

Embracing Nature-based Solutions in Urban River Management

AMBIKA MALHOTRA-KOTHARI

*Programme Manager,
Climate Centre for Cities, National Institute of Urban Affairs, New Delhi*

DR. VICTOR R SHINDE

*Head,
Climate Centre for Cities, National Institute of Urban Affairs, New Delhi*

Abstract

The relationship between river and land has been forgotten within the urban fabric. With climate stresses becoming common in the form of cyclones, unpredictable intense rainfalls, and extreme heat coupled with water insecurity, Indian cities are struggling to keep up. Nature-based Solutions (NbS) are a response in which green-blue infrastructure reduces the pressures of urbanisation on the river and the strain of flooding on cities, while at the same time, reinforces economic and social growth. It also creates public spaces for communities, generates job opportunities, and safeguards the larger environmental ecosystem.

This paper analyses the role of Nature-based Solutions on urban rivers through case studies and breaks down four key under-explored aspects that prevent the scaling-up of NbS in India. NbS projects lack funds for planning, implementation, O&M, and long-term management. The paper zooms into standards, regulatory and participatory methods, and financing mechanisms that help in scaling up NbS, attract investments, develop contextual solutions, and provide clarity to all stakeholders. The objective of the paper is to present the value of NbS for urban rivers and climate stresses through holistic planning for clarity on benefits to stakeholders and potential investors to enable implementation and uptake.

Keywords: Urban River Management, Nature-based Solutions, Urban Planning, Urban Flooding, Private Sector Financing, Standardisation of NbS

The Urban Paradigm

With climate extremities becoming more common each year, heavy rainfalls and cyclones coupled with insufficient drainage systems and incapacity of rivers have often brought Indian cities to their knees or rather floating in sewage water. This not only brings loss and damage to life and property but also increases infectious diseases, destroys crops, damages public infrastructure, reduces mobility, and adversely affects the local and regional economy. Unplanned rapid urbanisation has led to loss of natural drainage networks, reduction of floodplains and river capacity, and increase in unnatural catchments within the grey infrastructures of the city. Within the urban fabric, the relationship between a river and land has been forgotten in the last 100 years.

In 2018, flooding was responsible for global economic losses of more than 37 billion dollars (USD), while drought caused losses worth approximately 28 billion dollars (Podlaha, Lörinc, Bowen, & Bhattacharya, 2018). If humans did not intervene, would it be called flooding or erosion or just the nature of a river? We draw a line on a paper defining the edges, floodplains, or water levels. Without the line, the river does not flood, it just flows naturally.

As most cities are developed along rivers, one must find ways of living with them. Additionally, extreme climate stresses further add to the pressures felt by cities. The cities that experienced three to four months of monsoon, are now breaking under high intensity rains that are funnelled into just one month. As floods are becoming more prevalent and recurrent in many Indian cities, there are elevated impacts on life, property, and economy, and cities need to take an action-based approach.

Immediate Need for Combined Effort

Nature has many functions and advantages in urban rivers and waterbody management. Some of these are:

- Wetlands have a high carrying capacity, thus making them important elements in reducing the pressure of high-intensity rains.
- Floodplains store large volumes of water during extreme events, thereby delaying or buffering the downstream impacts (IUCN, UN Environment, & UN Environment-DHI, 2018). They also provide reduced flood risks, groundwater recharge, and extremely fertile land.
- Maintenance of natural drainage systems in a city helps in eliminating urban flooding.
- Mangroves are like walls which reduce high waves from reaching land. They are also breeding grounds for many types of fish and organisms.
- Restoration or rejuvenation of upstream river ecosystems provides a new source of income as well as cleaner water for downstream communities.
- Large green covers along the rivers act as riparian buffers that support in cooling cities, and improve air quality. According to the India State of Forests Report (Ministry of Environment Forest and Climate Change, 2019), the carbon stock from forests (including plantations) in 2019 was estimated at 26.12 billion tonnes of CO₂ equivalent.
- Appropriate grasses with wide root networks increase the stability of floodplains and prevents erosion.

The use of nature for simultaneous benefits towards biodiversity and societal well-being was defined for the first time at the 2016 World Conservation Congress by the International Union for Conservation of Nature (IUCN). Here, Nature-based Solutions (NbS) was defined as - actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits (IUCN, UN Environment, & UN Environment-DHI, 2018).

Nature-based Solutions (NbS) are where green-blue infrastructure can reduce the pressures of urbanisation on the river, and flooding of the river on cities. It also supports creating spaces for communities and reduces the burdens of climate change and water scarcity while complementing the existing grey infrastructure to build resilience in a city.

Sponge cities are a type of NbS that helps to passively clean, absorb, and store water. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) 2.0 launched in October 2021 in selected 500 cities and towns, featured a holistic approach towards urban aquifers by using the strategy of sponge basins to effectively turn cities into sponge cities (Thara, 2023).

Figure 1: Hypothetical Scenario of NbS Along Urban Rivers



Source: E Cohen-Shacham, 2016

While NbS cannot be a siloed approach for river management, it brings great value within a holistic plan. It can support disaster management in terms of river-edge and floodplain protection; restore base flow and groundwater levels; reduce stormwater run-off and unplanned water collection; and help in wastewater clean-up to increase reuse and return flow to the rivers. In the last 10 years, water hazards have been among the top five risks in the likelihood and severity of impacts, as per the World Economic Forum's global risk assessment (World Economic Forum, 2019). As seen in Figure 1, using NbS along with grey infrastructure can help in safeguarding communities, essential services, environmental ecosystems, and investments.

Good Practices

Many indigenous practices are also various types of Nature-based Solutions where the community lives with the rivers by safeguarding the ecology. For example, in the Netherlands, permeable dams are a mesh of wooden logs where the water and sedimentation go through but cuts down the waves that erode the edges (Winterwerp, 2020). At a larger scale, the East Kolkata Wetlands (Figure 2), made up of 12,500 hectares that were initially salt marshes, were later transformed into fish farms and paddy fields. Surrounded by the city, it is one of the main discharge sites for Kolkata's sewage, but using NbS, it produces much of the city's fish, vegetables, and flowers under community ownership. The site supports the livelihood of nearly 74 percent of the working population from the adjoining areas. It recycles 750 million litres of municipal wastewater (including domestic and some industrial effluent) and generates 22 tonnes of fish and 150 tonnes of vegetables per day (Mukherjee & Sen, 2020).

Figure 2: East Kolkata Wetlands in the Middle of Densely Populated Kolkata



Source: Google Earth Pro, accessed on 17th June 2023.

From a climate action lens, NbS is a technology that undertakes both adaptation and mitigation practices. Circular models of water management using Nature-based solutions have emerged as effective in minimising water extraction from rivers and waterbodies, conserving resources, increasing return flow to the rivers, and helping cities in generating revenue. By emphasising the recovery, treatment, and reuse of water in a circular approach, India can alleviate its water stress and pave the way for a greener and more resilient future.

In 2011, Bengaluru decided to recharge the Amani Doddakere Tank (ADT) in Haskote, which had been completely dry for 18 years (Danso, Naidu, & Drechsel, n. d.). The wastewater from the city to the lake flowed through an unlined natural canal which automatically treated the wastewater in the process. The groundwater started recharging in the region, and farmers began tapping into the canal, thus preventing the water from reaching the tank. The intent of the project failed as very little water reached the tank, but using NbS of an unlined canal helped in reusing the wastewater to rejuvenate and support the social and economic factors of the region (Danso, Naidu, & Drechsel, n. d.).

Benefits and Initiatives of NbS

With an investment of 4.5 billion US dollars under the Namami Gange Programme (Press Information Bureau, 2023), a number of initiatives have emerged for rivers. However, many of these initiatives are limited to pollution abatement and covering infrastructure gaps, not considering the social, economic, and environmental value of the rivers and water bodies.

In June 2019, 12 percent of India's population was already living in a 'Day Zero' scenario due to excess ground water extraction, key reservoirs' reduced capacity, inefficient water management, and weak monsoons (Matto, 2019). With extreme climate and water stress being experienced by many Indian cities, there is an immediate need to look at the issues holistically with collaboration across all stakeholders to plan for sustainable urban river management with appropriate monitoring and financing mechanisms.

Some of the social, economic, and environmental benefits of Nature-based Solutions for cities include:

- Tourism
- Livelihood generation
- Carbon sequestration
- Temperature reduction in place of Urban Heat Island Effect
- Real estate growth due to proximity to Blue-Green Infrastructure (BGI)
- Municipal revenue generation
- Enhanced health and well-being in nearby communities

As often seen, many jump onto the NbS train but lack the scientific mapping to contextualise the solutions. Trade-offs occur if maladaptation of NbS is undertaken. For example, certain climate change mitigation policies or climate action plans encourage NbS with low biodiversity value, such as afforestation with non-native monoculture (Seddon et al., 2020). Other challenges of ill-

informed NbS includes land degradation, food security, loss of livelihood, increase in pollen or pests, water availability, and rapid gentrification of the urban region. Selection of the right site with appropriate conditions along with scientifically selected NbS technology and long-term monitoring mechanisms, is the way forward.

With persistent innovation in understanding methods of urban river management, especially from an NbS lens, currently four key aspects lack research and strategies in the Indian context. This paper will detail the landscape of NbS in relation to the four under-strategised sections and present entry points to reduce obstacles for cities.

Stakeholder Engagement

One reason Nature-based Solutions are not fully exploited is because of the complexity of multiple jurisdictions and stakeholders that need to be engaged in implementing them (IUCN, UN Environment, & UN Environment-DHI, 2018). After all, in India, water is a state subject and implementation is funded by a central scheme, while the true benefits might be local to the city or the neighbourhood. Beneficiaries can be located across geographic and administrative boundaries. This makes it quite a task in collecting, collaborating, and convincing all stakeholders. Since NbS is a type of infrastructure that needs firm operations and management instruments post-implementation, stakeholder ownership is critical. Therefore, it is necessary to cut across this institutional complexity to plan, finance, and implement NbS in a coordinated manner.

For example, Aurangabad Municipal Corporation with other key government stakeholders and solution providers worked to restore a seven kilometre stretch of the Kham River. The dying seasonal river had turned into a nalla (a sewage and solid waste carrying drain). Through NbS, the riparian edges were restored using eighty-six native plant species, and the groundwater fed natural springs and wells were rejuvenated to enhance the base flow. The compelling part of the river restoration was the behavioural change activities and community participation. Through a citizen survey, it was clear that 40 percent of the city was unaware of the existence of a river in their city. Citizen-led plogging drives helped in collecting 300 kilogrammes of waste from the river, and using the waste, playful public spaces and signages were created.

From a ground-up approach, the city and other non-government organisations can help in bringing awareness to the waste choking stormwater drains, thereby adding to the city's reaction to excess water. Often, citizens are found engaging in poor practices that lead to pollutants entering the drains and rivers at both small and large scales. This includes disposal of daily household waste, raw sewage, synthetic fertilisers, and construction debris that block the flow of water in narrow channels. Thus, behavioural change is one of the primary strategies that influence citizens to refrain from such practices.

Another method of engagement can be to generate livelihood opportunities for the local communities through NbS. This entails charging a small fee for entering the area, job generation for maintenance, creating public spaces, or strategically placing kiosks or commercial activities within the site. Cities can run programs similar to the Ganga Praharis (Guardians of the Ganga), where the community becomes the eyes and ears in managing the river edge and floodplains from

encroachment and pollution. To achieve this, the traditional methods of disseminating knowledge must complement the strategies that are rooted in behavioural change.

Land Allocation

For urban NbS, land allocation is a big crisis as real estate values in cities are lucrative. It can take years, even decades, for ecosystems to deliver a full suite of benefits, whereas grey solutions can immediately produce anticipated results. Land allocation becomes a tedious process where real estate moguls present more revenue generation from the land for the city. However, this does not take ecosystem services into account. The Millennium Ecosystem Assessment Report (2005) defined Ecosystem Services as “the benefits people derive from ecosystems”. The report (Millennium Ecosystem Assessment, 2005) further divides it into four categories - provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth.

If certain green-blue areas are not conserved for their larger benefit to the city and its people, even unrelated profit-making economies and systems will struggle. The balance between immediate returns from economic growth and long-term returns from environmental protection needs to be balanced.

Standards, Regulations, and Scaling-up

Fundamentally, criticisms of the NbS concept stem from lack of globally recognised standards and principles that guide its implementation. This vacuum opens NbS up for harmful interpretations and misguided applications (Qi, Terton, & Vaughan, 2021).

In India, many cities are initiating tree planting drives in the name of climate action and Nature-based Solutions. However, without proper analysis of site conditions, indigenous plants and O&M practices, these methods lead to the misuse of the term NbS, thereby overselling the idea and reducing its value. Furthermore, without proper standards, the private sector utilises NbS for greenwashing or advertising carbon neutrality without changing their ecologically unfriendly practices.

For standardisation of NbS, the value of ecology within the rivers and their waterbodies needs to be measured. Thus, improved valuation first requires an understanding of how key river processes create significant improvements in the measurement of water flows, watershed conditions, and a range of biophysical processes, such as sediment transport, as well as social, economic, and cultural dependencies on rivers (Opperman, et al., 2018). But how does one identify and quantify these intangible benefits? Due to its large variety of social, economic, and environmental benefits, it is evident that the value of NbS is hard to quantify. It is also arduous to manage natural infrastructure when Nature-based Solutions are an entire ecosystem in comparison to grey infrastructure that is essentially a closed system.

In the case of Coimbatore, Tamil Nadu, the city decided to revitalise eight lakes that were connected to the Noyyal River by creating recreational facilities for the neighbouring communities. A mix

of NbS was designed to increase both the quantity and quality of wastewater that was entering the lakes (United Nations Environment Programme, 2022). No-go zones were designated to allow nature to thrive without human disturbance. A detailed environmental and social impact assessment was undertaken along with a management plan to facilitate adherence to the regulations under state and national policies and guidelines. Additionally, a dedicated institute, The Coimbatore Lakes and Catchment Management Authority, was proposed to ensure O&M during and post-completion were to be sustained along with an assigned fund.

Like the long-term planning in Coimbatore, other cities can also create regulatory bodies that oversee and prevent harm to the ecological systems that are important for the health of the city like acting as carbon sequestration hubs, and reducing the effects of climate change and water pressures. Further, city authorities can also focus on regular monitoring of activities around the ecological site. These activities include construction and its waste, prevention of commercial sand mining, and regular maintenance of existing natural and manmade canals. Collaborative efforts with local communities will help to keep the waterbodies, rivers, and their ecosystems clean and healthy for a long time. Standardisation and regulatory frameworks can improve and evolve the applications of NbS, help plan a consistent approach, and verify solution-oriented outcomes, which will lead to greater confidence in NbS among decision-makers, financiers, and communities.

Financing Nature-based Solutions

Urban flooding is significantly different from rural flooding as urbanisation and concrete cities lead to unnatural catchments, thus increasing the floods from 1.8 to 8 times and flood volumes by up to six times (National Disaster Management Authority, n. d.). Urban flooding affects livelihoods, mobility, economic activities, and services. It also affects commercial activities of big companies like Uber, Amazon, and Zomato, thereby making NbS a collective solution with respect to river and water management. As per Sheccid Gómez, et al. (2023), most NbS projects are financed either by the public sector or philanthropic funds, with only 14% being provided by the private sector. Some of the barriers in investing into the sector include:

- The length of time for Nature-based Solutions to provide a return on investment as it can take years for the solution to reach its full capacity
- Lacking proof of concept, especially from a climate action lens
- Lacking tax cuts or benefits from the city or state authorities
- Not being included in the larger schemes and policies at the centre thus preventing large investments
- Lack of clarity in contextualising the solutions to the geo-climate and local pain points
- Complex implementation methodology as multiple stakeholder groups are required
- Inadequate research on quantification of distribution of social and economic gains across stakeholders

Public funding cannot cover the gaps in protecting the river and its ecosystem. It is imperative to attract and include private capital in NbS projects. But with its current complexity, how does one make it straightforward and structured to not scare away funding? The costs and benefits of NbS need to be clear to the stakeholders and potential investors to increase uptake.

New financial tools like Green Bonds, Carbon Credits, or even simple decision-making tools can help in simplifying the sector for ease of investment. Decision making tools can be designed for different participants. For example, one can be for the private banking sector to understand, identify, measure, and assess their dependence and impact on natural capital (Sheccid Gómez, 2023), while another can be for city officials to select the right type of NbS for their designated sites with the exact issues to be addressed and the amount of funding required.

In July 2023, Junagarh applied and succeeded to become the first civic body in Asia to trade water credits. The program run by UNFCCC since 2014 allows projects or civic agencies to earn credits for water conservation (Khakhariya, 2023). The program addresses the water crisis that is experienced in many cities and also helps incentivise rainwater harvesting and groundwater recharge. Junagarh won nine million water credits for saving 10 million litres of water through the Hasnapur reservoir conservation project. The municipal corporation of the city can convert the water credits into financial instruments, thereby attracting finance from the private sector, banks, and impact funds for further development in the city.

Blended financing or co-financing tools can quickly add investment security and thereby increase the funds that are available for NbS. This is a strategic mix of public sector and philanthropic investment which will reduce the investment risk and increase project bankability, thus attracting large amounts of private capital (Sheccid Gómez, 2023). However, these investment strategies work best only when the risk is lower.

Lastly, it is also important to note which phase of the NbS project is lacking funds, whether it is in planning the project, implementation, or O&M, and long-term management. The post-completion operations and management section lacks funds significantly. Maybe this is because of the difficulty in identifying all direct and indirect benefits. The communities have to own the project, which is the key to the success or failure of a project. This will happen only if there is economic benefit for them. However, looking from another lens, is it fair to put the ownership and management on the community? The city can create financing mechanisms along with a MEL (Monitoring, Evaluation and Learning) system with ecological and social feedback systems built into it. The O&M (Operations & Maintenance) can be used as a selling point for NbS where the government can create roles for small service providers who can be within the regulatory framework of municipalities. These service providers or vendors can then be accountable for the NbS project in maintaining its performance and restoration and continue to be paid for their services.

Conclusion

In cities, especially dense informal housing in climate-vulnerable areas close to the river, many suffer increasingly due to flooding, extreme water shortage, or climate stress. This results in loss of life, livelihood, and the willpower to hustle each day. Nandini, having lived and worked in

Chennai in the care economy for five years with her family, had access to very little support after the floods or during intense heat waves with almost no water. Being in the care economy, she was not provided health or life insurance, nor was she given any formal support that is predominant in white- and blue-collar jobs.

Restoring the riparian buffer, a NbS strategy, along the floodplains would help in flood control, give cover from extreme heat, and restore the groundwater table. It might also help Nandini's family with a secondary source of income. Nature-based Solutions can change our ways of living with nature, supporting harmonious, healthy co-living.

With integration of differently scaled solutions into the larger water management of a city through master plans, policies, acts, implementation, and by-laws, NbS has the potential to make cities resilient, inclusive, and healthy.

Conflict of Interest

The authors declare no conflict of interest.

Bibliography

- Matto, M. (2019, June 21). India's water crisis: The clock is ticking. Retrieved from Down to Earth: <https://www.downtoearth.org.in/water/india-s-water-crisis-the-clock-is-ticking-65217>
- Khakhariya, N. (2023, October 25). In a first, Junagadh civic body gets water credits for rainwater harvesting. Retrieved from Times of India: <https://timesofindia.indiatimes.com/city/rajkot/in-a-first-junagadh-civic-body-gets-water-credits-for-rainwater-harvesting/articleshow/104687070.cms>
- Danso, G. K., Naidu, D. R., & Drechsel, P. (n.d.). Revival of Amani Doddakere tank (Bangalore, India). In T. & Francis, *Wastewater as a Resource* (Vol. 4, p. 710). Taylor & Francis.
- E Cohen-Shacham, G. W. (2016). *Nature-based Solutions to address global societal challenges*. Gland, Switzerland: IUCN.
- IUCN, UN Environment, & UN Environment-DHI (2018). *Nature-Based Solutions for Water Management: A Primer*.
- Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.
- Ministry of Environment Forest and Climate Change (2019). *India State of Forest Report*. Dehradun: MoEFCC.
- Mukherjee, J., & Sen, A. (2020, November 24). The political ecologies of Kolkata's wastewater wetlands: Not a 'wasted' enterprise. Retrieved from Global Water Forum: [4/the-political-ecologies-of-kolkatas-wastewater-wetlands-not-a-wasted-enterprise/#:~:text=The%20EKW%20recycles%20750%20million,tonnes%20of%20vegetables%20per%20day](https://www.gwf2020.org/4/the-political-ecologies-of-kolkatas-wastewater-wetlands-not-a-wasted-enterprise/#:~:text=The%20EKW%20recycles%20750%20million,tonnes%20of%20vegetables%20per%20day).
- National Disaster Management Authority (n.d.). *Urban Floods*. Retrieved from National Disaster Management Authority: <https://ndma.gov.in/Natural-Hazards/Urban-Floods>
- Opperman, J., Orr, S., Baleta, H., Garrick, D., Goichot, M., McCoy, A., ... Vermeulen, A. (2018). *Valuing Rivers: How the diverse benefits of healthy rivers underpin economies*. https://awsassets.panda.org/downloads/wwf_valuing_rivers_final_.pdf: WWF.
- Podlaha, A., Lörinc, M., Bowen, S., & Bhattacharya, A. (2018). *Weather, climate & catastrophe insight: 2018 annual report*. Aon.
- Reuters (2024, March 20). Not just Bengaluru. Many cities in India stare at summer water crisis as reservoir levels fall to 5-year lows. Retrieved June 15, 2024, from The Economic Times: <https://economictimes.indiatimes.com/news/india/not-just-bengaluru-many-cities-in-india-stare-at-summer-water-crisis-as-reservoir-levels-slide/articleshow/108636966.cms>

- Seddon, N., Chausson, A., Berry, P., Girardin, C. A., Smith, A., & Turner, B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. Royal Society Publishing.
- Sheccid Gómez, V. L. (2023, February 23). Pathways to Unblocking Private Financing for Nature-based Solutions. Retrieved from World Resources Institute: <https://www.wri.org/update/pathways-unblocking-private-financing-nature-based-solutions>
- Sisay E. Debele, L. S. O. (2023). Nature-based solutions can help reduce the impact of natural hazards: A global analysis of NBS case studies. *Science of The Total Environment*, 902. Retrieved from Nature-based solutions can help reduce the impact of natural hazards: A global analysis of NBS case studies.
- Press Information Bureau. (2023, August 06). DG, NMCG gives presentation on Namami Gange to World Bank EDs during an impact assessment meeting in Agra. Agra.
- Thara, D. (2023, October 12). AMRUT 2.0: Focus on Functional Tap Connections & Water Security In More Than 4000 Cities – Smt D Thara, IAS, Additional Secretary (A&CV), Ministry of Housing and Urban Affairs Government of India. (W. Digest, Interviewer)
- United Nations Environment Programme (2022). Nature-based Solutions to Emerging Water Management Challenges in the Asia-Pacific Region. Nairobi: CTCN Knowledge Brief.
- Winterwerp, J. A. (2020). Managing erosion of mangrove-mud coasts with permeable dams – lessons learned.
- World Economic Forum (2019). The Global Risks Report, 14th Edition. Geneva: World Economic Forum.