THE EMERGENCE OF NATURE-BASED SOLUTIONS IN LATIN AMERICAN URBAN POLICIES: A CRITICAL REVIEW

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1. Introduction

Today, 55% of the world's population lives in urban areas, a figure projected to reach 68% by 2050 (UN DESA, 2018). As urbanization accelerates, cities must become more sustainable and resilient to ensure a good quality of life while meeting population and environmental needs (Lafortezza et al., 2018). Urban ecosystems are fragile and complex, shaped by diverse socio-environmental dynamics that demand conservation, restoration, and sustainable landscape design (Toxopeus et al., 2020; Tozer et al., 2020). Contemporary urban challenges have become "wicked" problems, emerging from the confluence of cultures, perspectives on nature, and competing spatial interests (Newman & Head, 2017). Nature-based solutions (NbS) offer an integrated approach to protect and enhance ecosystems and nature-society connections, fostering sustainable and resilient cities (McEvoy, 2024).

Latin America is the world's most urbanized region, with more than 80% of its population living in cities (UN-Habitat, 2012). Rapid urban expansion in recent decades has pushed cities beyond their administrative and technical boundaries (UN-Habitat, 2012). Urban areas in this region are also recognized as hotspots of vulnerability to floods, heat waves, and other hazards that climate change is expected to aggravate (Reyer et al., 2017). Latin American cities are multifaceted social constructions, described as a "collective unity" encompassing both positive and negative tendencies (Rodgers et al., 2011). On the one hand, poverty, informality, and income gaps have declined, alongside urban, social, and environmental policies, and the provision of public goods have strengthened (CEPAL, 2024; UN-Habitat 2012). On the other hand, structural challenges persist, including slow economic growth, inequity, and uncontrolled urban sprawl, threatening urban sustainability (CEPAL,

2024; Rodgers et al., 2011; UN-Habitat 2012). Latin America faces a governance paradox, in efforts to balance government-led initiatives with grassroots movements rooted in indigenous practices, often seen as conflicting (Breen et al., 2020; Anguelovski et al., 2018).

In this context, green spaces and infrastructures remain inequitably distributed, frequently linked to green gentrification (Breen et al., 2020; Tozer et al., 2020) and often deprioritized given the region's many challenges including unmet basic needs (Giannotti et al., 2021; Wild et al., 2024). NbS come as a crucial response to these socio-environmental challenges, making localized understandings of NbS urgent in the region. Urban policies represent potential entry points and catalysts for successfully advancing NbS concepts (Kauark-Fontes et al., 2023a; Mendonça et al., 2021; Sarabi et al., 2019). Such policies and plans can either steer NbS adoption and implementation forward or drastically hinder them (Mendonça et al., 2021). They can help to overcome barriers, foster cross-level NbS integration and enable local participation (Frantzeskaki et al., 2019; Kauark-Fontes et al., 2023a). However, urban policies can also provoke undesired results, promoting "business-as-usual" practices and reinforcing top-down, non-participatory approaches (Remme & Haarstad, 2022). In some cases, they can exacerbate inequalities and power imbalances or even generate new ones (Tozer et al., 2020).

NbS research is unevenly distributed worldwide, particularly for governance issues (Li et al., 2021). Despite higher vulnerability to climate change (IPCC, 2023) and distinct governance challenges and urban realities (Dobbs et al., 2019), NbS research studies in Africa and Latin America are rare (Li et al., 2021; Zarei & Shabab, 2025). Similar approaches, such as ecosystem services or ecosystem-based approaches, when incorporated in policies, are often superficially tackled (Andersson, 2021) and although these concepts are closely related to NBS, they are not identical (Mendes et al., 2020). Understanding how NbS operate in diverse contexts is crucial, particularly given the urgency for co-creation, collaboration (de Abreu et al., 2023; Rubi & Hack, 2021; Wickenberg et al., 2021), and inclusion of local and indigenous knowledge (Tippett et al., 2007; Wilk et al., 2020).

We addressed this gap by investigating how NbS are emerging in Latin American urban policies and plans. Through four case studies – Bogotá (Colombia), Buenos Aires (Argentina), Santiago (Chile), and São Paulo (Brazil) – we critically analysed the integration of NbS into Latin American urban policies. We aimed to: i) examine the theoretical conceptualization and perception of NbS in the Latin American context; ii) identify how NbS are being integrated in urban policies and plans in the four selected Latin American cities; and iii) analyse what the integration of NbS in urban policies and plans should entail in terms of purpose, institutional transformation, and planning practices for the future advancement of the concept in the region.

2. Methodology

We followed a qualitative case study methodology to analyse NbS integration into local policy and planning across Bogotá, Buenos Aires, Santiago (Chile), and São Paulo. These cities were selected based on their participation in the H2020 CONEXUS project, through which they piloted NbS within their urban contexts and demonstrated explicit intentions to advance the concept. We reviewed the current status of NbS emergence in these cities and investigated how it is being positioned in public policies and plans, to identify the discourses and perspectives they foster. To guide the investigation, we applied an analytical framework based on systems analysis—incorporating functional, structural, and process perspectives (Miettinen, 2008) (see Table 1). The functional perspective (Bergek et al., 2008) highlights what is aimed to be achieved with NbS, and the motivations for their implementation. Mapping functions involves identifying expectations, drivers and constraints of NbS. The structural perspective examines the formal actors and institutions involved in NbS implementation, investigating how enacted policies enable or constrain collaborations and how actors' interactions shape implementation and innovation. The process perspective (Edwards, 2000) explores socio-ecological relationships channelled through NbS and the networks managing them.

For this analysis, we applied two research methods: a literature review of NbS in Latin America, and an assessment of NbS policies and plans in the four cities.

2.1 Literature review

To analyse NbS theoretical perceptions and discourses in Latin America, and to assess what their integration into urban policies and plans would entail, we reviewed scientific literature in English, Spanish, and Portuguese without time restrictions. We selected databases based on two criteria: (1) availability of peer-reviewed articles from diverse Latin American countries, and (2) reliable search engines for accurate keyword identification. Although we explored Latin American databases like Redalyc, we excluded them due to unreliable search results—for example, retrieving papers on green energy or sustainable urban planning that did not explicitly address NbS. The final selection – screened using Web of Science, Scopus, and SciELO – was complemented with publications in Spanish and Portuguese identified through snowballing, to include articles from major Latin American research repositories not covered by these databases (e.g., the University of São Paulo repository). We used the following combination of keywords: Urban AND Nature-based Solutions AND Latin America/South America/Chile/Brazil/Colombia/Argentina, selected to reflect the research focus on understanding the NbS concept in this context. Other related concepts and keywords were not included.

We found 132 articles, reduced to 98 after removing duplicates. Using the PRISMA method (Moher et al., 2009) (see Figure 1), we manually screened titles and abstracts for relevance, excluding 42 that did not explicitly address NbS or lacked a geographic focus on Latin America. In cases where the results of screening abstracts were ambiguous, we retained the paper for full-text review. This process yielded 56 articles, though it was not possible to download 5 of them, that were consequently discarded. Full-text analysis led to the further exclusion of 15 articles that mentioned NbS only tangentially (e.g., in relation to sustainable food systems or bioeconomy). Ultimately, 36 articles published between 2017 and 2023 were retained. We then applied snowball sampling from these papers and their key authors, adding

14 articles. In total, 50 articles were included and analysed using the analytical framework, emphasizing functional, structural, and process perspectives.

2.2 Document analysis

To evaluate NbS integration in local policies, we collected official open-access documents from the four case studies, mapping the formal governance structure in place. The process involved three steps:

1. Data collection – We gathered 79 strategic, action, and master plans in force across municipal, metropolitan, provincial, regional, and national levels. Documents were included if they were publicly available online through official government repositories, valid at the time of collection (up to 2024), written in their original languages, issued by any municipal department (not only environmental ones), and focused on urban environments.

2. Data screening and cleaning for eligibility – We screened documents with MAXQDA using a predefined set of keywords (see Table 2) tested by the authors, to capture all documents that included the term NbS. This step excluded most of the documents and identified only 12 documents explicitly mentioning NbS. We then manually reviewed the results to correct errors, and discard documents that did not incorporate the concept. No other documents were excluded, leaving 12 documents for analysis.

3. Data analysis – We analysed the 12 documents explicitly mentioning NbS using thematic coding informed by the analytical framework, with attention to emerging topics such as barriers and needs for NbS advancement. Key aspects examined included the rationale for NbS inclusion, the specific topics addressed (when applicable), involved actors and institutions, NbS implementation tools/mechanisms, and requirements for advancing NbS in the region.

3. Results & Discussion

This section jointly presents and discusses the findings. The literature review examined how NbS were theoretically conceptualized and perceived through the analytical framework, highlighting barriers and needs for advancing the concept and integrating it more effectively into Latin American policies (section 3.1). The policy analysis addressed the integration of NbS in urban policies and plans within the four selected cities, identifying drivers, departments involved, and planning and institutional relationships promoted (section 3.2). Finally, section 3.3 reports work to combine insights from both data sources and bridging theory and practice, exploring what NbS integration into urban policy and planning should entail to support the concept's future advancement.

3.1 Theoretical conceptualization and perception of NbS in the Latin American context

The literature review showed that while the term "nature-based solutions" appeared in Latin American studies, the concept was not always directly discussed or the primary focus of the articles reviewed. Instead, the NbS concept was often referred to alongside related concepts like urban forests, urban parks, and green infrastructures (see also Wild et al., 2024). Of the 50 articles reviewed, 35 focused on specific solutions with varying thematic scopes (see Figure 2). Water-related interventions (e.g., stormwater management, urban drainage) predominated, representing 35% of the total, and followed by ecological restoration (20%), biodiversity restoration and conservation (12%), and other topics such as air pollution mitigation and urban forest management (totalling 33%). Among all articles, NbS was most frequently linked with urban sustainability discourses (26 articles), followed by climate change or disaster risk reduction (13 articles), and urban resilience (9 articles). Only 2 articles linked NbS to human health and well-being (see Figure 3). Studies linking NbS with urban resilience were also associated with sustainability, indicating that urban resilience discourse has been a complementary or joined with NbS framing.

We found that 58% of the articles aligned NbS with international agendas, particularly the International Union for Conservation of Nature (IUCN) and the European Union definition. However, the literature also contained significant criticism, often questioning the concept's clarity and practical relevance. As a result, related terms such as ecosystem services, green infrastructure, and ecosystem-based adaptation were frequently used as substitutes or alongside NbS. Although there was some agreement with the international definitions, NbS adoption still required further development and contextualization to fit regional realities (see also van der Jagt et al., 2023). Marques et al. (2021) and Ordóñez Barona et al. (2023) caution that solutions from the Global North do not necessarily function similarly or address the same needs elsewhere—a concern also raised by Dobbs et al. (2019) for urban ecosystem services.

The literature highlighted colonial influence in certain NbS discourses and dissemination (Ordóñez Barona et al., 2023; Vellozo et al., 2022) which may have hindered NbS development and integration in the region. Reflecting this critique, 28 articles – though focusing on Latin America – stemmed from international collaborations or projects involving lead researchers and case studies beyond the region, often from the Global North. At the same time the literature emphasised a strong social relevance of NbS in the region, framing these interventions as ways to restore human-nature relationships and to work with and for nature (Diep et al., 2022; Mercado et al., 2024). Lastly, our review showed that, as in other regions (Kauark-Fontes et al., 2023a**)**, NbS in Latin America has also been framed as a sustainability strategy and as a mean to foster employment and promote a green economy – always with a strong social orientation (Hölscher et al., 2024).

3.1.1 Perceived barriers and needs for NbS integration in Latin America within the literature

Across the literature, we found emerging needs and barriers to the advancement of NbS in Latin America, affecting their integration in urban policies and plans. Interestingly, many barriers were identified as essential next steps for strengthening and disseminating NbS in the region. Eight categories emerged from the analysis: socio-cultural; built environment and natural landscape; knowledge; environmental justice; institutional and organizational;

financial; political; engagement and coordination among actors, findings that align with Zarei & Shabab (2025). As shown in Figure 4 and 5, in terms of barriers, institutional and organizational (17%), socio-cultural (17%), and environmental justice (16%) were common themes, while in terms of needs the most relevant were knowledge (26%), engagement of actors (21%) and environmental justice (15%). These were examined through the functional, structural, and process perspectives.

Figure 5. Barriers emerging from the literature review.

Figure 6. Needs emerging from the literature review.

From a functional perspective, three main points stand out: human-nature relationships, environmental justice, and recognition of the role of knowledge — the latter being among the most predominant in the literature, highlighting its importance. Mercado et al. (2024) stressed the need to build new relationships between people and nature, shifting from a utilitarian view to a more inclusive one–nature 'with' people rather than 'for' people. This emphasises the urgency of the challenge to address both sociocultural and environmental contexts, as environmental inequalities are inherently tied to socio-economic deprivation. Green gentrification was found to be a major concern, for example Baumgartner (2021) contended that people's access to urban nature was restricted based on class, income, or social hierarchy, leading to unequal distribution of NbS benefits in the reported case of São Paulo's Parque Augusta (Baumgartner, 2021). The consequent exclusion of the poorest from the benefits of NbS is another recurring concern (see Diep et al., 2022), indicating that NbS may reinforce social injustice if not carefully planned.

We also found that there is limited NbS-specific knowledge and a strong need for more education and capacity building. Suggested measures included increased public support for environmental education programs (Portugal del Pino et al., 2022), specialized training for NbS-based urban infrastructure (Vera-Puerto et al., 2020), and education and training based on system-level capacities to integrate NbS into urban planning and governance (Devisscher

et al., 2022). Rubi & Hack (2021) further highlighted the value of spaces for knowledge sharing in Latin America and beyond, to spread experiences among practitioners and researchers across countries. Such efforts can enhance community awareness of NbS benefits, their relevance for urban challenges, and the capacity to better foster and sustain those benefits (Diep et al., 2022; Kozak et al., 2020).

From a structural perspective, our results suggested the need for systematic, multilevel, and democratic NbS governance grounded in equity and science. Most articles stressed the need to overcome institutional and organizational barriers, to establish long-term visions through inter-institutional, intersectoral, and interdisciplinary collaboration (de Abreu et al., 2023; Kozak et al., 2020). Greater acceptance of diverse governance modes — such as community-led initiatives or public-civic partnerships — could also support local solutions, strengthen the NbS community, and advance environmental justice in Latin America (Torres et al., 2023). For example, in Chile, public parks acted to focus collective efforts to improve the quality of life for socially and politically marginalized communities (Reyes-Paecke et al., 2023). Public investments and funding for NbS, however, remained low and inadequate (Hale et al., 2023; Redondo et al., 2022). The cost-effectiveness and multifunctionality qualities of NbS were not fully recognized (Portugal del Pino et al., 2022). To address this, Torres et al. (2023) recommended increasing funding for local implementation and improving fund management for environmental conservation and enhancement.

Finally, from a process perspective, strong and broad political support was highlighted as being crucial in facilitating political transitions and sustaining NbS across the region. This support must be paired with a long-term, systemic, and integrative approach (Lemes de Oliveira et al., 2022). Key challenges are to ensure: meaningful community inclusion in decision-making through diverse participation (Redondo et al., 2022); stronger links between public management, civil society, and the private sector (Kozak et al., 2020); and participatory alternatives based on co-creation (de Abreu et al., 2023). Most articles (42) underscored the need for more active participation in NbS implementation. Explicit calls for participatory processes and stakeholders' involvement were evident in 21 papers; 15 described effective

participatory methods, ranging from co-design and co-creation to community-based initiatives; while 6 papers referenced limited participatory approaches involving only local authorities, experts, technicians, or the local population only through questionnaires. This highlighted the need for deeper stakeholder engagement.

3.2 Current policy integration of NbS in the analysed Latin American cities

Our analysis identified 12 documents explicitly mentioning NbS: 4 in Bogotá, 2 in Buenos Aires, 3 in Santiago, and 3 in São Paulo (see Table 3). All were published after 2020, with timeframes ranging from 2 to 30 years (some extending to 2050). The earliest were the climate resilience plans of the four cities, launched in 2020. Although these documents explicitly mentioned NbS, the concept was generally not central to their discourse. In 9 documents, NbS were acknowledged as valuable, but documents lacked clear definitions, local interpretations, or consideration of local social implications and requirements. Only 3 plans (*Estrategia Climática de Largo Plazo de Chile* in Santiago, and *PLANPAVEL* and *PlanClima SP* in São Paulo), embedded NbS more substantially in the text, providing context-specific examples, primarily related to drainage and flood management.

From a functional perspective, all documents referred to climate change adaptation and mitigation as the main drivers for integrating NbS (see Table 4). This emphasis likely reflects the need to align with global agendas and the growing concerns about climate change impacts in Latin American cities as climate-related events become more frequent and severe (Programa de las Naciones Unidas para el Medio Ambiente, 2023). We found that NbS were almost exclusively framed around broader environmental issues (climate change, biodiversity, etc.), with little connection to quality of life, well-being or water and food security. This partially mirrored previous studies, e.g. Kauark-Fontes et al. (2023a), conducted in three European cities where regulating services were prioritised over provisioning and cultural ecosystem services. The most common NbS types were green roofs and urban forests (see Table 4), followed by vegetated permeable pavements and ecological corridors. These reflected the

main themes developed in the literature review, including water-related interventions, ecological restoration, and biodiversity conservation. Locally tailored solutions were also noted, such as Sustainable Urban Drainage Systems (SUDS) in Bogotá, reflecting the city's focus on flood-risk reduction, and agroforestry systems in São Paulo, aligned with local and national priorities.

From a structural perspective, 5 documents were developed by environmental departments, 3 by planning departments, and 2 by the development departments. Most documents (7) were produced at the municipal level, 4 at the national level, and 1 at the regional level. While 9 documents call for inter-institutional coordination and cooperation, practical implementation was limited – only 3 plans explicitly include cross-level and interdisciplinary collaboration (see Table 3). São Paulo's *PLANPAVEL* established an inter-secretarial work group led by the Green and Environment Secretariat and in collaboration with the Urban Development Secretariat and the Municipal Secretariat of Subprefectures. Similarly, Santiago's *Politica Nacional de Parques Urbanos* was elaborated by national and regional commissions, alongside intersectoral groups including representatives from the Ministries of Environment, Social Development, Health, Housing and Urbanism, as well as urban parks directors, architects, and landscape architects. Chile's *Estrategia climática de largo plazo* followed the same approach. However, financing and funding mechanisms for NbS implementation were found to be largely absent, confirming the gap identified in the literature review.

Analysis of processes established that most documents highlighted the importance of participation: 9 of the 12 included participatory elements, though at varying scales and levels of depth. All relied on consultation as the main participatory tool, reflecting doubts about the real meaning of the term "participatory" (Remme & Haarstad, 2022; Toxopeus et al., 2020). Some included instruments such as thematic workshops and working groups, public audiences, digital platforms for consultation and opinions exchange, yet these methods sometimes fell short of fostering genuine bottom-up engagement or the deeper inclusion advocated in the literature. For instance, Santiago's *Política Nacional de Parques Urbanos*

was developed through regional commissions, an inter-ministerial working group, and two citizen consultations, which incorporated selected civil society and park management input but stopped short of shared decision-making.

Environmental education emerged as the most frequently cited strategy for advancing NbS, indicating a shared recognition across the selected cities of the importance of local learning and capacity building — an emphasis also highlighted in the literature review. Activities often targeted associations, local citizens, and schools, with particular attention to younger generations. São Paulo's *PLANPAVEL*, for example, defined environmental education as a continuous, participatory, and interdisciplinary process to build values, knowledge, and skills for sustainability-oriented citizenship.

From our document analysis, we found that the need to advance NbS in the region (see Table 4) is interestingly connected with specific challenges evident from the literature. From a functional perspective, research and knowledge were centrally important themes, particularly when combined with recognition of ecological and cultural relationships and a stronger focus on environmental justice. The structural analysis identified that essential challenges include institutional barriers, such as poor integration across levels of governance or weak supporting policies, and inadequate funding mechanisms. From a process perspective, we identified integrated planning, cross-sectoral collaboration, and more meaningful participation as key priorities.

3.3 Where do we go from here? Future advancements for the integration of NbS into urban policies in Latin America

Our findings show that the integration of NbS into local policies and plans remains at an early stage, requiring further efforts to ensure effectiveness. We identify five key factors that support the integration and advancement of the NbS concept in the urban policies and plans of the four Latin American cities analysed, also serving as guidance for other cities in

the region. Some of these factors are consistent with experiences reported in other regions, while others highlight specific singularities of Latin American cities.

3.3.1. Adoption of context-specific understanding and purpose of NbS

As with other concepts, NbS should be adapted to regional contexts and needs to be effectively integrated into local urban policies (Dobbs et al., 2019), moving beyond standardized perspectives imported from elsewhere. The findings indicate differences between local policies with an emphasis on climate change, compared with broad calls in the literature for socio-ecological urban sustainability, suggesting stronger alignment with global rather than local priorities. Furthermore, although the NbS types identified in policies partially reflect themes from the literature, they remain largely focused on environmental issues, with social dimensions and benefits — strongly emphasized in regional scholarship — still sidelined. Finally, critiques of the utilitarian perspectives often applied to nature, and calls for approaches grounded in local and ancestral knowledge, are absent from the policies analysed.

To move forward, it is crucial that NbS policies in the region address these gaps. Otherwise, they risk being disconnected from citizens' needs, reproducing inequalities, and not addressing key drivers of long-term success such as community stewardship, cultural values, and social acceptance. Policies should reflect local realities and lived experiences, making them more legitimate and widely supported (Sarabi et al., 2019). This is particularly relevant in cities where mismatches between citizens' needs and perceptions of NbS persist — for example, disagreements over public space design (e.g., reduced parking) (Rubi & Hack, 2021), doubts about NbS effectiveness (Redondo et al., 2022), or security concerns related to NbS implementation (Portugal del Pino et al., 2022; Diep et al., 2022). In addition, adopting a context-specific understanding of NbS is crucial to avoid perpetuating colonial legacies and associated mistrust (Rees & Doyon, 2023). A new paradigm in Latin American urban policies is needed—one that fully accounts for socio-cultural contexts. The success of NbS depends more on public acceptance than that of grey infrastructure (Anderson and Renaud, 2021), and

immediate quality-of-life concerns linked to poverty or precarious living can take precedence over ecological preservation or restoration (Badola et al., 2011).

Pathways toward this goal should prioritise alignment with the goals and cultural values of Latin American contexts (de Abreu et al., 2023; Devisscher et al., 2022; Redondo et al., 2022). Incorporating diverse knowledge systems from multiple actors can strengthen the cultural diversity (Mercado et al., 2024). Combining transdisciplinary expertise with tacit, community-based, and indigenous knowledge can bridge scientific and place-based insights (Wilk et al., 2020). At the same time, this approach preserves and integrates non-hegemonic, non-Western knowledge into urban planning and governance, contributing to more sustainable city transformations (Mercado et al., 2024).

3.3.2. Increased local knowledge and experiences

Moving forward, our results show a strong need for greater NbS knowledge, local best practices, and knowledge sharing in the region, corroborating the importance of capacity building highlighted in other studies (Mercado et al., 2024; Rubi & Hack, 2021). But here, we also show that this gap is mirrored in the analysed policies of all cities, which emphasize environmental education as the most frequent strategy for advancing NbS. Although important, education alone is not sufficient. To advance NbS in practice, policies must also support research, experimentation, and especially the training of local actors. Strengthening these instruments can foster more context-specific experiences in the region and help dispel misconceptions, such as the perceived higher costs of NbS compared to grey infrastructure (Portugal del Pino et al., Torres et al., 2023) and doubts about their effectiveness (Redondo et al., 2022).

To achieve this, establishing a science-based common language that bridges broader and local knowledge can facilitate exchange among diverse actors and unlock the full potential of NbS (Hale et al., 2023). Such an approach allows local actors to build technical capacities suited to their ecological and social contexts while integrating diverse knowledge systems and cultural perspectives (Mercado et al., 2024). This should be reinforced not only through a

system of local policies that align and complement one another to deliver NbS benefits in Latin American cities, but also by promoting the use of online repositories such as *Naturaleza Transformativa* (https://naturaleza-transformativa.com/) or the creation of regional knowledge-sharing spaces, as suggested by Rubi & Hack (2021). This can be done by embedding requirements for inter-city and inter-regional collaboration within policy frameworks (Zarei & Shabab, 2025), mandating reporting of NbS outcomes into shared databases or observatories, supporting the creation of city-to-city networks, or initiatives such as digital twins.

3.3.3. Integrated instruments and governance structures for long-term planning

Our findings also show that, despite repeated calls in both literature and policy for interinstitutional coordination, there is a clear difference between them: most policies call for such collaborations but remain developed in silos. Business-as-usual planning and limited inter and cross-governmental coordination continue to hinder NbS integration in practice, as also observed in other regions (Sarabi et al., 2019; Kauark-Fontes et al., 2023a). Overcoming these sectoral barriers is urgent to move towards horizontality, transdisciplinarity, and inclusion. Collaboration across disciplines and governance levels can address procedural and legislative gaps between expertise and political support (Zarei & Shabab, 2025), but this remains a minimum. NbS policies should go beyond calling for interinstitutional coordination and instead set the example: be developed through interdepartmental, transdisciplinary groups capable of fully grasping and leveraging NbS potential in the region. This has already been noted by scholars in other regions (e.g., Wamsler, 2015; Sarabi et al. 2019; Wickenberg et al., 2021) and in Latin America (Kauark-Fontes et al., 2023b), but the persistence of this gap shows the need for more efforts towards this goal. This suggests a potential challenge in the region in translating multi-departmental cooperation into practice, possibly due to entrenched fragmentation, rigid structures and weak governance arrangements (Breen et al., 2020).

Nevertheless, some frontrunners cities and plans are brought by this study — such as São Paulo's PLANPAVEL, which features an interdepartmental and multilevel working group,

and Santiago's *Política Nacional de Parques Urbanos*, which established a national, regional, intersectoral, and interdepartmental commission — demonstrating an advancement within the region of good practices of inter-institutional coordination and cooperation. These plans can act as local references for developing new collaborative and integrated policies in the analysed cities and their surrounding contexts. They are especially relevant in countries such as Chile, where urban development is primarily mandated by regional and national governments, and for other Latin American cities, like Buenos Aires, where such practices for NbS are still emerging.

Furthermore, our findings confirm that NbS in Latin America is still primarily integrated within environmental and planning policies. Integrating NbS into policies beyond these sectors — such as health and water management — could help advance the concept and its core discourses (e.g., sustainability, climate change) while leveraging the wide range of co-benefits that NbS can provide (Kauark-Fontes et al., 2023a). Their potential impacts on specific issues, such as health and well-being (e.g., Iungman et al., 2025), or building energy reductions (He et al., 2023), should be more actively recognized and disseminated in policies to strengthen such links (Scolobig et al., 2025), rather than being limited to a single lens (Baró et al., 2014). This is especially important in a region characterised by limited infrastructure and high inequality amid rapid and often uncontrolled urbanisation (Hernández-García & Cruz-Suárez, 2022; Portugal Del Pino et al., 2022).

3.3.4. Sustainable financing strategies

In terms of financing, our study reveals limited and inadequate funding in the region, alongside a lack of appropriate mechanisms. While this challenge is noted in the literature (Hale et al., 2023; Redondo et al., 2022), it is even more evident in local urban policies, where instruments for funding are often absent, links with economic development departments and the private sector are critically lacking, and data scarcity is an issue (Wild et al., 2024). This funding gap is not unique to Latin America but reflects a global challenge (Mendonça et al., 2021), with financing often overlooked in implementation frameworks (Wickenberg et al.,

2021) and persistent difficulties in engaging the private sector (Lupp et al., 2021). Yet, it is even more pronounced in the Latin American policies analysed.

The absence of local financing and business models that reflect the multi-stakeholder nature of NbS tend to be place-specific and adaptable, and ensure long-term robustness and sustainability, is a crucial barrier in the region. In this regard, the studied cities may explore, adapt and integrate in their policies diverse funding opportunities, such as eco-taxes (van der Jagt et al., 2023), carbon schemes, public and private co-financing (Op de Beeck et al., 2024), and participatory budgets. In addition, the region could explore NbS Value Proposition Development, identifying its full set of monetary and non-monetary values to build a local business case in collaboration with the private sector, moving beyond business-as-usual (Konijnendijk et al., 2023).

3.3.5. Enabling collaborative processes for more just and inclusive NbS

Despite urgent calls in literature for deeper involvement of civil society and local communities in the development and management of NbS, this remains side-lined in policies. As also seen in European cities (Kauark-Fontes et al., 2023a; Puskás et al., 2021), participation is acknowledged but often remains limited to consultation, perpetuating top-down governance rather than fostering horizontality, transdisciplinarity, and inclusion. Our findings corroborate Remme & Haarstad (2022), who note that while public participation is often emphasized in NbS approaches, it is rarely put into practice. The same applies to justice perspectives, which remain largely theoretical (Toxopeus et al., 2020).

Considering that most of Latin America's population lives in cities marked by inequalities, the need for transforming urban planning to enhance resilience is increasingly important for the region (Hardoy et al., 2022). Participation can bridge gaps between science and public management, improving decision-making (Ramon et al., 2023). Successful and sustainable NbS integration depends on deeper and wider inclusion of local communities (Puskás et al., 2021; Torres et al., 2023). In this sense, participatory processes and inclusion deserve specific attention within NbS policies, notably in regards to what is intended for

‘participatory’ and how to effectively incorporate participation into planning and policy-making. Too often, so-called participatory processes do not include direct citizen involvement, for instance when opinions are sought only on pre-formed solutions or after decisions have already been made (Campbell-Arvai & Lindquist, 2021). Nonetheless, we observe that in Bogotá all analysed plans incorporated participatory strategies, even if at different scales, which is an important achievement.

Building on this progress, NbS policies should move beyond consultations embracing the region’s collective culture through collaborative and inclusive governance (Hölscher et al., 2024), where communities are partners in decision-making (Remme & Haarstad, 2022; Tozer et al., 2020). Such collaboration can create a self-reinforcing loop of engagement, knowledge recognition, and integration, fostering new ways of thinking about local areas and support NbS integration (Tippett et al., 2007). Pathways to embed this in policy include not only existing city-led instruments (e.g., workshops, public audiences, and digital platforms) but also co-creation, co-design, and community-led initiatives — such as participatory budgeting, citizen assemblies, or advisory boards with real decision-making power — and practices rooted in local traditions like *mingas* (Medina et al., 2025). Policies should also assess how NbS benefits and burdens are distributed, embedding social equity alongside ecological goals to ensure justice. This can be achieved through stakeholder mapping, explicit focus on vulnerable groups, and empowering activities.

4. Study limitations

Limitations of our study lay in its focus on only four cities, all of them major urban centres. As a result, the findings cannot be considered fully representative of the entire Latin American region, where other contexts play a role and smaller cities may face distinct challenges and opportunities for NbS implementation. A second limitation concerns our strict inclusion criteria: by analysing only documents that explicitly mention “NbS,” we may have overlooked policies using alternative terminology which could serve as entry points for the

concept. To address this gap, future studies should also examine policies framed under related concepts, providing a fuller picture of NbS integration in the region.

5. Conclusion

Through a literature review and policy analysis, we examine how NbS are emerging in urban policies in Bogotá, Buenos Aires, Santiago, and São Paulo. This deepens understanding of how NbS are conceptualised and perceived in Latin America, how the concept is being integrated into local policies in these cities, and what its integration should mean for the future advancement of NbS in the region. Our findings show that NbS remain at an early stage within policies, and significant progress is still needed for Latin American cities to adopt the concept in context-specific ways. We identify five key factors that can support this integration and guide other cities in the region: (i) adopting context-specific understandings and purposes of NbS that reflect local realities and socio-cultural values; (ii) strengthening local knowledge, research, and capacity building; (iii) creating integrated, cross-sectoral governance structures; (iv) broadening policy scope to recognise multiple NbS benefits for better financing and funding options; and (v) advancing inclusive, justice-oriented participatory processes. These factors are deeply interconnected: progress in one reinforces advances in the others. Strengthening local knowledge supports collaborative governance; inclusive processes enhance legitimacy; and sustainable financing is more viable when embedded in integrated, context-sensitive institutions. Together, these factors highlight that advancing NbS in Latin America requires a systemic, locally grounded approach rather than a linear process. We also find encouraging examples in the region: Bogotá has included participation across all its analysed plans, even if to a certain extent, while São Paulo's *PLANPAVEL* and Santiago's *Política Nacional de Parques Urbanos* establish best practices of interdepartmental and intersectoral working groups. These cases illustrate that, although significant challenges remain, there is already foundations to build on — offering concrete entry points for strengthening effective NbS policy integration in Latin American cities.

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Table 1. Summary of the Analytical Framework (borrowed from Miettinen, 2008).

Analytical Perspective	**Description**
Functional	Understanding what NbS aim to achieve and the motivations behind their implementation, independent of specific socio-political structures.
Structural	Identification of formal actors and institutions involved in NbS implementation.
Process	Analysis of socio-ecological relationships fostered through and for NbS and the network behind them.

Table 2. Predefined set of keywords for the first document screening

TYPE	Keyword
00*	Urban, City
0	Nature-based Solutions
1	Green, Garden(s), Vegetation, Park(s), Ecosystem(-based), Ecologic(al), Plant(s), Biodivers(ity), Nature, Nature-based, Environment
2	Urban nature, Urban trees, Urban forest(ry), Urban Agriculture
3	Blue Infrastructure, Wetland, Retention Ponds, SUDS
4	Preservation areas, Protected areas, Environmental areas

Table 3. Policy documents analysed.

City	Name	Year	Type of Department	Governance level	Inter- & cross-governmental collaboration	Participation in the elaboration
Bogotá	Plan de Acción Climática Bogotá 2020-2050	2020	Environment.	Municipal	No	Yes
	Plan de Ordenamiento Territorial (POT) - Bogotá Reverdece 2022-2035	2022	Planning	Municipal	No	Yes
	Plan Marco para la Gestión de las Áreas Protegidas y la Estructura Ecológica Principal	2022	Environment.	Municipal	No	Yes
	Plan Nacional de Desarrollo 2022-2026	2022	Planning	National	No	Yes
Buenos Aires	Plan de Acción Climática 2050	2020	Environment.	Municipal	No	
	Plan de Ejecución Metropolitana (Parcial) AMBA Parques metropolitanos	2021	Development	National	No	No
Santiago	Plan de Acción para el Clima y la energía sostenible. Estrategias de mitigación y adaptación al cambio climático: 2020-2030	2020	Environment.	Municipal	No	No

City	Name	Year	Type of Department	Governance level	Inter- & cross-governmental collaboration	Participation in the elaboration
	Estrategia climática de largo plazo de Chile (2050)	2021	National Gov.	National	Yes	Yes
	Política Nacional de Parques Urbanos	2021	Housing Ministry	National	Yes	
São Paulo	PLANPAVEL - Plano Municipal de Áreas Protegidas, Áreas Verdes e Espaços Livres	2022	Environment.	Municipal	Yes	Yes
	Plano de Ação Climática (PlanClima SP)	2020	Mayor’s Office	Municipal	No	No
	Metrópoles Sustentáveis Cidadãos Mais Felizes	2022	Development	Regional	No	Yes

Table 4. Emerging concepts in documents mentioning NbS.

Aspect Analyzed	Bogotá	Buenos Aires	Santiago	São Paulo
Main purpose (for integrating NbS)	Climate change adaptation and mitigation	Climate change adaptation and mitigation	Climate change adaptation and mitigation	Climate change adaptation and mitigation
	Disaster risk reduction		Disaster risk reduction	Disaster risk reduction
	Water management			Water management
NbS typology	SUDS	SUDS	Urban forests	Vegetated permeable pavements
	Vegetated permeable pavements	Vegetated permeable pavements	Green roofs	Green roofs and walls
	Green roofs	Green roofs and walls	Ecological corridors	Urban forests
	Urban forests	Urban forests		Rain gardens
	Protected areas	Rain gardens		Ecological corridors
		Ecological corridors		Agroforestry systems

NbS perceptions	NbS cited as possible solutions but not central in the discourse	NbS cited as possible solutions but not central in the discourse	The concept of NbS is embodied in the strategy and comprehended as useful solutions	NbS are often mentioned as practical solutions apparently based on concrete knowledge
	NbS considered as a new input but not concretely incorporated in the plan	NbS considered as a new input but not concretely incorporated in the plan	NbS cited as possible solution but not central in the discourse	NbS cited as possible solution but not central in the discourse
Strategies to foster NbS	Environmental education	-	Environmental education	Environmental education
			Traditional knowledge valorization	Climate focused governance
			Improved regulatory instruments in territorial planning	
			Realize an integrated management of the territory to increase resilience, including multi-sectoral actors and local communities	
			Cooperation and exchange of experiences	
Needs	Integrated planning	-	Monitoring and evaluation	Monitoring and evaluation

Merging of different scales of governance		Improved integrated governance models	Overcome political-institutional barriers
Alliances and coordination with other sectors of the society		Alliances and coordination with other sectors of the society	Overcome business-as-usual habits and choices
Appropriate funding mechanisms		Improved participation	Reduced costs
Increased research and knowledge			Develop and sustain technological progress
Recognition of ecological and cultural relations			
Overcome sectoral barriers and planning in silos			
Ameliorate inter-institutional coordination			
Democratization of knowledge (environmental information and disaster risks management)			
Focus on environmental justice			

Participation	All plans included participatory processes in their elaboration (at different levels). Most of them included citizens and local communities.	The elaboration of one plan included consulting processes with citizens, also claiming for communities' effective participation.	Participatory processes have been applied for the elaboration of two plans, the other one claims for and suggests citizens participation.	Participatory processes have been applied for the elaboration of two plans, the other one claims for and suggests citizens participation.