

Urban Nature-Based Solutions: Key Recommendations for Overcoming Technical Limitations and Political Challenges



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Abstract

This opinion article advocates for Nature-based Solutions (NbS) as a pivotal alternative to face urban issues. The interdisciplinary integration of civil and environmental engineering, biology, and ecology underpins NbS, encompassing strategies like green roofs and permeable pavements. These solutions offer environmental, social, and economic benefits, including enhanced biodiversity, improved air quality, and water regulation. However, the implementation of NbS is not without challenges. Technical limitations like suitability for specific urban contexts, maintenance requirements, and potential ecological risks are significant concerns. Social and financial challenges include public acceptance, equitable access, funding, and cost-benefit analysis. Regulatory frameworks and intersectoral coordination further complicate NbS implementation. To address these challenges, the article suggests a multidisciplinary approach involving scientists, urban planners, policymakers, and the community. Key strategies include amending urban planning policies, fostering collaboration between government and private entities, public awareness campaigns, and establishing task forces for oversight. Investing in research, monitoring, and adaptive management is crucial for refining NbS applications. The article concludes by underscoring the collective effort required to integrate NbS into urban landscapes, advocating for ongoing research, policy integration, and community involvement to transform cities into sustainable, resilient environments harmonious with nature.

Keywords: Urban healthy; Greener Cities; Sustainability; Environmental Policy

Opinion

The accelerating trend of urbanization presents formidable challenges, including the increasing density of urban areas and the concomitant decline in green spaces. This urban expansion triggers a series of environmental and health ramifications, such as extreme climate events, escalated pollution, and ecosystem degradation Bressane [1]. This scenario necessitates innovative and sustainable strategies vital for fostering greener, healthier cities, capable of delivering multiple benefits including enhanced biodiversity and climate change resilience. To address these challenges, the concept of nature-based solutions (NbS) has emerged as a pivotal alternative. NbS are grounded in the principle of harnessing natural processes to mitigate complex urban challenges Biswal [2]. Unlike traditional, human-engineered gray infrastructure, NbS are inspired by and utilize living or inert materials and techniques emulating natural processes Bressane [3]. This approach is deeply rooted in the interdisciplinary integration of civil and environmental engineering, biology, and ecology. It involves various strategies like green roofs, vertical gardens, and permeable pavements, aimed at seamlessly

incorporating nature into urban landscapes Monteiro [4]. The concept of ecosystem services is central to NbS, providing a range of benefits including environmental quality enhancement, biodiversity augmentation, and human well-being improvement Sowińska-Świerkosz [5]. Regarding potential applications and expected results, NbS can optimize air quality by deploying green spaces and trees that filter pollutants and foster oxygen production. In water regulation, these solutions employ green infrastructure, including permeable surfaces and wetlands, to manage floods, enhance water quality, and facilitate groundwater recharge Biswal [2]. Urban green spaces supporting biodiversity offer habitats for pollinators crucial to plant pollination and food production Clement [6]; Simelton [7]. By regulating the urban microclimate through shade provision, these solutions minimize the heat island effect, contributing to broader climate resilience Calliari [8]. NbS may provide cultural and recreational spaces, promoting leisure, relaxation, and community engagement, ultimately enhancing overall well-being. Furthermore, access to urban nature, facilitated by NbS, offers proven psychological

benefits, alleviating stress and anxiety, and promoting mental well-being Bressane [9].

Numerous cities worldwide have successfully implemented NbS to mitigate the adverse effects of urbanization, for instance:

a) Singapore's Garden City Vision: extensive green infrastructure, including vertical gardens, and park connectors, aims to enhance urban biodiversity and mitigate the urban heat island effect Han [10].

b) Portland's Eco roofs Program, USA: it incentivizes green roof installations to manage stormwater, reduce energy consumption, and improve air quality Chang [11].

c) Cheonggyecheon Restoration, South Korea: Seoul's revitalization project transformed a concrete-covered stream into a thriving green corridor, improving water quality Cho [12].

d) Copenhagen's Cloudburst Management Plan, Denmark: it incorporates green roofs, permeable surfaces, and green spaces to manage stormwater, reducing flood risks Ziersen [13].

e) Tokyo's Greening Aoyama Project, Japan: it incorporates greenery into urban design, enhancing aesthetics, reducing heat island effects, and promoting biodiversity Ikeda [14]; and

f) Medellin's Green Corridors, Colombia: strategic green corridors connect parks and green spaces, providing ecological pathways and promoting biodiversity within the city Reynolds [15].

These several examples underscore the versatility and efficacy of NbS in diverse urban contexts. In conclusion, the integration of NbS represents a pivotal paradigm shift in urban development, offering a harmonious coexistence between human activities and the natural environment. On the other hand, there is potential challenges and limitations associated with the NbS implementation. Determining the most suitable NbS for a specific urban context can be challenging. Factors such as local climate, soil type, and existing urban infrastructure can significantly impact the effectiveness and scalability of NbS. While often touted as low-maintenance, some NbS may require significant ongoing care, particularly in urban settings where natural processes are constrained by built environments. Introducing new species or ecosystems can lead to unintended ecological consequences, such as invasive species proliferation or disruption of local habitats and biodiversity. Successful implementation of NbS often requires active community involvement and support. Ensuring equitable access to the benefits of NbS is critical. There is a risk that NbS projects may inadvertently contribute to social inequality or gentrification.

Secure and sustained funding for the implementation and maintenance of NbS can be a major challenge, especially given the often-long-term nature of these projects. Quantifying the economic benefits of NbS can be complex, making it difficult

to justify investments, particularly when compared to more traditional, but less sustainable, infrastructure projects. Existing urban planning and environmental regulations may not be conducive to NbS, requiring significant modifications to facilitate their implementation. To overcome these challenges, a multidisciplinary approach is essential, involving collaboration among scientists, urban planners, policymakers, and the community. Strategic planning, robust research, community engagement, adequate funding, and policy support are crucial for the successful implementation and sustainability of NbS in urban environments. To fortify this commitment, it is imperative to emphasize the essential role of ongoing research in refining and advancing NbS applications. Researchers must delve deeper into the intricacies of NbS effectiveness, refining methodologies and uncovering new possibilities. Continuous monitoring and adaptive management are essential but often overlooked. Simultaneously, policymakers play a pivotal role in translating research findings into actionable policies. By staying abreast of the latest advancements in NbS and incorporating evidence-based practices into urban planning, policymakers can contribute significantly to the creation of sustainable urban landscapes. Furthermore, active involvement and engagement of local communities are paramount. Encouraging community participation in NbS initiatives not only enhances the success of projects but also fosters a sense of ownership and shared responsibility for urban well-being. Through community workshops, education, and collaborative decision-making, cities can truly thrive as vibrant ecosystems that balance human activities with the natural environment.

The infographic in Figure 1 summarizes some policy recommendations and practical strategies for implementing NbS in diverse urban settings. Within the policy framework and urban planning, we recommend amending existing urban planning policies to integrate NbS as a core component of city development plans. This involves modifying zoning and land-use policies to accommodate multifunctional green spaces and NbS interventions. Additionally, it is crucial to foster policy integration across various sectors, including water management, urban planning, and public health. Such integration is essential to maximize the benefits of NbS, ensuring a holistic and effective approach to urban sustainability and resilience. Concerning funding and economic incentives, it's important to encourage collaboration between government entities and private companies for funding NbS projects. Utilizing financial instruments such as green bonds or dedicated environmental funds is also vital to finance NbS initiatives effectively. Moreover, providing tax breaks, subsidies, or other incentives to businesses that integrate NbS into their operations or properties can further promote the adoption of these sustainable practices. For public awareness and education, it's crucial to implement comprehensive campaigns that raise awareness about the benefits of NbS and actively involve communities in the planning process. Supporting local initiatives and grassroots movements that aim to introduce NbS

in neighborhoods is also important, ensuring that these projects align with the specific needs and preferences of residents. To ensure equitable access, design NbS projects to be inclusive, ensuring they are accessible to all community members, especially marginalized and vulnerable groups. In terms of governance and institutional capacity, it is essential to establish interdepartmental committees or task forces to oversee the implementation of NbS.

This will ensure coherent and coordinated efforts across various government agencies. Additionally, for policy consistency and longevity, it is crucial to develop policies that guarantee the long-term sustainability of NbS, making them resilient to political changes. Research, monitoring, and adaptation are critical components for the success of NbS in urban environments. To begin with, investing in research is fundamental.

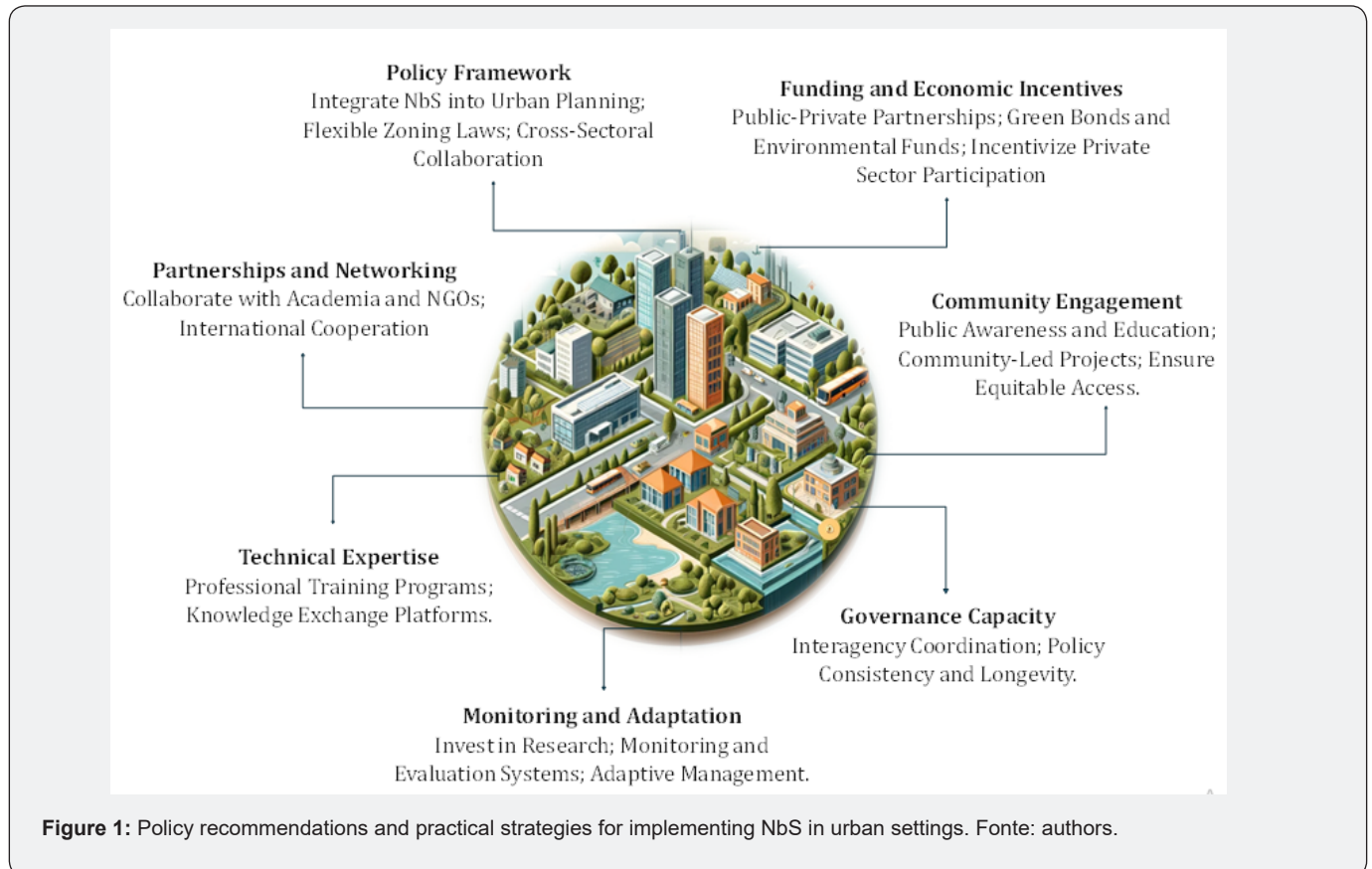


Figure 1: Policy recommendations and practical strategies for implementing NbS in urban settings. Fonte: authors.

This involves funding studies that explore innovative NbS applications and comprehensively understand their impacts across different urban contexts. Alongside, it's essential to implement robust monitoring and evaluation systems. These systems are designed to track the performance of NbS and assess their ecological, social, and economic impacts, providing valuable insights for decision-making. Furthermore, adopting an adaptive management approach is crucial. Utilizing data obtained from monitoring activities enables us to continuously refine and optimize NbS, ensuring they remain effective and relevant over time. This integrated approach ensures that NbS can be dynamically tailored to meet the evolving needs of urban areas. Building technical expertise and capacity is essential for the effective implementation of NbS. To achieve this, developing professional training programs is key [16,17]. These programs should be tailored for urban planners, architects, engineers, and landscape designers, equipping them with the necessary skills and knowledge to design and implement NbS effectively.

Additionally, establishing knowledge exchange platforms plays a crucial role. These platforms would facilitate the sharing of best practices and experiences among cities and stakeholders involved in NbS. Such collaborative environments not only foster learning and innovation but also ensure the continuous improvement and adaptation of NbS strategies in diverse urban settings.

Forging robust partnerships and networks is pivotal for advancing NbS. Collaboration with academia and NGOs is one such strategic approach. By partnering with universities and non-governmental organizations, cities can tap into a wealth of technical expertise, enhance community outreach efforts, and gain access to alternative funding sources. Furthermore, engaging in international cooperation is equally vital. Participation in global networks and agreements allows cities to benefit from and contribute to a pool of best practices on a worldwide scale. Such international engagement facilitates the sharing of experiences and lessons learned in NbS implementation, fostering

a collaborative approach to addressing urban environmental challenges. In conclusion, the transformative potential of NbS calls for a collective and sustained effort. By continually advancing research, integrating evidence-based policies, and actively involving communities, we can ensure that our cities evolve into resilient, green havens that exemplify the harmonious coexistence between urban life and the natural world. The time is now for decisive action and collaborative commitment to shape cities that not only endure but flourish in harmony with nature.

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