relationship with climate change, 70% stated that the NbS project they knew was meant to address it, 20% answered it was not, and 10% reported they did not see a correlation; this shows this topic has some presence in city planning or the discourse of city planners. To the question "Does the master plan of the municipality in which you work define typologies for a nature-based solution?" all respondents answered that it did not. Some respondents indicated other planning instruments but not the master plan; however, none of these plans mentioned NbS. This result suggests that NbS is still an emergent or embryonic concept in the environmental policy agenda of Brazilian cities. It also indicates that the concept is still embryonic and not yet foreseen in policy and territorial planning instruments, such as the master plan. When asked about NbS locations, a question aimed at ascertaining a possible uneven distribution in the region, more than half (18) answered that they were not aware of any NbS projects in peripheral regions, slums, or neighborhoods with a green area deficit; six out of the 31 were able to name projects with community participation.

When asked if it was possible to identify unwanted social and/or environmental impacts resulting from implementing any NbS project(s), 60% answered "no", while 10% answered "yes" and 30% chose "not sure." As a follow-up question, the respondents were asked, "If so, which of the impacts listed below represent the side effect that you are aware of?" "Conflicts with the local community" was the most common answer (36.36%), followed by "gentrification of the surroundings" (9.09%), "rising land prices" (9.09%), and "displacement of families" (9.09%). Some respondents also indicated aspects other than the options mentioned above; for instance, improvements in housing conditions

[2] One example was the construction of the Brazilian Catalog of SbNs, which was prepared jointly with the CGEE/MCTI, through the GEF CitInova Project: https://catalogo-sbn-oics.cgee.org.br/ Which seeks to present a broad perspective and approaches to territorial dynamics, and socioeconomic and environmental challenges, in order to find the most appropriate solutions for each context and need. As well as the creation of the Urban Biconnection Alliance, which is a partnership of different institutions that operate in the Brazilian context around this agenda: http://www.fundacaogrupoboticario.org.br/pt/acontece-por-aqui/Paginas/organizacoes -come together-to-stimulate-the-use-of-nature-based-solutions-in-brazil.aspx Recently, WRI Brasil launched the SbN Accelerator for cities and also carried out a broad process of building the concept and operation of the initiative, as well as selecting the cities that will benefit: https://www.wribrasil.org.br/ projects/accelerator-of-nature-based-solutions-in-cities

Fig. 3. Keywords representing respondents' understanding of NbS

were verified along with projects where there was involuntary resettlement. Also, respondents pointed out that with recovery in specific areas, there was an increase in real estate prices that benefited everyone, and gentrification was less intense. Another point raised was regarding the difficulty of maintaining the new green areas. These findings are in line with those reported by Gadda et al. (2019) for the Brazilian case; however, this study novelty confirms that NbS in their cities did not have "developing a Just City" as an explicit goal, nor did it seek to immediately address the contribution of environmental or green programs to inequality among people.

To explore thoughts that could contribute more specifically to recommendations, respondents were asked, "What actions/mechanisms could prevent the negative impacts/side-effects of nature-based solutions?" "Promotion of collaborative governance (involving multiple actors)" was the most common answer (28%), followed by "local community involvement from the design phase of the proposal to its implementation" (22%), "a better integration of technical, local, and traditional knowledge in the development of projects/programs" (18%), "initiate the project/program based on demand from the community" (17%), and "involvement of multiple actors (even with contrasting views) in a project development collaborative process" (12%).

The survey results highlight that NbS is an emerging issue in the environmental policy agenda for Brazilian cities. They also confirm that the concept is still embryonic and not yet foreseen in policy and territorial planning instruments, such as the master plan. Additionally, the findings show that themes linked to the climate change agenda, such as re-florations projects and water management, have some presence in the city planning or discourse of city planners.

An environmental justice lens contributes to these questions, as pointed out by Anguelovski et al., (2019, p.49), because "environmental inequalities exist not only in the distribution of environmental bads in the extraction of natural resources but also in the allocation of environmental goods and services, which is particularly manifest in cities." Depending on how NbS is applied in cities, it can reinforce privilege differentials in accessing nature's benefits. For example, if a local government chooses to invest in parks, green areas, rain gardens, or linear parks in regions where such facilities already exist, or chooses to offer more significant provisions of such infrastructure, to the detriment of the most disadvantaged areas, the social side effect that must be avoided is instead reinforced.

Here, we wish to approach methods for environmental justice by questioning the maintenance of such special privileges. The question is "NbS: for whom, when, where, why, and how?" As noted, few responses mentioned NbS projects were mentioned in slum areas, peripheries, or areas lacking access to the benefits of nature. In this regard, the respondents highlighted the importance of considering the development of NbS based on the demands of marginalized groups with little access to green areas, despite often living near them. It is a distinguishing feature of Brazil, and of other countries in the Global South, that living close to green areas, green infrastructure, or nature does not necessarily imply access to or full benefits from it, given enclosures or use restrictions.

In such a situation, it is interesting to note the responses to the question: "What actions/mechanisms could prevent the negative impacts/side-effects of nature-based solutions?" "Promotion of collaborative governance (involving multiple actors)" was the most common answer (28%), followed by "local community involvement from the design phase of the proposal to its implementation" (22%), "a better integration of technical, local, and traditional knowledge in the development of projects/programs" (18%), "initiate the project/program based on demand from the community" (17%), and "involvement of multiple actors (even with contrasting views) in a project development collaborative process" (12%). These results highlight the importance of a co-design approach to deploy NbS projects in the country.

The results also indicate the practitioners' difficulty exemplifying concrete NbS projects already installed in the cities. The problems relate to co-design, a basic principle introduced, for example, by the IUCN recommendations, or to lesson "d" in Frantzeskaki (2019) work, which states that "co-creation of nature-based solutions requires diversity and learning from social innovation." In that light, the challenge of co-design may be associated with a reduction in society's interaction and participation channels in recent years, which enables the government's elitist orientation in the distribution of green amenities in cities. As the literature review showed, only with a change in the status quo and inversion of priorities can this space-production paradigm be altered.

The "policy needs to implement nature-based solutions" presented by Frantzeskaki et al. (2020) are reinforced by Mahmoud and Morello (2021) for the importance of citizen engagement and social innovation methodologies in the co-design and co-implementation of nature-based solutions. However, the same authors also point out barriers: "[…] embedding co-creation into decision-making routines is still a challenge and requires to overcome practical obstacles, among others: breaking siloes in decision-making procedures, managing the costs of continuous day-to-day activity of back-and-forth dialogue between owners, authorities, and stakeholders, which is demanding in terms of effort, time and money". (Mahmoud and Morello, 2021, p.273).

Reflecting on Frantzeskaki (2019) recommendations, how will NbS be "aesthetically appealing to citizens" if citizens do not participate in the process or are dismissed from it? Additionally, does the initiative exist simply to perpetuate inequalities and green privilege? Likewise, it will be difficult to practice "trust in the local government" or "collaborative governance." Therefore, active citizenship is important, and these themes are addressed across regions, along with the recommendation that NbS "create new green urban commons" (Frantzeskaki, 2019; Cousins, 2021). Non-state practices, such as community gardens, have

been mentioned in the literature review as remarkable innovation spaces for heterogeneous groups and as a way to address social issues in Brazilian cities (Costa and Sakurai, 2021), but did not appear in the practitioners' responses.

5. Recommendations - NBS: An emerging concept and its challenges for a "Just City"

In this section, we present three major recommendations for the Brazilian context that should be considered in an integrated package of planning and actions. These are based on the three dimensions of justice referred to in the literature review – procedural justice, recognition justice, and distributive justice – and on the need to avoid green gentrification (GG) (Table 1).

To tackle environmental injustice issues resulting from the deployment of NbS in the Global South, several aspects need to be addressed: (i) macro issues related to institutional structure and financing models, (ii) issues related to planning/governance approaches, (iii) techniques and legal instruments, and (iv) issues related to participatory planning processes and multi-actor governance. The recommendations were developed based on the theoretical framework, the results of the survey, and a focus group with the practitioners. For the first block of recommendations, the main inputs came from the literature review regarding the differences between North and South and topics related to environmental justice. The second block of recommendations takes into account the perceptions of the practitioners on the instruments and projects that can address NbS considering the realities of Brazilian municipalities, especially discussed in the focus group stage. The third recommendation includes the practitioners' emphasis on the importance of an inclusive approach to designing and implementing NbS projects where participatory arenas and multi-actor governance are prioritized.

A limitation is that regular citizens were not included as participants in the study. As this is exploratory research to validate the implementation of the emerging NbS agenda, the focus was on diagnosing the current understanding and application of NbS projects in Brazil to anticipate undesirable outcomes.(Fig. 4).

5.1. Recommendation 1: Global and local articulation to tackle structural and financial issues

The first cluster of recommendations deals with the structural and financial issues faced by countries in the Global South that impact the development of NbS. These issues are directly linked to the neoliberal turn in government, including in Brazil, which has reduced budgets and public capacities (Zimmermann and Momm, 2022). Considering the evidence from the survey and the focus group, and despite the recognition of the benefits of NbS, its implementation is still hindered in many ways. In Brazil, the neoliberal turns aggravated inequality and led to a "ceiling" for public spending despite the country's need for large public investments in infrastructure, especially in the most impoverished areas of cities.

The Brazilian proposal for the implementation of the federal public spending ceiling, a Constitutional Amendment Proposal, was approved on December 16, 2016, which prevents public sector investments - even in social or environmental areas - from a predetermined ceiling (Mariano, 2017). The result of this in several areas has been worrying, mainly in themes such as health and education, as well as in the environmental area. In the environmental area, it should also be noted that Brazil has gone through a declared process of dismantling environmental policies and spaces for civil society participation. The dismantling process has already been the subject of several surveys, mappings, and studies that verified the scrapping of inspection, planning, and environmental management institutions (Barbosa, 2021). As well as the country's geopolitical isolation in key issues of environmental climate negotiations. There is an expectation - which needs to be confirmed that with the change of government in 2023, the country will once again seek

Table 1
Matrix of actions and mechanisms to articulate each set of recommendations and connections with dimensions of justice related to NbS projects (PJ: Procedural Justice; RJ: Recognition Justice; DJ: Distributive Justice; GG: Green Gentrification).

Recommendations		Dimensions			
		PJ	DJ	RJ	GG
1: Global and local articulation to tackle structural and financing issues	1.1 Creation of and increase in funding and international cooperation focused on local implementation				
	1.2 Creation and maintenance of policies and programs for reducing inequalities and vulnerabilities (e.g., housing, education, health, disasters) and gaining recognition (e.g., racial, ethnic, gender, ways of life)				
	1.3 Creation and better management of funds aimed at environmental conservation and improvement and construction of analysis parameters that lead to a transition to NbS				
	1.4 Construction of development programs at different levels, within governments, and through public consortia—multilevel, polycentric, and collaborative governance				
2: Transparency and inclusion in the design and implementation of instruments for environmental justice	2.1 Adoption of coercive and inductive regulation instruments to guarantee land use control and environmental and cultural protection (e.g., indigenous lands)				
	2.2 Adoption of economic and stimulus instruments associated with environmental protection and improvement				
	2.3 Territorial prioritization of the most vulnerable and susceptible areas, strategic zoning, focus on more macro action at the political level, decision-making				
	2.4 Promotion of joint effort support program and collective initiatives (e.g., environmental education, conservation of native seeds and species program, including research on its usage to NbS as well as a focus on regions, biomes, cultural characteristics)				
	2.5 Definition of budget and rubrics aimed at the implementation and maintenance of green areas and other NbS initiatives				
	2.6 Elaboration of projects to raise financial resources				
3: Participatory processes, inclusion, and multi-actor governance in the development and implementation of	3.1 Qualifying existing and new participatory arenas by integrating dialogic practices and social learning processes to co-design NbS projects				

(*continued on next page*)

Table 1 (*continued*)

Recommendations		Dimensions			
		PJ	DJ	RJ	GG
NbS projects toward environmental justice	3.2 Using mechanisms to ensure maximum representation of the local population in the collaborative processes of NbS projects 3.3 Training of technicians to conduct collaborative NbS projects within socially and environmentally vulnerable communities and traditional population 3.4 Including diverse participatory methodologies suitable for various participant profiles throughout the different phases of the NbS project 3.5 Building partnerships with the local community at the design and conception phase of NbS project to achieve internal community cohesiveness to develop collaborative processes 3.6 Identifying demands, local community-specific needs, and practices to guide NbS proposition 3.7 Including participatory processes involving the local community in the implementation and maintenance of NbS projects				

some kind of protagonist in the environmental area, especially one that is aligned with scientific knowledge and not denialism (Tollefson, 2022).

Parallel with the neoliberal turn, the current president Bolsonaro government (2019–2022) has been aiming to develop flexible laws and rules in the environmental system, ostensibly to balance advantages like trade with detriments like deforestation. However, there is pressure from both the environmental movement and green economy actors, such as international funds, to question measures that result in worsening environmental conditions (Momm et al., 2020).

Against such a backdrop, it is essential to consider the geopolitical relations between regions, countries, and international agencies that provide lines of financing and cooperation for countries in the Global South, focusing on the development of NbS projects. For NbS projects unrelated to the federal government, where local government can have access and autonomy, financing structures tied up at the national level can create barriers and lead to dependence on international political agreements (see Table 1, action 1.1). At the national level, to tackle structural inequalities, it is essential to create and maintain policies and programs to reduce vulnerabilities (e.g. climate change adaptation, housing, education, health, wellbeing, disasters) and to recognize the differences between social groups (e.g. first nations/indigenous status, race, ethnicity, gender, ways of life) (see action 1.2). Thus, the interrelation between the development of NbS and such issues assumes a central position. The implementation of specific guidelines for NbS is necessary to build development programs that address environmental justice at different levels. This will involve the consideration of specifics of the context, attention to project design, implementation, maintenance and monitoring, and incorporating lessons learned from other experiences and contexts. In addition, these guidelines need to follow a practical and applicable logic (see action 1.4). Aiming to improve resource availability and financial flows, it is important to establish mechanisms under existing or new funds, that are oriented to environmental conservation aligned with human well-being, with clear parameters and guidelines (see action 1.3).

5.2. Recommendation 2: Transparency and inclusion in the design and implementation of instruments for environmental justice

The second cluster of recommendations involves implementing or creating planning instruments at the local level to help the reach of NbS through a clear environmental justice lens. This is linked with distributive justice, specifically control and use of land, and procedural justice, in particular intersectoral articulation, participation and interaction within the public sector, and monitoring processes that also develop local capabilities. Especially in Brazil, it involves a context marked by strong sectorial bias in the elaboration of projects. For example, in terms of water-related projects, there is still a tendency to follow a late 20th-century engineering approach, despite the existence of more environmentally integrated approaches and techniques. It takes place through

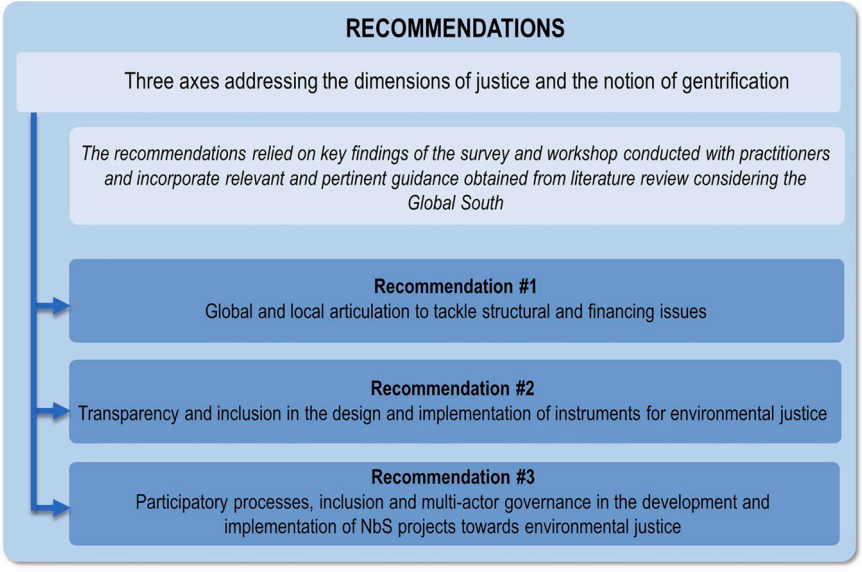

Fig. 4. Recommendations.

technical conservatism marked by the use of gray infrastructure instead of green and blue ones. Nevertheless, in the Brazilian case, the public sector institutional and normative framework is not favorable to innovation, whether as an executor or contractor of projects. The socio-technical networks, and a lack of technology, materials, equipment, and labor for the execution of projects, make it difficult to propose innovations, especially in small and medium-sized municipalities. Overall, the scale of Brazilian public policies in urban and environmental planning is marked by the prioritization of metropolises and large cities, neglecting the agenda and needs of the vast majority of small municipalities.

In addition, there is a lack of proposals and instruments to guarantee environmental protection, assure municipalities of financial resources, and integrate environmental demands into urban planning tools and formal processes. The municipalities' financial situation is critical, but priorities are constantly made concerning the municipal budget. Intersectoral projects can be reinforced with urban planning tools—a large part of the implementation will not be via secretariats for the environment due to the various issues that have to be addressed. Thus, it is necessary to advance command-and-control and inductive tools; transference of rights to build in protected areas, such as the creation of special zones of social and environmental interest and urban legal reserves; and imposition of territorial taxes, fees, and environmental licenses to fund these efforts (see action 2.1). Coercive and inductive tools are historically limited in effectiveness; instead, economic and stimulus tools and participative processes are necessary. One such tool that has been implemented in some regions is "Payment for Environmental Services," but others still need to be explored and applied, such as the creation of funds, cross-subsidies, environmental/social quality stamps, mechanisms for recovering land rents associated with environmental improvements (urban added value), differentiation between neighboring landowners and speculators (e.g., using the project's publication date, property values, and fees), private adoption, and concession of green areas (with joint structuring of central and peripheral regions) for maintenance and improvements (without losing public ownership and access) (see action 2.2).

To introduce, complement, and orientate instruments for environmental justice, prioritization of programs and projects by region is essential. The most vulnerable areas must be focused on, which will require macro-action at the national political level (see action 2.3).

In addition, supporting efforts and initiatives that consider NbS, promoting environmental education and programs to conserve seeds and native species, and fostering research about their usage, are recommended (see action 2.4). It is necessary to guarantee resources for the implementation of these tools by defining budgets for the implementation and maintenance of green areas, with processes that also develop local capabilities (see action 2.5). Additionally, it will be important to raise financial resources nationally and internationally. In terms of public expenditure, the budget must be related to specific programs and projects to break sectoral logic (see action 2.6).

5.3. Recommendation 3: Participatory processes, inclusion, and multi-actor governance in the development and implementation of NbS projects toward environmental justice.

The third cluster of recommendations addresses the different conditions for participation among the various actors involved in a NbS project and its impact on environmental justice. Stakeholders with greater economic power and political influence, most often aligned with hegemonic economic narratives and rationalist views of nature (Anguelovski et al., 2019; Safransky, 2014), strive to uphold the status quo while occupying privileged positions in decision-making forums. Bulding alternative views, and fostering local practices, and actions focused on overcoming inequalities from the perspective of the emancipation of marginalized communities through NbS projects are important. When participatory arenas do not recognize that the implementation of the urban green agenda is a disputed territory, as in the context of the deep socioeconomic disparities that characterize many cities in the Global South, it becomes difficult to advance environmental justice, since it is possible to reproduce the concentration of investments that configure urban policies.

Although public participation in the development of specific urban projects in Brazil is a legal obligation, the limitations of these arenas are noticeable in terms of their representativeness: the tools used to ensure equitable participation and the capacity to embrace social differences, promote collective knowledge, and co-designed solutions. In the multicultural Brazilian context, the coexistence of highly distinct social groups in the development of local NbS projects and their different agendas and worldviews need to be addressed through organized participatory processes to avoid tensions. Therefore, dialogic processes and social learning practices (which take advantage of mediated conflict and diversity as driving forces to create sustainable and environmentally fair solutions) stand as pathways for the implementation of participatory forums to build on NbS projects (see actions 3.1, 3.2).

In particular, the involvement of socially and environmentally vulnerable communities in NbS planning requires technicians and social mediators qualified in communicating and translating complex and difficult-to-understand ideas to target groups. A repertoire of diverse participatory methodologies (e.g. dialogue circles, focus groups discussion, role-play, world cafe) could be implemented to promote engagement and dialogue to explore collective solutions that meet benchmarks for participatory and recognition justice (see actions 3.3, 3.4).

Other crucial elements to consider in Brazilian and similar southern contexts include the frequently high crime rates among vulnerable populations, as well as the lack of services, basic infrastructure, distrust of government, disputes among local leaders, and rights to the city. These issues may lead to challenges in building cohesive collaboration between local communities and the public sector in the planning and implementation of NbS projects (see action 3.5). An additional cornerstone in ensuring recognition of justice is to acknowledge existing community practices (such as community garden spaces), consider cultural values, and pay heed to local demands, providing mottoes and strategies to guide the NbS program to reflect local identity (see action 3.6).

Finally, community participation must be ensured during the conception phase of the NbS, increasing local ownership of the project (see action 3.7). Business-as-usual planning opens up participation and interaction with the community only after the conception and design phases are concluded; however, it is challenging to overcome institutional and technical barriers to establish a genuine participatory process. According to the survey responses and focus group in our study, government representatives lack specific knowledge regarding social learning and co-creation possibilities, and due to workload or even political priorities have constrained capacity to foster the involvement of different stakeholders – even from other departments, but especially from local communities. Addressing this situation seems to be required to open better venues for the public to reveal their demands and needs.

Table 1 synthesizes the main actions and mechanisms for the implementation of the recommendations and connects the three blocks of recommendations and the three dimensions of justice to avoid green gentrification (Fig. 1).

6. Conclusion

This study contributes to reducing the knowledge gap on the current context of NbS in Brazil and the Global South and supports the need to bring environmental justice and inequalities into this discussion. The main objective was to assess the target context from the perspective of policy–science interface, aiming to anticipate the side effects of NbS projects which could reinforce green privilege in the country. To this end, a survey was applied in several Brazilian municipalities to draw a diagnostic approach for NbS in the country, so as to make recommendations for decision-makers to develop strategies aimed at greening cities and tackling environmental injustice simultaneously. Overall, the

results reinforce the importance of local implementation and the need for participatory redefinition. A limitation of this research is that regular citizens were not included as participants; however, as this was exploratory research to verify the implementation of the emerging NbS agenda, the focus was on diagnosing the current understanding and application of NbS projects in Brazil and anticipating undesirable outcomes.

An important finding of this study is that, while the concept of NbS is spreading in cities and communities of different scales worldwide, implementation projects are still scarce in Brazil. Additionally, despite the high level of green privilege and environmental inequalities in the country, recognition of the need to include justice dimensions in NbS projects remains distant, according to the practitioners.

The identification of key topics and elaboration of recommendations are important steps in overcoming the traditional planning process in NbS design. This study has proposed three blocks of recommendations. The first block of recommendations addressed global and local conditions to tackle structural and financing issues of countries in the Global South that impact the development of NbS. The second block took into account the perceptions of practitioners on the instruments and projects that can address NbS considering the realities of Brazilian municipalities, especially as discussed in the focus group stage. The third block included the practitioners' emphasis on the importance of an inclusive approach to designing and implementing NbS projects, where participatory arenas and multi-actor governance are prioritized. In line with the last block, a radical planning process that involves citizens and communities right from the conception and design phase seems to be crucial for breaking this traditional planning process and guaranteeing that a key guideline for NbS, co-design, is followed.

Finally, the findings obtained from the literature review, the survey and focus group results, and the recommendations are intended to contribute to further research in the Global South on the design and implementation of NbS, in particular, to its benefits and contradictions, in two main directions. The first concerns the definition of the central, mandatory analytical elements for the evaluation of the interventions, to configure a research agenda that will not consider only the formal and functional aspects of NbS, but also socioeconomic and political aspects. The second is related to providing resources for the construction of just alternatives of NbS for Brazilian cities, in terms of the dimension discussed here. The Brazilian case represents an essential contribution to the discussion in the context of South–North dialogue regarding NbS, and may be replicated in other countries with similar social inequalities and vulnerabilities, for example in Latin America, Africa, and Asia.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

No data was used for the research described in the article.

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