T20 Policy Brief

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Task Force 02

SUSTAINABLE CLIMATE ACTION AND INCLUSIVE JUST ENERGY TRANSITIONS

Investing in Sustainable, Inclusive, and Resilient Green Infrastructure

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Abstract

In rapidly growing urban areas of developing countries, the allocation of green zones often lacks scientific rigour, leading to fragmented landscapes and compromised permeability that contributes to flash flooding during heavy rainfall. Sealed urban surfaces exacerbate urban flooding, droughts, and heat island effects as extreme weather events become more common in the Anthropocene age. A standardised approach is crucial to maximise the benefits of nature-based solutions in space-constrained cities. This approach should utilise street networks and stream channels to identify green zones strategically. These zones must prioritise NBS implementation to restore water flow regimes and mitigate urban environmental challenges. A policy brief for G20 members proposes using street networks and stream channels as placeholders for green zone identification. These zones should be situated to provide ecosystem services alongside active community engagement for inclusivity in urban development. Overlaying land use maps with surface run-off data can assess the suitability of potential NBS within these zones. Implementing such a standardised approach can enhance sustainable climate action in urban planning, promoting resilient green infrastructure, and mitigating the adverse effects of urbanisation on natural ecosystems. This integrated strategy aligns with global efforts to address climate change and fosters collaborative solutions among G20 nations.

Keywords: Nature-based Solutions (NBS), urban planning, green zones, stream channels, road network

Diagnosis of the Issue

There is a consensus that urban green areas are crucial for cities. However, there is a lack of clarity on how green areas can be integrated into the land use of densely populated cities, especially in rapidly growing countries. While rapidly growing cities like Bengaluru, India, has seen a staggering decline, with green areas dropping by 78% between 1973 and 2014 (Gupta 2024), the case is no different in cities in developed countries. The United Kingdom, for example, witnessed a decrease in the proportion of green spaces within urban areas, falling from 63% in 2001 to 55% in 2018 (Brown and Mijic 2019) .

As cities expand, so do areas covered by buildings and roads, disrupting natural drainage and amplifying flooding risks. Reduced infiltration and increased surface runoff cause flash floods and droughts. Chennai, grappling with a 22% decline in vegetation cover between 1992 and 2012, has been oscillating between floods and droughts in the recent few years (TK et al. 2022), attributed to the shrinkage of the marshy lands. The 2015 Chennai floods caused a huge economic loss of 3 billion USD (National Institute of Disaster Management (NIDM) 2021).

Increased impervious surfaces and reduced infiltration combined with climate change create a vicious cycle as frequent floods and droughts damage existing infrastructure, necessitating further development. The report ‘Global Infrastructure Resilience’ estimates global infrastructure losses due to disasters and climate change at $301-330 billion annually (CDRI 2023).

These points highlight the critical connection between urbanisation, impervious surfaces, and extreme weather events with the need for resilient infrastructure. Mitigating these issues requires innovative solutions to restore natural water flow regimes by

integrating with natural vegetation within urban environments. However, having green spaces to meet specified area requirements may be insufficient. A deeper understanding of the existing urban spatial structure is crucial to maximise its effectiveness and resilience.

Need for an in-depth understanding of Urban Spatial Structure in the Natural Context: Uncontrolled human activities lead to undesirable impacts in cities. Therefore, planned interventions are needed to guide a complex system, such as cities, to desirable states (Allen 2012; Portugali 1997). With the ever-increasing availability of data and increasing computational capabilities, urban practitioners can leverage insights from urban spatial structures within natural landscapes to inform decision-making.

The urban spatial structure, as dictated by the intricate network of streets, is inherently shaped by the contours of natural terrain. Within this framework, Guerreiro explains how human-made elements like streets, buildings, and parcels are seamlessly integrated into the broader natural context (Guerreiro 2010). Guerreiro underscores the pivotal role of natural terrain as the genesis for configuring and evolving urban spatial patterns defined by streets. Can a synthesise of these metrics that consider human-made features in the natural context aid in directing nature-based solutions for enhancing resilience to extreme weather events?

Our empirical research on a sample of global cities (George, Paul, and Dhawale 2021a; 2021b) shows:

1. Higher surface runoff near arterial roads (Figure 1).

2. Negative association between vegetated areas at higher-order stream networks and arterial road intersections with extreme weather events.

The findings call for the scientific placement of urban green areas, considering the profiles of the natural topography and the street network.

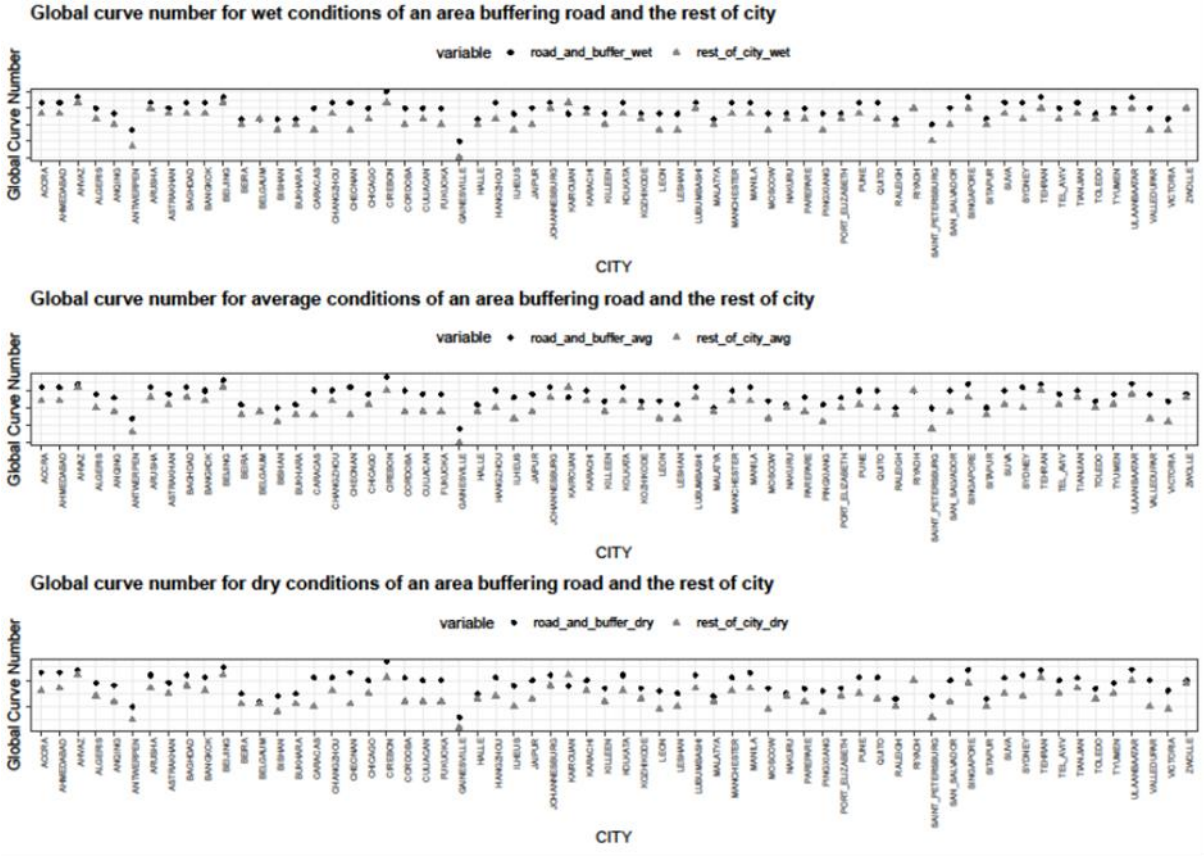

FIGURE 1. Global curve number, an indicator for surface runoff, for a 500 m buffering on either side of the road and the rest of the city for average, wet and dry conditions for a sample of cities representing the urban world. The surface runoff is higher for a 500 m area buffering the road than the rest of the city.

Restoring natural drainage

Urban green areas should be scientifically located to be multi-functional and integrated with nature-based solutions (NBS). The green area interventions should preserve or restore water flow regimes as close to their normal state with full regard to the catchment

area from the ridge to the valley, known as the ridge-to-valley approach (Samra and Sharma 2009; Elamon, Jose, and Kurian 2022), necessitating an in-depth understanding of urban spatial structure in the natural context.

Weak Implementation of land use plans

WHO recommends nine sqm of green space per person (World Health Organization 2021). For Indian cities, standards specify 12-18% green cover in cities (URDPFI 2014). While master plans are prepared following prescribed national or international guidelines, they often fail to translate this into reality. Indian cities like Chennai (0.81 sqm/capita) and Pune (1.4 sqm/capita) (Pargaien 2022) fall far short of WHO's recommendation. Weak implementation of master plans due to limited resources and competing land uses creates a gap between plans and implemented projects. Addressing this is crucial for urban health and well-being.

In light of these findings, the policy paper recommends developing and implementing a standardised approach to identifying potential green zones in urban areas, leveraging street networks and stream channels.

Recommendation

The Actionable Recommendations for G20 Members for integrating urban greens into densely populated cities, especially in rapidly for cities in growing countries, include:

Decision Support Guide for Identifying Green Zones with NBS

A decision support guide can help identify locations for green infrastructure in cities and incorporate it into city plans. The guide should facilitate:

Standardised Green Zone Identification for NBS

Develop and implement a standardised approach, leveraging street networks and stream channels, to identify green zones in urban areas. These green zones should house NBS, prioritizing intersections of higher-order stream channels and arterial road networks for strategic placement. NBS are most effective when mimicking natural water treatment processes. The intersections, identified through network analysis, are ideal locations for NBS implementation. Further, land-use maps can then help determine suitable vegetation types. These can enhance social and physical attractiveness and improve overall urban resilience. This approach can be a roadmap for implementing the Infrastructure Working Group's priorities for sustainable infrastructure and resilience.

Decision Support for the Type of NBS

One can quantify the environmental stressors of land, air and water to determine the type of NBS. Once the environmental stressors are identified, these can be used to select the appropriate NBS using tools such as the Nature-based Solutions Performance Assessment tool (“Nature-Based Solutions Performance Assessment” 2020) or the NBS

Selection Tool (“NBS Selection Tool” 2020) to help local governments choose from the many NBS options. The former can be used in two ways: (1) Once a challenge is identified, the tool is 'NBS Selection Tool' of GU useful to visualize the score of the suitable NBS, or (2) For each selected NBS, one can visualize the score of the potential challenges it can mitigate, and the ecosystem services it can provide. The latter is an excel tool where one can select the challenges that need to be prioritized for different areas, and the result tab ranks recommend NBS for each area by ranking solutions.

Adoption of Legislative Framework

Promote the establishment of legal frameworks that enforce strict adherence to designated urban green spaces in master plans. Clear, standardized procedures for allocating green space and specifying its use will bridge the gap between planning and implementation, ensuring sustainable urban development.

Capacity Building and Knowledge Sharing

Invest in capacity-building and knowledge-sharing programs for local governments and stakeholders on green zone identification, NBS design, implementation, and monitoring by exchanging best practices and lessons learned, leveraging existing platforms.

Community-Centric NBS Implementation

Drawing inspiration from initiatives such as the "inclusive cities" advocated during the Indian presidency of G20 and the current emphasis on the demand side of infrastructure under the Brazilian presidency, we recommend two fundamental principles:

- **Accessibility**: Accessible urban green spaces should be universally available to all citizens, regardless of socioeconomic status. The policy brief recommends strategically placing green areas and nature-based interventions at the intersection of major stream channels and road networks. This approach inherently ensures convenient accessibility for communities and equitable allocation. Placing green areas strategically next to road networks will promote community involvement and responsibility and stimulate public-private partnerships to finance and sustain green infrastructure initiatives, enhancing urban resilience.
- **Affordability**: High-quality green infrastructure should not be a privilege for the wealthy. Community stewardship models, where residents take ownership of parks and natural areas, can be a powerful tool. Encouraging public-private partnerships for funding and maintaining green infrastructure projects further empowers communities in urban resilience efforts. These models foster a sense of community pride and environmental responsibility and demonstrably reduce maintenance costs.

Co-ordination of Governing Bodies for Implementation, Monitoring & Impact Evaluation

The duty of governing agencies does not stop at planning and financing urban green areas. Instead, they should establish a methodology for monitoring implementation and evaluating its impacts.

In Finland, the establishment of a National Urban Plan (NUP) starts at the local level, with the municipality preparing an application and a management action plan in consultation with the city council and local government (Lidmo, Bogason, and Turunen 2020). Next, the Finnish Ministry of Environment coordinates the NUP establishment

process, evaluating potential parks based on biodiversity value, size, ecological function, and location.

Singapore's Index on City Biodiversity, launched in 2008 and revised in 2021, has been used by cities worldwide to evaluate and monitor the progress of their biodiversity conservation efforts. Singapore conducts the study every three years.

Scenarios of Outcomes

Standardizing the identification of urban greens with appropriate NBS and prioritising accessible and affordable NBS creates inclusive green infrastructure, fostering social equity, enhancing urban living, and promoting sustainable development. Implementing these recommendations can provide the following benefits.

Benefits of Standardising the Location of Green Areas

A standardized approach to identifying locations for urban green spaces could be a valuable addition to national strategies like India's CITIIS 2.0 initiative and aid in preparing detailed master plans.

G20 countries can learn about Antwerpen's Bioviens project that stresses connecting the green and blue infrastructures as these are the living veins for biodiverse and healthy cities. 'Rozemaai', a neighbourhood in Antwerp, a historical stream that disappeared in the 1960s, is recreated with eco-friendly river banks. This includes a sustainable drainage system in which stormwater flows via swales into a water stream with nature-friendly river banks, trees and bushes in the neighbourhood, green parking lots, allotments and recreational facilities such as picnic tables. Singapore's Nature Corridors acts as a network of green areas providing ecological corridors and recreational spaces within the highly urbanized environment.

Benefits of Incorporating NBS in Green Areas

The success of urban greens lies in their multi-functional nature. Incorporating NBS serves the additional purpose of managing environmental stressors. Here are examples of how 'NBS Selection Tool' translates to action in Liverpool (URBANGreen UP 2022):

- **Summer Shading**: Planting broad-leaved trees with wide canopies in strategic locations can maximise summer shade, reducing heat gain in buildings during hot months. Conversely, choosing trees with a more open canopy allows for passive solar heating in colder seasons.
- **Urban Carbon Sink Creation**: Planting trees along new green corridors increases shaded areas and maximises carbon capture. Careful selection of tree varieties can effectively reduce heat island effects and air pollution.
- **Urban Heat Island Mitigation in Parking Lots**: Planting trees in parking areas creates "green parking," integrating traffic with green spaces. This reduces the heat island effect through shade and improves stormwater filtration and carbon sequestration. Species with high canopies and nitrogen-fixing properties are particularly effective.

Promoting Inclusive Green Infrastructure

Tackling the disparity in accessibility and availability of urban greens can promote inclusivity. Disparity in urban greens is rampant even in cities of developed countries. Wealthier areas in England, for example, have five times more green space than deprived ones (Brown and Mijic 2019). Engaging the community in planning ensures that green infrastructure meets public needs and preferences.

Very early on, Singapore recognised the limitations of human engineering in solving urban issues and actively sought inspiration from nature to coexist in the changing climate. In Singapore, around 78% of the public housing blocks are within a 10-minute walk to urban green space, and the equitable distribution of green spaces across residential neighbourhoods with approximately 15 square meters per person (Ok 2023). These well-

managed green spaces are aesthetically pleasing and vital tools in mitigating pollution, managing water scarcity, and promoting mental well-being.

The G20 recognises the importance of Green Infrastructure. Bilateral collaborations like Brazil-UK aim to boost sustainable infrastructure investment in projects promoting gender equality and reducing inequality, while initiatives like the UK's Green Infrastructure Framework (GIF) target increasing urban green cover to 40%. These efforts will foster new businesses and carbon sequestration, aligning perfectly with the G20's focus on sustainable development and individual nations' specific commitments.

Implementing the proposed policy framework, encompassing legal reforms, standardised green zone identification tools, and collaborative community-driven NBS implementation, can lead to positive outcomes for urban green infrastructure, including enhanced resilience, ecological connectivity, and community well-being. These instruments help preserve and develop urban green areas to support biodiversity, inculcating the city's socio-cultural values. Efficient financing of climate-resilient infrastructure hinges on strategic placement, particularly in densely populated cities.

Conclusion

By adopting these recommendations, G20 members can lead the way in integrating sustainable, inclusive, and resilient green infrastructure into urban planning. This approach not only addresses climate change but also fosters social equity, ensuring a healthier and more sustainable future for urban populations.

Priority	Description	Implementation Strategy	Relevant G20 Members	Expected Outcomes
Sustainable Infrastructure	Promote the development of infrastructure that supports sustainable development goals (SDGs)	Establish clear guidelines and standards for sustainable infrastructure projects. Encourage public-private partnerships (PPPs) to invest in green infrastructure.	All G20 members, with specific initiatives in countries facing rapid urbanization	Reduced carbon footprint, enhanced resilience to climate change, improved quality of life
Resilient Infrastructure	Strengthen the resilience of infrastructure to natural disasters and climate change	Implement risk assessment and management frameworks, promote the use of NBS	G20 members prone to natural disasters such as Japan, USA, Indonesia	Reduced damage and losses from natural disasters, improved public safety and economic stability
Inclusive Infrastructure	Ensure infrastructure projects are inclusive and benefit all segments of society	Develop policies that promote equal access to infrastructure, particularly in underserved and rural areas	Members with significant rural populations like China, India, and Brazil	Increased social equity, improved access to services, and reduced poverty

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