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AUSTRALIAN AID
Compendium on Water Sensitive Urban Design
September, 2024

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National Institute of Urban Affairs

NATIONAL INSTITUTE OF URBAN AFFAIRS
Compendium on Water Sensitive Urban Design
September, 2024

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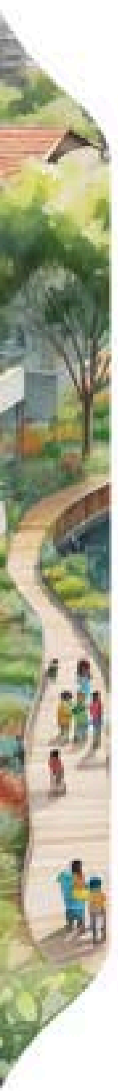
FOREWORD



For several years, many cities like Delhi have been experiencing a decline in water security. 45% of Delhi remains unplanned which leads the informal settlements to face water scarcity and flooding issues. Groundwater levels are falling, flooding incidents are rising, concerns about water pollution are growing, and encroachments on water bodies are increasing.

To address the imminent challenges, the city must adopt a water-sensitive approach that integrates the entire urban water cycle and its interactions with society. This requires concerted and coordinated efforts from different stakeholders, including government agencies, citizen groups, NGOs, academicians, and influencers, to support the overall effort to transform Delhi from a water-vulnerable to a water-secure city. While all agencies in Delhi are doing commendable work to improve the situation, there is scope to step up the ambition.

With this intent, the **Delhi Water Forum (DWF) has been set up as a first-of-its-kind enabling platform for diverse stakeholders in the city to ideate and synergise their efforts to make Delhi a 'water-sensitive city'**.

The overall objective of the DWF is to establish an avenue for progressive discussions and corresponding actions for making Delhi a water-sensitive city.

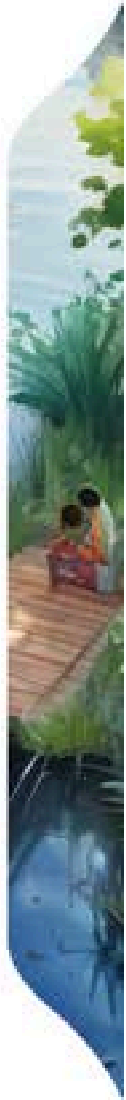
The Forum:

- provides a platform for various water-related agencies in Delhi to periodically share, discuss, and seek feedback on their ongoing and proposed plans for the water sector in Delhi.
- seeks to infuse new and contemporary thinking about water-sensitive planning and actions amongst the members of the Forum.
- supports the translation of water-sensitive aspirations into practice.

This 'Compendium on Water-Sensitive Urban Design' has been prepared as a tool to support the DWF member organisations, with relevant technical guidance on integrating innovative water-sensitive approaches to urban planning and development. While the compendium is specifically tailored to meet the specific needs of Delhi, it can also serve as a valuable resource for other cities striving towards water-sensitive urban development.

This initiative is part of the Australia India Water Security Initiative (AIWASI), that seeks to create an enabling environment for good water management practices in Australia to be contextualised and adopted for the Indian conditions. AIWASI is led by Australia's Department of Foreign Affairs and Trade (DFAT) and India's Ministry of Housing and Urban Affairs (MoHUA), in collaboration with the World Resources Institute (WRI India), McGregor Coxall (McGC), the National Institute of Urban Affairs (NIUA), and the Mahila Housing SEWA Trust (MHT).

In addition to city-scale initiatives, AIWASI is also supporting the implementation of Community Demonstration Projects (CDPs) in two settlements, namely Bakkarwala and Mubarakpur Dabas in Delhi.



MESSAGES

Water security is a critical challenge for both Australia and India. Through our bilateral relationship we are cooperating on water resources management and working together to find practical solutions to shared challenges.

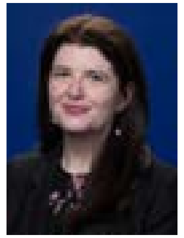
Water scarcity and quality are increasingly pressing issues for urban areas around the globe, exacerbated by rapid urbanisation and climate change. In response, water-sensitive urban design universally has emerged as a transformative approach that integrates sustainable water management practices into urban development.

The Australia India Water Security Initiative is a collaborative multi-year initiative supported by the Australian Government and implemented in India by a consortium of Australian and Indian agencies. The initiative has been playing a pivotal role in fostering knowledge exchange and technical cooperation between the two countries, towards advancing water security and sensitivity, and strengthening water governance in Indian cities.

This Compendium on 'Water-Sensitive Urban Design,' is a tangible outcome from the collaborative effort facilitated under the Australia India Water Security Initiative. It captures a wealth of knowledge and practical strategies from across the world. It aims at empowering cities to adopt the water-sensitive urban design principles effectively and tailor fit-for-purpose local practices.

It serves as a crucial guide for a range of cities, from mega-cities like Delhi to small towns across India. It provides a comprehensive set of case studies that elucidate how engineering design approaches can integrate and manage different parts of the urban water cycle sustainably, view stormwater as a resource and promote environmentally conscious urban development.

I extend my appreciation to the National Institute of Urban Affairs team and all contributors for their efforts in developing this knowledge product. I believe that Indian cities and institutions will draw inspiration from these ideas and contribute towards the broader goal of promoting water-sensitive thinking in urban development.



Ms Carly Partridge
Minister Counsellor Policy
Australian High Commission, New Delhi

MESSAGES

India faces significant water challenges, including frequent floods, severe droughts, and widespread water pollution. The increase in urban population has further intensified these issues, putting immense pressure on the country's water resources.

According to the 2021 Energy and Climate Change report, over 600 million people in India are experiencing extreme water stress and insecurity. The Aqueduct Water Risk Atlas by the World Resources Institute ranks India 13th among the 17 most water-stressed countries globally. Yale University's 2022 unsafe drinking water index ranked India 141 out of 180 countries. Additionally, the World Bank reports that extraction of groundwater has been on the rise for decades, and about 17% of groundwater blocks are overexploited.

As we tackle these complexities of urban water management, water-sensitive urban design (WSUD) emerges as a holistic and sustainable approach. WSUD integrates urban planning and design with the entire water cycle, promoting the sustainable management of water resources. This approach addresses immediate water challenges and contributes to long-term urban resilience and sustainability.

Despite existing extensive knowledge of WSUD, cities need further guidance to effectively incorporate these approaches into ongoing urban development efforts. In response, we have developed this "Compendium on Water-Sensitive Urban Design", aiming to promote water-sensitive planning and development in cities. This compendium serves as a crucial resource, providing cities with the knowledge and tools necessary to implement these principles effectively.

The case studies included in this document cover a wide range of WSUD practices, focussing on the rejuvenation of water bodies, river management, the development of water-sensitive parks and public spaces, and planning for water-sensitive cities. By adopting these strategies, cities can enhance their resilience to water-related challenges while creating healthier and more liveable urban environments.

Dr. Debolina Kundu
Director (AC)
National Institute of Urban Affairs
(Ministry of Housing & Urban Affairs, Government of India)

MESSAGES

Water is at the heart of our cities—essential for life, economic development, and the environment. Yet, many of our urban areas are facing unprecedented water-related challenges, like frequent flooding, severe droughts, declining water quality, and the overexploitation of vital water resources.

In Delhi, water security has been deteriorating for several years. The city faces a substantial water demand-supply gap, currently estimated at 325 million gallons per day (MGD). According to A report by the Central Ground Water Board (CGWB) indicates that the city is extracting more water than it recharges. Of the city's 34 blocks, half are over-exploited, seven are semi-critical, and only three are considered safe. Despite having around 20% of the area under green cover, the frequency and severity of flooding events in Delhi have been increasing. Moving forward, it's clear that the city and its multiple agencies must adopt water-sensitive approaches that account for the entire urban water cycle and its interaction with society to address these urgent challenges.

The importance of Water-Sensitive Urban Design (WSUD) cannot be overstated, especially as cities like Delhi continue to grow at an unprecedented pace. WSUD offers a paradigm shift in how we approach these challenges. By integrating water management into the very fabric of urban planning and design, WSUD enables us to create cities that are not only resilient to water-related risks but also vibrant, healthy, and sustainable. It promotes the harmonious coexistence of urban development and natural water systems, ensuring that water is managed sustainably as a valuable resource at every stage of the urban water cycle. This has become critically important for cities in view of growing challenges from the impacts of climate change.

Many cities worldwide are now embracing WSUD principles to address urban water challenges. This "Compendium on Water-Sensitive Urban Design" showcases a diverse array of practices and case studies from around the world, demonstrating the tangible benefits of adopting a water-sensitive approach. As you explore the pages of this compendium, I encourage you to think critically about how these practices can be adapted and implemented in your own urban contexts and hope to see it being of use in scaling up these practices in many more cities.

Rajiv Ranjan Mishra
Chair, Delhi Water Forum & Chief Advisor,
National Institute of Urban Affairs
(Ministry of Housing & Urban Affairs, Government of India)

MESSAGES

As Indian cities continue to grow rapidly, we stand at a critical juncture. By 2050, India's urban population is expected to nearly double, reaching around 800 million people. This rapid urbanization presents significant challenges and opportunities to address crucial sustainability issues. The decisions we make today will shape our cities' futures and our ability to meet the United Nations Sustainable Development Goals (SDGs). Urban water insecurity, environmental degradation, and unequal resource distribution are major challenges in our expanding cities. These issues are exacerbated by the impacts of climate change, such as rising temperatures and unpredictable rainfall, threatening water security, sanitation, and livelihoods, particularly in disadvantaged communities.

The Australia India Water Security Initiative (AIWASI) Community Demonstration Project (CDP) addresses these challenges strategically. The AIWASI CDP is informed by overarching GEDSI principles entailing a thorough understanding of the different risks, opportunities, barriers, and impacts faced by all sections of the society. Focusing on two disadvantaged communities in Delhi—Bakkarwala and Mubarakpur Dabas—this "living laboratory" is generating educational, social, and environmental benefits. The project enhances water literacy, expands green spaces, and improves water security through Water-Sensitive Urban Design (WSUD).

WSUD is an integrative approach that reimagines urban water management. It promotes sustainable water use, management, and conservation, enhancing city livability. Unlike traditional practices, WSUD integrates water sustainability into urban planning and design, treating cities as water catchments where rainwater is a resource, water bodies are assets, and citizens are stewards of this vital resource.

This compendium compiles global case studies showcasing nature-based solutions and WSUDs that have successfully addressed water quality, flood resilience, and urban livability challenges. By highlighting the processes, impacts, and lessons from these projects, we aim to inspire government, non-government, and sector experts to enhance existing infrastructure and create new ones. These case studies demonstrate that WSUD is a practical and achievable goal, not just a theoretical concept. They emphasize the importance of cross-sector and community collaboration to realize resilient, inclusive, and water-sensitive cities.

As we progress, it is crucial to learn from these examples, adapt them to local contexts, and scale them to meet the growing urbanization challenges. The future of Indian cities depends on our ability to manage water sustainably and equitably. WSUD offers a roadmap to ensure our cities are not only resilient to water-related challenges but also vibrant, healthy, and inclusive for all.

Madhav Pai
CEO,
WRI India

DEFINITIONS

Aquifer - A hydraulically continuous body of relatively permeable unconsolidated porous sediments or porous or fissured rocks containing groundwater. It is capable of yielding exploitable quantities of groundwater.

- IGARC

Biodiversity - The term biodiversity (from “biological diversity”) refers to the variety of life on Earth at all its levels, from genes to ecosystems, and can encompass the evolutionary, ecological, and cultural processes that sustain life.

- American Museum of Natural History

Bioremediation - Bioremediation is a managed or spontaneous process in which chemical reactions mediated by (micro)biological organisms degrade or transform contaminants to less toxic or nontoxic forms, thereby remedying or eliminating environmental contamination.

- Comprehensive Biotechnology (Third Edition), 2011

Bioretention Systems - Bioretention is a stormwater infiltration practice that treats runoff from paved areas by using the natural properties of soil and vegetation to remove contaminants.

- Sustainable Technologies Evaluation Program

Bioswales - Bioswales are landscape features that collect polluted stormwater runoff, soak it into the ground, and filter out pollution. Bioswales are similar to rain gardens but are designed to capture much more runoff from larger areas of impervious surfaces like streets and parking lots.

- Milwaukee Metropolitan Sewerage District

Biophilic Design - Biophilic design is an approach that fosters beneficial contact between people and nature in modern buildings and landscapes.

- Space Refinery

Blue-Green Infrastructure - A strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services while also enhancing biodiversity.

- European Union

Climate Change - Climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural due to changes in the sun’s activity or large volcanic eruptions. However, since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil and gas.

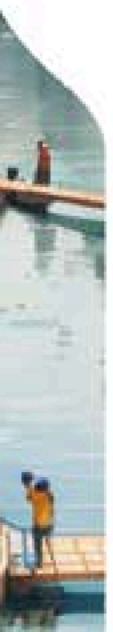
- United Nations

Carbon Sequestration - Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

- U.S. Geological Survey (USGS)

Community Bore - A community bore is a bore or multiple bores supplying groundwater via a reticulated network to several properties in urban developments for non-drinking uses including private garden watering and/or for irrigation of communal green spaces within the development.

- Government of Western Australia Department of Water and Environmental Regulation



Constructed Wetlands - Constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and their associated microbial assemblages to improve water quality.

- U.S. Environmental Protection Agency (EPA),

Ecological Restoration - Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

- Society for Ecological Restoration (SER),

Flood Resilience - Flood resilience refers to minimizing damages during flooding, reducing risk to people and infrastructure, and allowing for adjustments to occur where possible.

- Vermont Department of Environmental Conservation

Green Roofs - A green roof is a layer of vegetation planted over a waterproofing system that is installed on top of a flat or slightly–sloped roof. Green roofs are also known as vegetative or eco-roofs.

- National Park Service,

Microclimate - A microclimate is a small section within a larger macroclimate that differs with temperature and precipitation. This change can be caused by geologic or man-made features that cause additional shading, heat pockets, and precipitation.

- Tandi Carignan, 2023

Nature-based Solutions - Nature-based Solutions are actions to address societal challenges through the protection, sustainable management, and restoration of ecosystems, benefiting both biodiversity and human well-being.

- International Union for Conservation of Nature (IUCN)

Sponge City Approach - The Sponge City concept is a Chinese urban planning model that relies on natural stormwater management infrastructure, with a focus on flood control and mitigating urban development’s impacts on hydrology and ecosystems.

- Fluence

Surface Water Management Plan (SWMP) - A Surface Water Management Plan (SWMP) is a study to understand the flood risk that arises from local flooding, which is defined by the Flood and Water Management Act 2010 as flooding from surface runoff, groundwater, and ordinary watercourses.

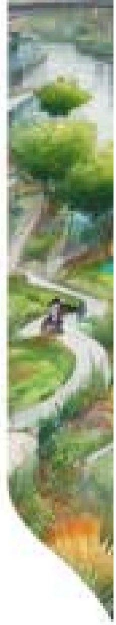
- East Sussex Country Council

Sustainability - The United Nations Brundtland Commission defined sustainability in 1987 as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."

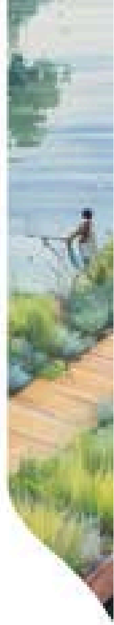
- United Nations, 1987

Sustainable Urban Drainage Systems (SuDS/SUDS) - Sustainable urban drainage systems (SUDS) are water management systems designed to handle natural water processes in an efficient manner, channeling the drainage in urban environments through modern drainage systems.

- BuildPass, 2021



ACRONYMS AND ABBREVIATIONS



CDD - Consortium for DEWATS Dissemination

CEMDE - Centre for Environmental Management of Degraded Ecosystems

CNRS - Centre for Natural Resource Studies

CRDF - Civilian Research and Development Foundation

CSOs - Combined Sewer Overflows

CSR - Corporate Social Responsibility

DDA - Delhi Development Authority

DEWATS - Decentralised Wastewater Treatment Systems

DNCC - Dhaka North City Corporation

DWER - Department of Water and Environmental Regulation

EIA - Environmental Impact Assessment

EPA - Environment Protection Authority

FIFA - Federation Internationale de Football Association

GRI - Green Rainwater Infrastructure

GRIHA - Green Rating for Integrated Habitat Assessment

GTPUDA - Gujarat Town Planning and Urban Development Act

HMDA - Hyderabad Metropolitan Development Authority

IIMB - Indian Institute of Management Bangalore

ITC - Indian Tobacco Company

LED - Light-emitting Diode

LEED - Leadership in Energy and Environmental Design

MGSDP - Metropolitan Glasgow Strategic Drainage Partnership

MLA - Member of the Legislative Assembly

MUGA - Multi-Use Games Area

NBS/NbS - Nature-based Solutions

NIF - National Foundation for Delhi

NGO - Non-Governmental Organisation

NSW - New South Wales

PaWS - Pathways to Water-Resilient South African cities

PET - Polyethylene Terephthalate

PV - Photovoltaic

PVC - Poly Vinyl Chloride

PWD - Public Works Department

RAJUK - Rajdhani Unnayan Kartipakkha

SCADA - Supervisory Control and Data Acquisition

SEPA - Scottish Environment Protection Agency

SDG - Sustainable Development Goals

SHGs - Self-Help Groups

STP - Sewage Treatment Plant

SUDS/SuDS - Sustainable Urban Drainage Systems

SWAB - Scientific Wetland with Active Biodigester

SWM - Stormwater Management

SWMP - Surface Water Management Plan

UCT - The University of Cape Town

UDDTs - Urine Diversion Dehydration Toilets

ULBs - Urban Local Bodies

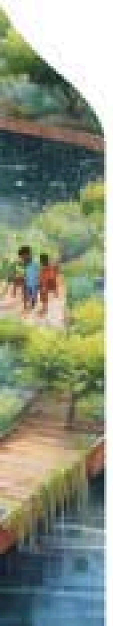
UNHCR - United Nations High Commissioner for Refugees

UERs - Urban Extension Roads

USP - Unique Selling Proposition

WSUD - Water-Sensitive Urban Design

WWF - World Wide Fund for Nature



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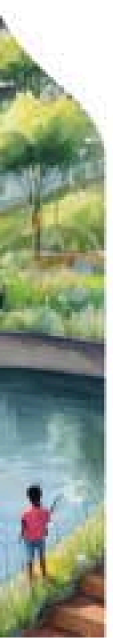
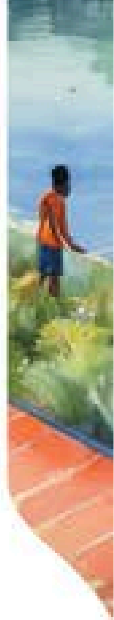
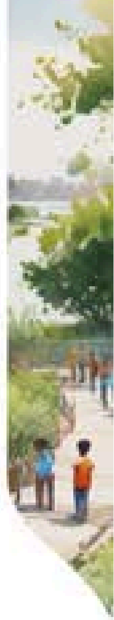
PLANNING INTERVENTIONS

CASE STUDY SUMMARY TABLE

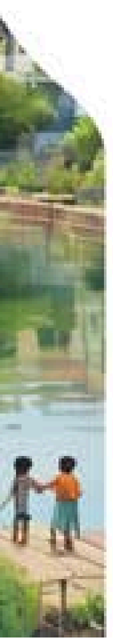
S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
1	**Revitalising Kaban Lake by Creating a Water Remediation Buffer and an Accessible and Safe Waterfront** Kazan, Russia	City/neighbourhood	Government of the Republic of Tatarstan	Lake pollution due to dumping of untreated domestic and industrial waste and urban runoffs	1. Reclaimed waterfront fosters ecological health and cultural vitality 2. Formerly deserted waterfront sees 50,000 daily users, fostering inclusivity and recreational opportunities	One-year implementation time for lake revitalisation with natural, cultural, and social development
2	**Restoring Stormwater Drains through Rain Gardens Underneath Begumpet Flyover** Hyderabad, India	Ward, settlement	Hyderabad Metropolitan Development Authority (HMDA)	Water insecurity and pollution, mosquito breeding	1. Increased flood protection and improved water quality 2. Improved public health due to the creation of a vibrant open public space	Natural wastewater treatment
3	**Building Flood Resilience through Lake Redevelopment and Interlinking of Lakes** Ahmedabad, India	City/neighbourhood	Ahmedabad Urban Development Authority & Municipal Corporation	Flooding, water scarcity, lake pollution and groundwater depletion	1. Reduced flooding/waterlogging 2. Improved groundwater table 3. Creation of vibrant public space 4. Real estate boost	Creation of public spaces/ waterfronts
4	**Integrated Urban Water Management of the Hatirjheel Area through Engineered and Nature-based Solutions (NbS)** Dhaka, Bangladesh	Neighbourhood	RAJUK (Rajdhani Unnayan Kartipakkha)	Pollution, loss of biodiversity, urban flooding	1. Restored wetland ecosystem 2. Improved recreational avenues 3. Generation of revenue through water taxi and amphitheatre	Integration of engineered solutions with NbS
5	**Rajokri Lake Rejuvenation Project** Delhi, India	District/ neighbourhood	DJB, Department of Irrigation and Flood Control	Urban flooding, ecological degradation	1. Flood resilience and improved water quality 2. Restoration of freshwater ecosystem and creation of green public space 3. Protection of historic and cultural heritage	Use of low-cost natural methods
6	**Kyalasanahalli Lake Rejuvenation through Collective Community Efforts** Bangalore, India	Ward, settlement	Anand Malligavad (Lakeman of India)	Habitat degradation, pollution	1. Restored ecological balance, reduced pollution and groundwater recharge 2. Enhanced citizen-lake connect with over 3000 volunteers	Economic and quick implementation process
7	**Wetland Management of Neknampur Lake through Nature-based Solutions (NbS)** Hyderabad, India	District	Dhruvansh NGO and Hyderabad ULBs	Pollution, loss of biodiversity, urban flooding	1. Restored ecological balance and enhanced citizen-lake connect 2. Groundwater recharge	Restoration of damaged ecosystems through NbS
8	**Creation of An Artificial Lake Using Treated Water from Pappankalan STP in Dwarka** Delhi, India	Ward	Delhi Jal Board	Water scarcity, groundwater contamination	1. Rise in groundwater table by 7 meters 2. Improved biodiversity and creation of recreation spots for citizens	Reuse of treated used water for recharging aquifers

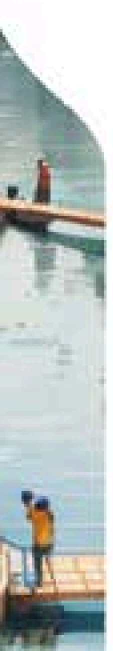
S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
9	**Royal Botanic Gardens – Working Wetlands Royal Botanic Gardens Birdwood Avenue Through Storm water management** Victoria	District/ City	Royal Botanic Gardens Melbourne	Public Utilities Board, National Parks Board	1.Better water quality, wildlife boost, and 20,000+ plants. 2. 40% less potable water used, improved irrigation. 3. Enhanced engagement and aesthetics.	Innovative use of floating wetlands made from recycled materials
10	**Rejuvenation of Parkes Wetlands by retrofitting old infrastructure** Australia	Ward	Parkes Shire Council	Unused Decommissioned Infrastructure, Habitat Loss, Poor Accessibility	1. Enhanced ecosystems and groundwater levels 2. Better town access to blue-green spaces. 3.Improvement in mental health and fitness of locals	Repurposing sewage treatment ponds into a community-centered, ecologically rich wetland
11	**River Restoration at the Bishan Ang Mo Kio Park through the Active, Beautiful and Clean (ABC) Waters Program** Singapore	City/ward	Public Utilities Board, National Parks Board	Water insecurity, pollution and mosquito breeding	1. 48% reduction in flood-prone area 2. 40% increase in water carrying capacity of channels 3. Improved public health 4. Reduced soil erosion	Naturalisation of river flow and public participation
12	**Creation of Bead-like Wetlands which Regulate Floods Through the Qian'an Sanlihe River Ecological Corridor** Qian'an City, China	City/ward	Construction Bureau of Qian'an City	Flood, drought, pollution and unregulated urban stormwater runoff	1. Ecological restoration and rejuvenation of the 'Steel City' 2. Creation of an active public space	Use of low-maintenance native vegetation for collection and dissemination of urban stormwater runoff
13	**Yamuna Biodiversity Park: Restoring Ecology and Water Systems for a Sustainable Capital** Delhi, India	City	Delhi Development Authority, Centre for Environmental Management of Degraded Ecosystems (University of Delhi)	River pollution, ecological degradation, flood risk, biodiversity and habitat loss	1. Groundwater replenishment and biodiversity restoration 2. Flood prevention and management, improved quality of life	Restoration of ecological and natural systems
14	**Flood Mitigation in Rohingya Refugee Camps through Ecological Restoration** Dhaka, Bangladesh	District/ settlement	Centre for Natural Reource Studies (CNRS)	Water scarcity, pollution, environmental degradation, landslides due to deforestation	1. 1100+ acres of degraded land restored 2. 123% increase in biodiversity species 3. Water security and wastewater recycling 4. Awareness and training to 3000 refugees	Active collaboration among all stakeholders for NbS implementation
15	**Beijing Yongxing River Greenway through Sponge Riparian Corridor and Drought-Resistant Plantation** Beijing Daxing District, China	Settlement/ city	Daxing Planning Bureau, Daxing District, Beijing Municipal Government	Lack of stormwater management, habitat degradation, lack of public green spaces	1. Flood resilience and increased green cover 2. Filtration of urban water runoff 3. Pedestrian-friendly, green public space creation 4. 4 km of river developed cost-effectively	Drought-resistant plantation in the wetlands, sponge riparian corridor, and use of recycled materials

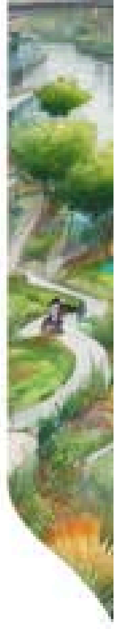


S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
16	**Urban Flood Regulation in Minghu National Wetland Park through Terraced Wetland System** Lupanshui, China	Settlement/ city	Liupanshui Municipality	Stormwater management, native habitat and river water degradation, urban flooding	1. Flood regulation and water recharge 2. National Wetland Park designation (2013) 3. Transformation of wetland into valuable and accessible space	Terraced riverfront landscape, use of existing features for flood control and ecological restoration
17	**Canal Rehabilitation Through Green Infrastructure in Atlasville** Johannesburg, South Africa	Ward/ settlement	Fourth Element Consulting	Flooding and pollution	1. Improved flood protection and water quality 2. Improved public health and reduced diseases 3. Vibrant public space creation, improving quality of life	Addressing floods through NbS
18	**Restoration of the Small Creek concrete channel to a more natural waterway, co-designed with the community** Queensland, Australia	Ward/ settlement	Ipswich City Council Landscapology Bligh Tanner Streamology	Flooding, mosquito breeding, loss of habitat and Degrading water Quality	1. Better water quality, biodiversity, and erosion control. 2. Enhanced community engagement, recreational paths. 3.Increased property values, lower maintenance costs.	Transformation of Small Creek from a concrete drain into a natural waterway.
19	**Angus Creek Stormwater and Reuse Scheme through natural and mechanical treatment processes.** New South Wales, Australia	City	Blacktown City Council and Optimal Stormwater Pty Ltd	Drought, degradation of aquatic ecosystems, increased Algal Blooms	1. Reduced pollutants, erosion, and drought impact with carbon-neutral operations. 2. Boosted community support and local aesthetics. 3.IMajor water savings, lower costs, and self-funded through internal sales.	Integration of stormwater harvesting with natural and mechanical treatment processes.
20	**Slacks Creek Catchment Recovery Project** **City of Logan** South East Queensland, Australia	City	NA	Community Disconnection, Pollution, Habitat Loss	1. Improved water quality, biodiversity 2. Enhanced community resilience and creation of accessible green spaces. 3. Attracted investments from local and state governments.	Comprehensive approach to ecological restoration with strong community involvement
21	**Transformation of Benjakitti Forest Park through Water-quality Remediating Wetland** Bangkok, Thailand	City/ ward	Finance Ministry of Bangkok, Thailand	Urban flooding, inadequate drainage infrastructure, groundwater exploitation	1. Flood mitigation, despite heavy Bangkok rain 2. Largest central green space in the city that promotes an active lifestyle and has become an iconic landmark	Low-maintenance regenerative system of wetlands with mini-islands
22	**Nanchang Fish Tail Park for Flood Resilience** Nanchang, China	City/ neighbourhood	Turenscape Institute	Flooding and habitat degradation	1. Increased stormwater storage potential 2. Reduced pollution and enhanced biodiversity 3. Opportunities for nature exploration	Use of landscape architecture to revitalise the environment



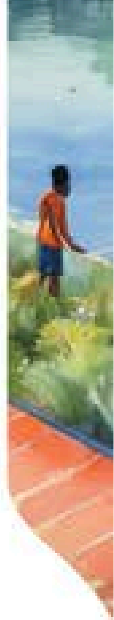
S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
23	**Adyar Ecological Restoration Park** Chennai, India	City/ neighbourhood	Pitchandikulam Forest Consultants and Idea Design	Habitat degradation, flooding, pollution	1. Increase in water spread from 5.53% to 49% and improved water quality 2. Habitat creation, number of birds, butterflies, and reptile species reported	Holistic restoration, sustainable maintenance, and environmental education
24	**Urban Water Management through Sponge City Construction in Qingshangang Wetland Sponge Project** Wuhan, China	City/ ward	Water Affair Bureau of Qingshan District, Hubei Design Branch of Pan-China Construction Group Co. Ltd.	Urban flooding, water pollution, water scarcity	1. Elimination of black, odorous water bodies 2. Coping mechanism for a 50-year rainstorm 3. Urban greenways and recreational areas	Rejuvenation of degraded area using sponge techniques
25	**Stormwater Management at Leidsche Rijn** Utrecht, Netherlands	Settlement/ city	Pitchandikulam Forest Consultants and Idea Design Utrecht Municipality	Housing shortage, uncontrolled urban development, environmental and transportation issues	1. Improved stormwater infiltration, groundwater recharge and reduced flooding 2. Awareness and engagement programs fostering community cohesion 3. Reduced reliance on external water sources, saves costs	Integration of green spaces, sustainable housing, efficient public transport and water management
26	**Sponge Parks for Water Retention** Chennai, India	City/ neighbourhood	Chennai Municipal Corporation	Flooding and groundwater depletion	1. Improved water quality, groundwater recharge and flood protection 2. Cost effective intervention to address local urban flooding	Easy-to-implement strategy to manage stormwater and recharge groundwater
27	**Restoration of Jamburi Park** Dhaka, Bangladesh	Neighbourhood	Ministry of Housing and Public Works of Bangladesh	Illegal land use, lack of open and green spaces	1. Increased flood protection 2. Improved solid waste management 3. Improved community health and well-being	Capitalising on open spaces and creating a functional green area
28	**Gardens by the Bay: Biophilic Design Oasis** Singapore	City	National Parks Board, Singapore	Limited land availability	1. Public space and biodiversity creation & microclimate regulation in a dense urban area 2. Water conservation, energy efficiency, and improved awareness about sustainable practices	Biophilic innovation integrating nature + tech vertical gardens
29	**Luxury Meets Nature: Exploring Biophilic Design at the ITC Grand Chola** Chennai, India	Building	ITC Hotels Ltd.	Lack of humidity control and water management	1. Reduced water demand and creation of an environment-conscious luxury experience 2. LEED Platinum Certification, GRIHA 5-star rating, saving energy and cost	Biophilic design adaptation for a luxury experience
30	**Transformation of Industrial Brownfield Land to a Multi-funtional Living System, Shanghai Houtan Park** Shanghai, China	Settlement/ city	Shanghai World Expo Land Development Co. Ltd.	Flooding, water pollution, environmental degradation	1. Creation of a multi-functional living system using innovative ecological water treatment methods 2. Creation of a productive landscape, educational opportunities about urban agriculture	Constructed wetland, flood protection, urban agriculture, integrating existing industrial structures



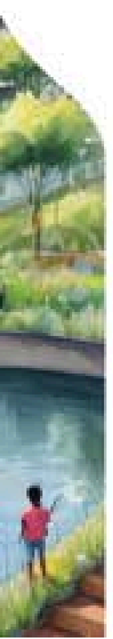


S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
31	**Community Inclusiveness - Water and Sanitation Intervention** Cuttack, India	Ward/ settlement	National Foundation of India	Inadequate water infrastructure, poor health condition, and unemployment	1. Reduced water contamination, water table replenishment 2. Community empowerment and increased awareness about hygiene and sanitation	Community empowerment, especially women, ensuring long-term sustainability
32	**Stormwater Management through Rain Gardens in Renfrew Close** London, United Kingdom	Settlement	London Borough of Newham Council	Flood risk, addressing community capital	1. Reduced stormwater load on existing sewers, improved permeability 2. Enhanced biodiversity, creation of green spaces	Skill development in landscaping and horticulture, creating employment
33	**Nature-based Solutions (NbS) for Community Resilience** Onyika Settlement, Namibia	Settlement	Multi-lateral organisations	Flash floods, lack of basic services and sanitation, environmental vulnerability of informal settlements	1. Improved waste management, water management and flood protection 2. Increased green spaces and improved ecological balance 3. Enhanced safety, social justice, public participation and equitable access to basic resources	Nature-based solutions for community resilience and climate adaptation
34	**Sustainable Urban Drainage Systems (SuDS): Nature-based Solution for Flood Mitigation and Environmental Restoration** Johannesburg, South Africa	Building/ neighbourhood	Johannesburg Department of Environment	Flooding, poor water quality, lack of green spaces and rapid densification	1. Lowered local temperatures, enhanced carbon sequestration, creation of public green spaces, and improved flood protection 2. Improved awareness about NbS	Nature-based solutions for all-round efficient water management
35	**Integrated Water Balance and Quality Model - Restoration and Rehabilitation of Khajrana Talab and Lasudiya Mori Talab** Indore, India	Neighbourhood	Rockefeller Foundation and Indore Municipal Corporation	Flooding, stormwater and rainfall management, poor water quality, biodiversity degradation	1. Improved waste management, water quality, flood protection, and reduced biodiversity loss 2. Equitable opportunities for marginalised and indigenous groups and community-driven management of green spaces 3. Increased awareness about environmental and cultural heritage	Integrated water balance and quality model
36	**Eco-sanitation Transformation by Enhancing Water Efficiency and Green Spaces for Special Needs Education** Lima, Peru	Neighbourhood/ building	Rotária del Perú, Lima, Peru, Centro Educativo Básico Especial (education centre) "San Christoferus", Lima, Peru	Water scarcity	1. Reduction in potable water usage 2. Improved wastewater treatment and reuse 3. Enhanced green spaces and outdoor activities for differently-abled children 4. Reduced costs due to reduced water consumption and income generation	Innovative sanitation solutions with sustainable water management in arid urban areas

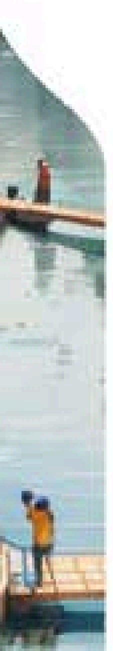
S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
37	**Informed and Improved Urban Water Management for New Infill Development in White Gum Valley** Perth, Australia	Settlement	City of Fremantle, Western Australian Department of Water and Environmental Regulation (DWER)	Water stress due to urbanisation, lack of water literacy	1. 65% reduction in mains water use across various typologies 2. Creation of a high-performance landscaped infiltration basin 3. Improved water literacy in residents, progress towards achieving Perth's water-wise vision	Informed urban water management within new developments in the city
38	**Raincity Strategy for Green Rainwater Infrastructure Management on Woodland and 2nd Street** Vancouver, Canada	Settlement	Green Infrastructure Implementation Branch, City of Vancouver	Water stress due to urbanisation	1. Creation of bioretention planting areas, increased pervious surfaces, urban rainwater infiltration and pollinator habitats 2. Greening of streets encouraged an active lifestyle	Increased stormwater capture capacity for high-density developments
39	**Østerbro Climate Resilient Neighbourhood through Blue-green Corridors, Green Roofs and Permeable Pathways** Copenhagen, Denmark	City	Copenhagen Municipality	Flooding, extreme rain events like cloud bursts, stormwater drainage	1. Biodiversity restoration, improved water and air quality and effective natural drainage 2. Creation of public green recreation space, improved public health and community participation	Climate adaptive neighbourhood planning
40	**Green Dhaka Campaign: Revitalisation of Justice Sahabuddin Ahmed Park for Community Well-being** Dhaka, Bangladesh	Settlement	Dhaka North City Corporation (DNCC)	Lack of waste management and ecological imbalance	1. Mitigation of flood and other climate change related risks 2. Improved livability, mitigation of urban heat island effect, groundwater recharge, and increase in public green spaces	Inclusive urban revitalisation
41	**A Holistic Approach to Achieve City-wide Water Balance: Revival of Traditional Systems and Nature-based Solutions** Chennai, India	City	Special Envoy for International Water Affairs of the Kingdom of Netherlands, Government of Netherlands	Flooding, water scarcity, pollution	1. Groundwater replenishment, reduced water pollution, reduced reliance on external water sources 2. Improved quality of life and awareness about NbS	Holistic approach to achieve city-wide water balance
42	**Grey to Green Scheme: Transformation of Flood-prone Areas Using Sustainable Infrastructure** Sheffield, United Kingdom	Settlement	Sheffield City Council with Robert Bray Associates	Flooding in river catchment areas, river pollution	1. 561% increase in biodiversity value 2. Reduced discharge into the river and flood mitigation 3. Green public space creation that encourages cycling and walking	UK's largest retrofit WSUD project and UK's largest inner city 'Green Street'

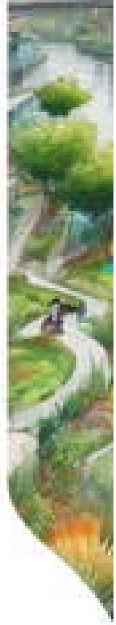


S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
43	**Rainwater Management Initiative Using Green Infrastructure for Pine Street** Vancouver, Canada	Settlement	Green Infrastructure Implementation Branch, City of Vancouver	Poor quality of urban rainwater runoff, overland flooding	1. Creation of bioretention planting area, increased pervious surfaces, 3.1 million litre urban rainwater runoff treated onsite annually 2. Improved public awareness and promotion of an active lifestyle	$30,000 saved by the use of green infrastructure
44	**Imperviousness Fee: An Equitable and Transparent Economic Incentive to Reduce Run-off** Germany	City	Municipal authorities	Groundwater depletion	1. 10,000 ha of roofs greened, balance between pervious and impervious surfaces improved in cities 2. Greater awareness and willingness in communities to manage runoff	Incentivisation to promote adoption of green infrastructure practices
45	**Pathways to Water Resilient South African Cities Project** South Africa	City	The University of Cape Town's (UCT) Future Water Institute and the University of Copenhagen (UCPH)	Water insecurity, flood management	1. Increased infiltration and cleaner stormwater runoff 2. Increased green community spaces and resident engagement 3. Cost savings by retrofitting and integration of existing infrastructure	Water resilience using SUDS and NbS
46	**Sustainable Urbanism with Green Roofs in Hohlgrabenäcker** Stuttgart, Germany	Neighbourhood	Planning Authority, City of Stuttgart	Urban flooding, urban heat island effect	1. Improved micro-climates, groundwater recharge, stormwater storage 2. Water-sensitive mandates enhancing community resilience 3. Cost savings compared to conventional drainage systems	Cost-effective decentralised stormwater management
47	**South East Glasgow Surface Water Management Plan with Attractive Rain Gardens and Community Green Spaces** Glasgow, Scotland	City	Metropolitan Glasgow Strategic Drainage Partnership (MGSDP)- Glasgow City Council, Scottish Water and SEPA	Urban flooding, unregulated surface water runoff, sewer outflow and spills	1. Enhanced flood resilience, improved biodiversity and carbon sequestration 2. Urban cooling, reduced flood damage costs and improved property values	Use of swales to collect runoff and direct it to a permeable-surfaced multi-use games area, raingardens
48	**Fitzroy Garden Stormwater Harvesting System: A Model for Urban Sustainability** Melbourne, Australia	City	The City of Melbourne's Urban Water Department	Climate change impact on heritage and environmentally significant areas	1. Reduced reliance on potable water for irrigation purposes and climate change adaptation of heritage greens 2. Enhanced user experience, improved public awareness	Efficient stormwater and rainwater management using WSUD

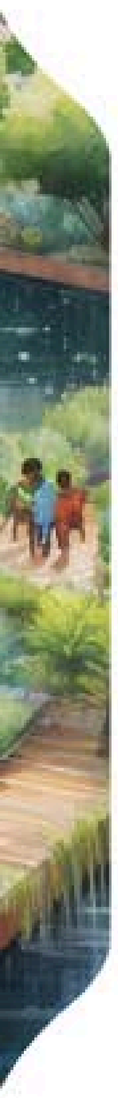


S. No.	Title of Case Study	Scale	Implementation by	Challenges Catered	Impacts	Project USP
49	**Green and Clean: Water Sustainability at IIMB Campus** Bangalore, India	Building	IIMB	Limited water resources, lack of awareness	1. Reduced water consumption, improved groundwater quality, and recharge of local aquifers 2. Increased awareness and collective environmental responsibility on-campus	Water conservation and energy savings
50	**City Within a Garden Emphasising on Green Roofs to Improve Air and Water Quality** Singapore	Building-scale, city-wide	National Parks Board Singapore, Housing Development Board	Stormwater management, wasted surface runoff, flooding, urban heat island effect	1. Reduced urban heat island effect and improved air quality 2. Enhanced visual appeal, accessible green roofs serve as community spaces, and improved food security 3. Energy and cost savings due to reduced need for air conditioning, contribution to green building certifications and incentivisation for developers	Extensive integration of green roofs, vertical greenery for enhanced sustainability and livability





EXECUTIVE SUMMARY



Water Sensitivity is a concept that looks at natural and anthropogenic urban water elements in an integrated manner, transforming cities from basic service-provision units to adaptive and climate-resilient environments that benefit the communities and the environment at the same time. The concept manifests in urban setups through Water Sensitive Urban Design, ensuring cities are both resilient to climate change and beneficial to their communities while being economically viable.

Over 90% of Indian cities struggle with waterlogging and flooding. For instance, Delhi received 228.1 mm of rain in just 24 hours in June 2024, exceeding the monthly average and causing widespread disruption (Indian Meteorological Department). A decline in monsoon rainfall over the last 6–7 decades has increased the frequency and extent of droughts in India. Around 70% of India's underground and surface water resources are contaminated (Sudhakar M. Rao et al, 2004). Indian cities have lost 70-80% of their water bodies in the past 40 years, reducing natural water storage and disrupting the water cycle.

These issues highlight the urgent need for an integrated approach to urban planning and development to manage water, reduce flooding, improve water quality, and restore the natural water cycle.

There are only a few Indian cities that have planned developments. Most Indian cities are characterised by unplanned developments and challenges like limited availability of land, lack of funding avenues, siloed operations of governing agencies, and lack of community awareness that inhibit the urban transition to a water-sensitive city.

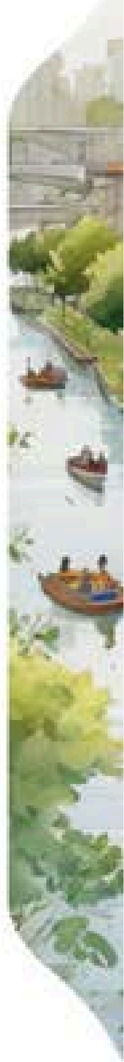
This initiative, undertaken at the request of one of the *Delhi Water Forum* Members for technical assistance, aims to serve as a reference document for interventions that Indian cities can potentially undertake.

This compendium involved extensive secondary research to identify relevant case studies. These cases were then categorised into five thematic areas, which were formulated based on prevalent urban water management challenges of India. The cases were analysed against the Water Sensitive Cities (WSC) goals, defined by Cooperative Research Centre for Water Sensitive Cities (CRCWSC) Australia, to highlight their alignment with water-sensitive urban design principles.

The Compendium on Water-Sensitive Urban Design (WSUD) Practices provides an overview of sustainable and tangible approaches for urban water management, showcasing 50 water-sensitive initiatives featuring 14 cases from Indian cities and 36 international cases. The cases of the compendium are divided into five categories: Lakes and Waterbodies Rejuvenation, River Related Initiatives, Parks and Public Spaces, Community-centric Interventions, and Planning Interventions. The document highlights the implementation process of projects under these thematics and how they can be scaled up in Indian urban contexts. It also emphasises existing frameworks and policies aligned with WSUD and includes matrices to illustrate co-benefits, SDG alignment, and WSC goals.

Through this guide, urban planners, policymakers, and stakeholders can:

- understand the importance of Water Sensitive Urban Design elements and their implementation.
- mainstream Water Sensitive Urban Design approaches into urban planning and development processes in various contexts.
- access a curated list of detailed examples of the successful application of WSUD in various urban contexts with actionable insights for implementation.
- sensitise themselves and the urban planning community to the benefits of WSUD practices through global and national case examples.



WSUD CONTEXT & ECOSYSTEM

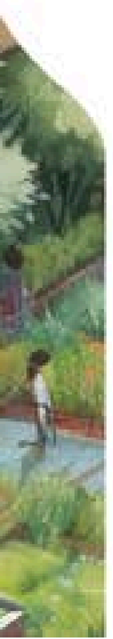
WATER SENSITIVE CITIES

Policies in Australia are designed to incorporate the management of catchments in order to enhance water resource utilisation, mitigate risks to human life and property such as flood resilience, reduce surface or groundwater inundation/water-logging, and uphold economic, social, and cultural values.

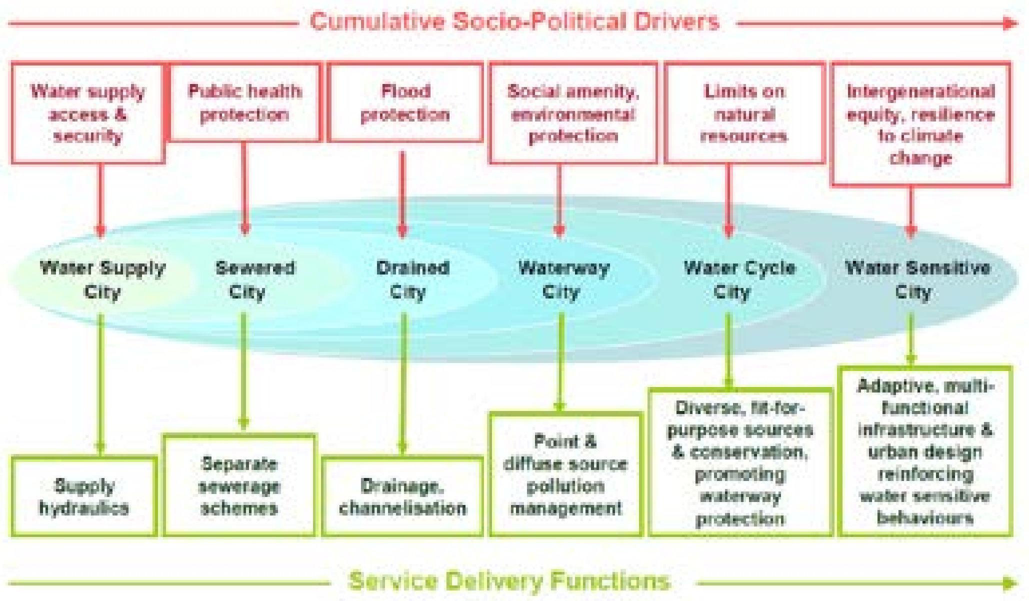
Australia's dedication to Water Sensitive Urban Design is enhanced through the activities of the Cooperative Research Centre for Water Sensitive Cities, which guides urban areas in a six-step process to transition into "water sensitive cities." While WSUD is acknowledged nationwide in Australia, the specific priorities of its components are adjusted according to the characteristics of local environments. Planners are now broadening their perspectives beyond engineering solutions as they progress towards the development of water sensitive cities.

On the other hand, while there is enough knowledge about water-sensitive city approach in India, the translation of this knowledge into practice has been fairly limited.

The Australia India Water Security Initiative (AIWASI) is helmed by Australia's Department of Foreign Affairs and Trade (DFAT) and India's Ministry of Housing & Urban Affairs (MoHUA). Under this initiative, the National Institute of Urban Affairs (NIUA), in association with World Resource Institute (WRI), McGregor Coxall (McGC), and Mahila Housing SEWA Trust (MHT), are working on a project aiming towards a resilient water-sensitive vision for Delhi based on the holistic management of integrated water cycle.

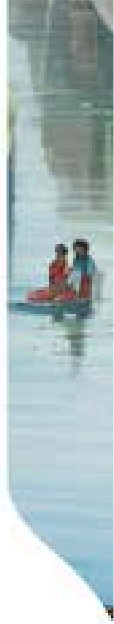


Right image: The six-step process to transition into a Water Sensitive City
Source: Wong et. al, 2008



The Water Sensitive Cities (WSC) Index, developed by the *Cooperative Research Centre for Water Sensitive Cities,* is a diagnostic tool to assess the water sensitivity of a city and inform management responses to improve water sensitive practices. Its 34 indicators are organised into seven goals:

89% of the cases in this Compendium cover all the 7 goals of Water Sensitive Cities Baseline

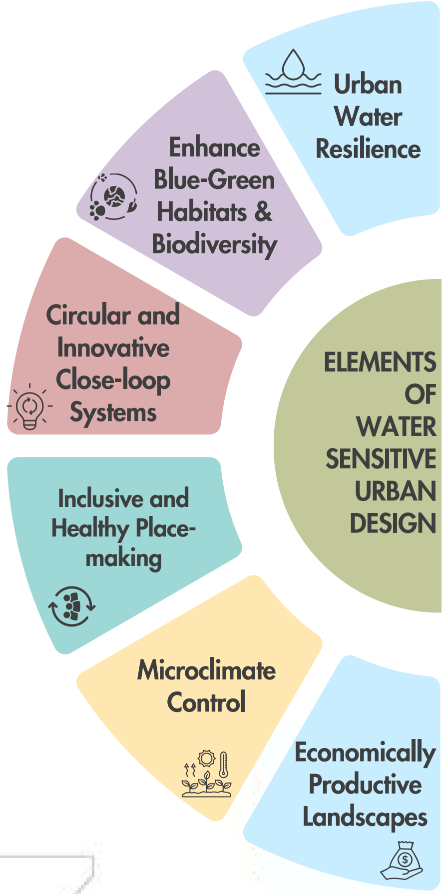


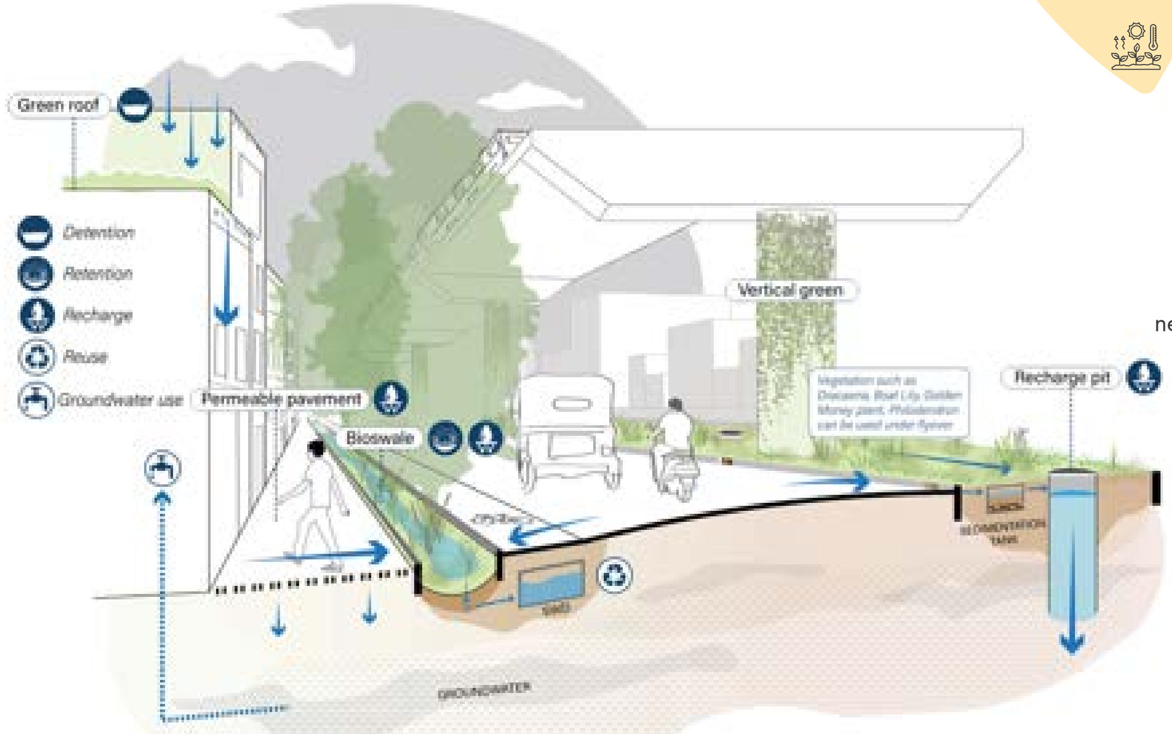
URBAN SNAPSHOT

Water-sensitive urban design (WSUD) is an approach to plan and design urban areas to conserve and restore the natural water cycle by integrating the built, open and greens to harness rainfall and protect rivers, lakes, other water bodies and groundwater.

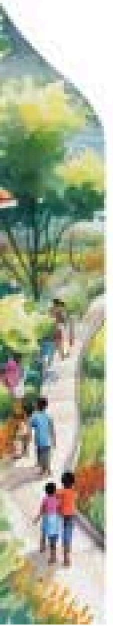
WSUD comprises a plethora of elements and components that work together to manage urban water sustainably. WSUD is characterized by green infrastructure, such as rain gardens, green roofs, and artificial wetlands, which help to capture, filter, and reuse stormwater.

Right image:
Elements of WSUD





Left image:
Interlinking transit corridors, building roofs, and neighbouring unused urban spaces for systemic capture of rainwater and recharge of groundwater
Source: WRI India, Illustration by Sindhuja Janakiraman

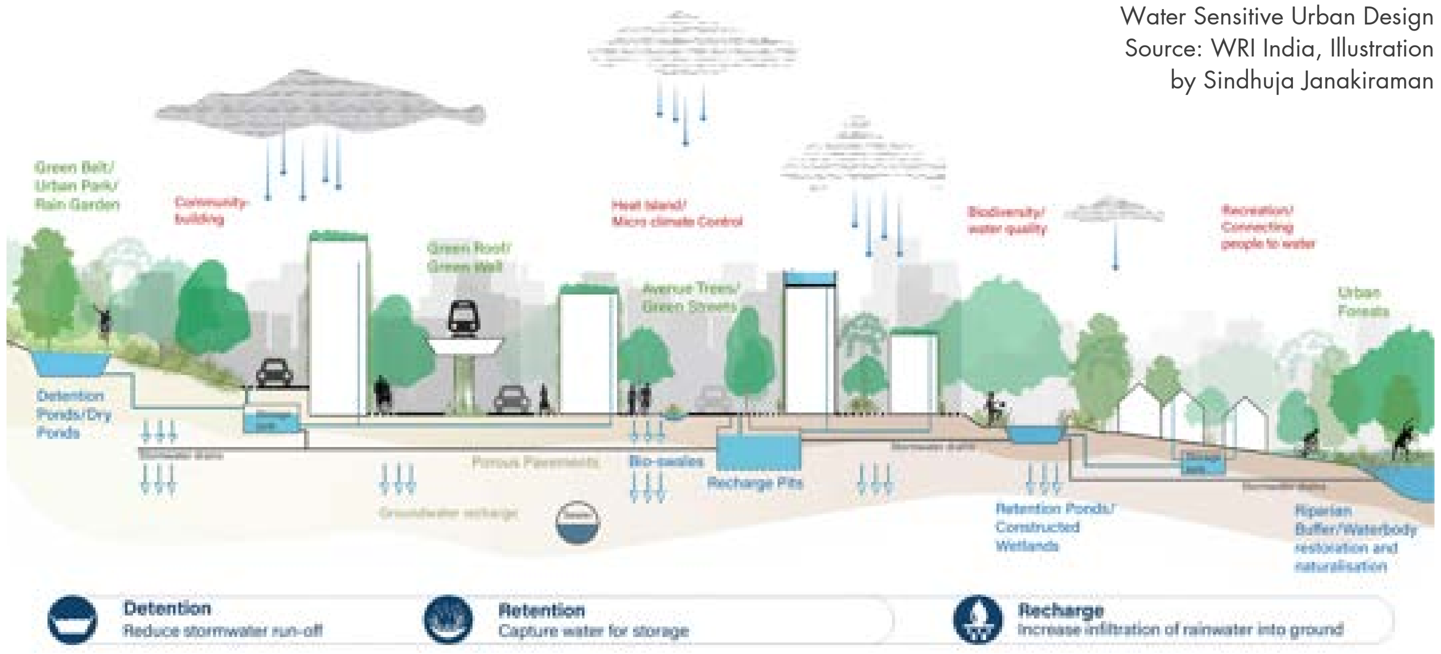


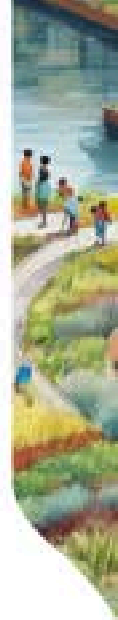
It integrates the natural water cycle into urban design to create resilient, liveable, and sustainable cities at four intervention levels.

1. City Region Level (urban and peri-urban): Involves policies, planning, and programs across the city region, including major waterways.
2. City Level: Includes permeable pavements and bioswales to manage urban runoff, recharge groundwater, and promote green corridors.
3. Neighbourhood Level: Encourages community involvement and local environmental benefits through community gardens and localized stormwater systems.
4. Building Level: Implements green roofs and rain gardens for water conservation and management.

WSUD enhances community well-being, promotes water-efficient landscaping with native species, and ensures social equity with access to clean water and green infrastructure. The goals are resilient urban areas, sustainable water management, improved liveability, and social equity, aiding cities in facing climate change and water challenges.

Below image: Components of Water Sensitive Urban Design
Source: WRI India, Illustration by Sindhuja Janakiraman





HOW TO USE THIS COMPENDIUM?

The compendium has been divided into these 5 broad thematic areas with different case studies showcasing various water sensitive urban design solutions:

Colours of Thematic Areas

Thematic Area	No. of Cases
Lakes and Waterbodies Rejuvenation - includes lakes, ponds, drains, and other water bodies	10
River Related Initiatives - includes rivers, creeks, river surroundings, and canals	10
Parks and Public Spaces - includes parks, wetlands, green areas, gardens, and other public spaces	10
Community-centric Interventions - includes initiatives led by communities or involving public awareness	9
Planning Interventions - includes initiatives with the perspective of urban planning, city drainage, green roofs, and rain gardens	11

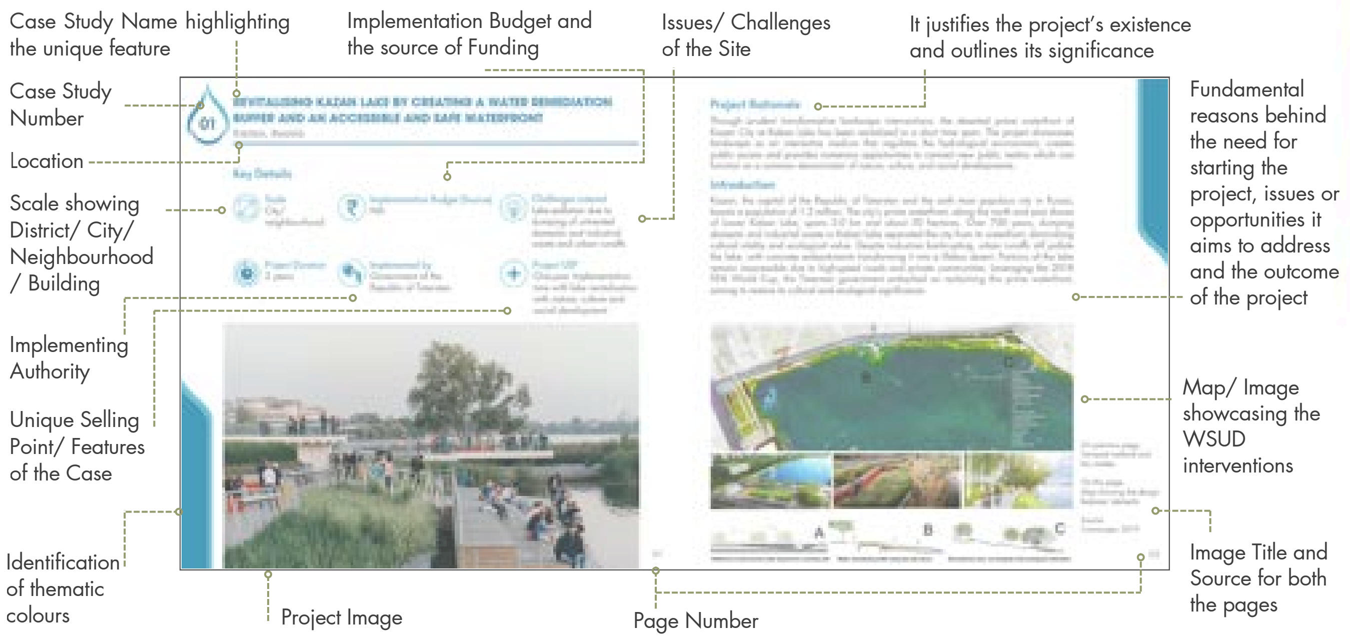
Each case study documentation delves into the process of designing and implementation, along with the impacts seen post implementation. The case studies have been curated based on the typical challenges faced in urban areas and how WSUD solutions have helped resolve the issues and provided multiple social and economic co-benefits. It also highlights the replicability of these solutions in the Indian urban context.

In addition, the compendium has been divided into the following sections:

- ***The Introduction*** section details the concept of Water Sensitive Cities, the importance of Water Sensitive Urban Design (WSUD), its constituent elements and components, and various scales of application in urban contexts.
- ***The Way Forward*** section highlights the co-benefits mapped for each case and their synergies with the Sustainable Development Goals.
- The section on ***Indian policies, missions, frameworks, and guidelines*** provide information on the various urban policies and programs that have alignment with WSUD and can provide funding avenues for adopting WSUD projects.
- Finally, ***the key considerations for implementation*** section emphasizes the ***'where' and 'why' it works*** for each case study and provides site conditions for successful implementation.

This document is designed for city officials, policymakers, and community groups and aims to promote the benefits of water-sensitive urban design to transform cities into inclusive, resilient, and water-sensitive environments. The goal is to enable stakeholders to select specific elements from the entire project and apply them in urban areas across India while also encouraging stakeholder participation and inclusivity.

Outline of the sections of each Case Study



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LAKES AND WATERBODIES REJUVENATION

Discover the transformative potential of Water Sensitive Urban Design with “Rejuvenation of Lakes and Other Water Bodies”. This concise guide offers practical insights and strategies for restoring urban waterways to their natural splendour. Dive into innovative approaches tailored to revitalising lakes and other aquatic ecosystems, ensuring sustainable water management and resilient urban environments.

01 REVITALISING KABAN LAKE BY CREATING A WATER REMEDIATION BUFFER AND AN ACCESSIBLE AND SAFE WATERFRONT

Kazan, Russia

Key Details

Scale
City/ neighbourhood

Implementation Budget (Source)
NA

Challenges catered
Lake pollution due to dumping of untreated domestic and industrial waste and urban runoffs

Project Duration
2 years

Implemented by
Government of the Republic of Tatarstan

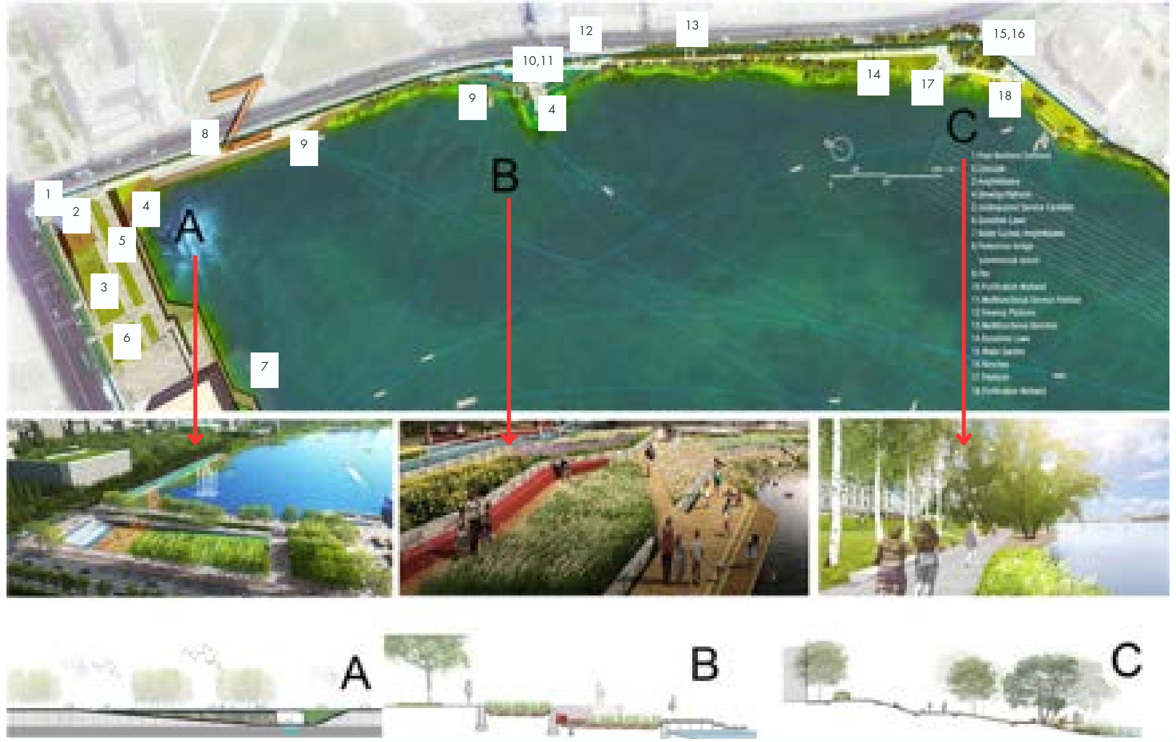
Project USP
One-year implementation time for lake revitalisation with natural, cultural, and social development

Project Rationale

Through thoughtful and transformative landscape interventions, the once-abandoned prime waterfront of Kazan City at Kaban Lake has been revitalised in a short period. The project highlights the use of landscape as an interactive medium that manages the hydrological environment, creates public access, and offers numerous opportunities to connect new public spaces that can serve as a common ground for natural, cultural, and social development.

Introduction

Kazan, the capital of the Republic of Tatarstan and Russia's sixth largest city with 1.2 million residents, features a prime waterfront along the north and east shores of the Lower Kaban Lake. This area spans 2 km and approximately 30 hectares. For over 700 years, domestic and industrial waste dumping isolated the city from its waterfront, reducing its cultural and ecological value. Even after industries closed, urban runoff continued to pollute the lake, and concrete embankments turned it into a lifeless zone. Parts of the lake remained inaccessible due to high-speed roads and private properties. Seizing the opportunity of the 2018 FIFA World Cup, the Tatarstan government initiated efforts to reclaim the waterfront and restore its cultural and ecological significance.



1. Park Northern Entrance
2. Cascade
3. Amphitheatre
4. Viewing platform
5. Underground service facilities
6. Sunshine lawn
7. Water curtain amphitheater
8. Pedestrian bridge / commercial stores
9. Pier
10. Purification wetland
11. Multifunctional service pavilion
12. Viewing platform
13. Benches
14. Sunshine lawn
15. Water garden
16. Benches
17. Platform
18. Purification wetland

A. Platforms are built into the water B. Water remediating bugger along lake shore C. Recreational uses integrated with ecological restoration

On the previous page: Terraced wetland and bio swales.

On this page: Map showing the design features/ elements. Source: Turenscape, 2019

Process Involved

To tackle these challenges, the Kaban Lake waterfront revitalisation project was commissioned to restore the vitality of Kazan's prime waterfront through three major transformative strategies:

01 Improving Accessibility and Safety: The waterfront's brutal concrete flood walls and traffic roads were replaced with a series of platforms and boardwalks, extending into the water beyond the concrete embankment. Ramps and stairs connect these floating pedestrian paths to the land-based paths. Additionally, bicycle and pedestrian trails were built along the lake shore, with numerous seating areas provided along the paths and platforms.

02 Creating a Water Remediation Buffer: Terraced wetlands and bioswales were installed along the lake shore to catch runoff from small ditches and urban surfaces. These biological infiltration facilities are integrated with recreational design and public education.

03 Introducing Programmed Activities: Collaborating with the Ministry of Culture and local communities, the project introduced various cultural and sports activities, music concerts, summer night movies, morning yoga sessions, and environmental education tours during the day.

Before

After

On this page:
Top- Community activities like yoga at the lakefront
Middle & Below - Series of before and after images of the project.

On the next page:
Music concerts and events at the waterfront.

Source: Turenscape, 2019

Impacts

Environmental

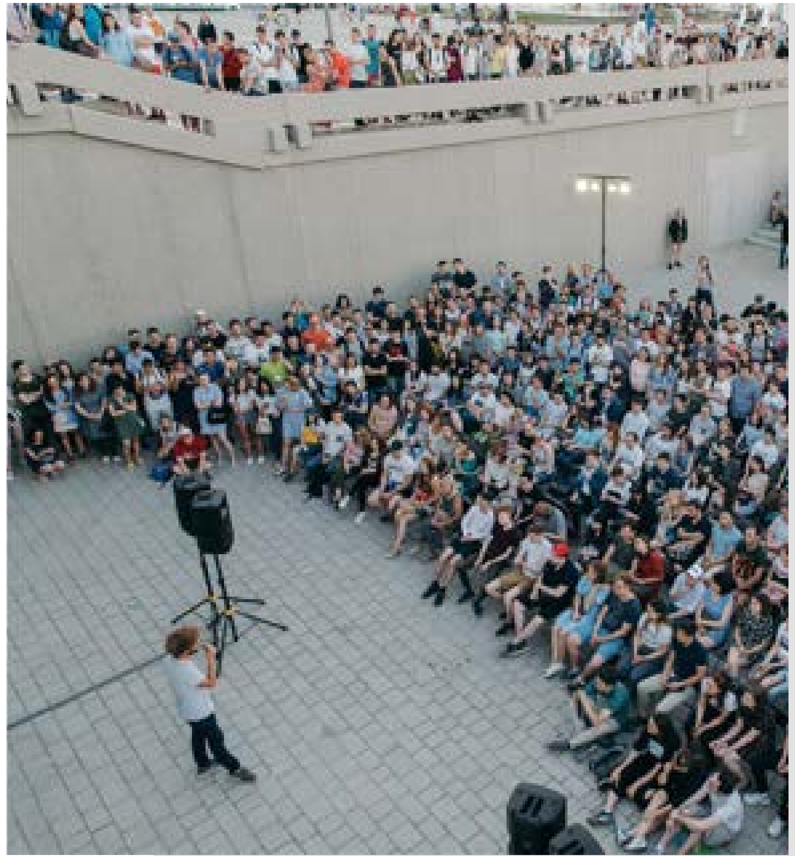
- Cleansed, vegetated lakefront attracts migrant and resident birds
- Reclaimed waterfront fosters ecological health and cultural vitality

Social

- Formerly deserted waterfront attracts approximately 50,000 daily users
- Diverse groups gather for various activities, fostering inclusivity
- Venue hosts concerts, movies, yoga, weddings, and other recreational events

Economic

- Project was implemented in a one-year time frame after the design



Scale it Up!

A similar idea with floating platforms and boardwalks, linked by ramps and stairs, and adding bicycle and pedestrian trails could be added to the existing lakes in any city to encourage positive people interaction. Implementing water remediation measures like terraced wetlands and bioswales along the riverbanks and the waterfronts would filter urban runoff and create an integration of recreational spaces.

Scan/Click to read more

02 RESTORING STORMWATER DRAINS THROUGH RAIN GARDENS UNDERNEATH BEGUMPET FLYOVER

Hyderabad, India

Key Details

Scale
Ward, Settlement

Implementation Budget (Source)
Rs 1.9 Crore
(Public local authority budget)

Challenges catered
Water security and pollution, mosquito breeding

Project Duration
3 months

Implemented by
Hyderabad Metropolitan Development Authority (HMDA)

Project USP
Natural wastewater treatment

Project Rationale

Begumpet is a major commercial and residential area in Hyderabad, situated to the north of Hussain Sagar lake. Before entering the Musi River, the water from several rainstorms and drain channels passes through the intersection of the Kukatpally Nala and the Yousufguda Nala, which is located in Begumpet. The Rain Garden Project has been designed to restore, conserve, and regenerate stormwater drains, especially ones crossing the intersection.

Introduction

Hyderabad faces the issue of urban flooding due to the degradation of stormwater drains and their use as dump yards by locals and businesses. This has resulted in water stagnation, mosquito breeding, and the spread of deadly diseases.

The Rain Garden Project covers an area of 20,000 sq.m. and lies below the Begumpet flyover. It protects land along the Begumpet Nala by integrating ecology with open public spaces. It aims to clean the polluted nala, separate the drain channel from the rainwater channel, plant native species, enhance public amenities, and facilitate wastewater management through wetlands.

On the previous page: Restored Begumpet Nala. Source: The Hindu, 2023

On this page: Landscaping underneath Nala. Source: Arvind Kumar, 2021

Process Involved

The project was initiated by the Department of Municipal Administration and Urban Development and implemented by Hyderabad Metropolitan Development Authority (HMDA).

01 Cleaning of debris and garbage dump at the Kukatpally Nala helped clear blockages for a smooth flow of water.

02 Heavy plantation along the edges of the nala was used to create a natural wetland system and foster groundwater recharge. It has been executed using native species like *vetiver typha latifolia, canna, cyperus alterniforus* and *ipomea carnea,* which reduced mosquito breeding in the Nalas.

03 Boulder aprons have been used along the nala edges to prevent soil erosion.

04 Public amenities at the nala have been improved using 10-foot-wide walking tracks shaded by coconut palms, crossover bridges, stepped green lawns beneath the flyover and well-lit landscapes illuminated by LED lights to enhance safety during nighttime

On this page:
Top-Clearing of debris.
Middle-Terraced plantation.
Below-Boulder aprons.

On the next page:
Raingarden at Begumpet Nala.

Source: Arvind Kumar, 2021

Impacts

Environmental

- Smooth flow of water
- Increased flood protection
- Improved water quality
- Prevention against soil erosion

Social

- Reduced diseases leading to improved public health
- Vibrant public space adding to quality of life

Economic

- Costs for desilting and wastewater treatments saved

Scale it Up!

There are several underutilised areas across the city, such as traffic islands and spaces under flyovers. These can be redesigned to act as water sponges for the city. These interventions will not only promote groundwater recharge and reduce waterlogging, but also make these underutilised spaces aesthetically pleasing and secure for citizen health and well-being.

Scan/Click to read more

03 BUILDING FLOOD RESILIENCE THROUGH LAKE REDEVELOPMENT AND INTERLINKING OF LAKES

Ahmedabad, India

Key Details

Scale
City/ neighbourhood

Implementation Budget (Source)
Rs 44 Crore (CRDF)

Challenges catered
Flooding, water scarcity, lake pollution, groundwater depletion

Project Duration
12 years

Implemented by
Ahmedabad Urban Development Authority and Ahmedabad Municipal Corporation

Project USP
Creation of public spaces/waterfronts

Project Rationale

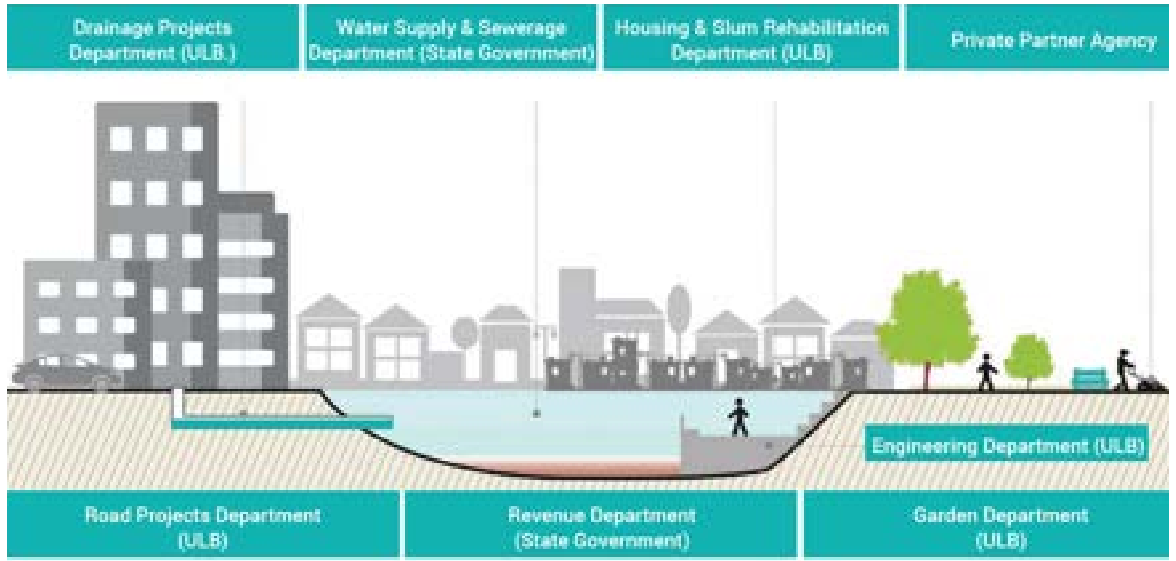
The project focused on interlinking lakes in Western Ahmedabad to tackle issues like waterlogging, water insecurity, and groundwater depletion. It aimed at improving the liveability of the area through lake-front development and creating green public spaces. While it successfully improved groundwater in some areas, no significant improvement has been seen in water quality due to issues like solid waste and sewage disposal.

Introduction

Ahmedabad suffers from extreme climatic conditions and groundwater depletion. In 2000, it experienced its worst flood after 1927, which led to the loss of countless lives and goods worth INR 5,000 million. Unplanned and unregulated construction had led to the loss of surface water bodies or *Talavadis*, and it was found that 75% of the buildings in AUDA were found to be violating the Gujarat Town Planning and Urban Development Act (GTPUDA).

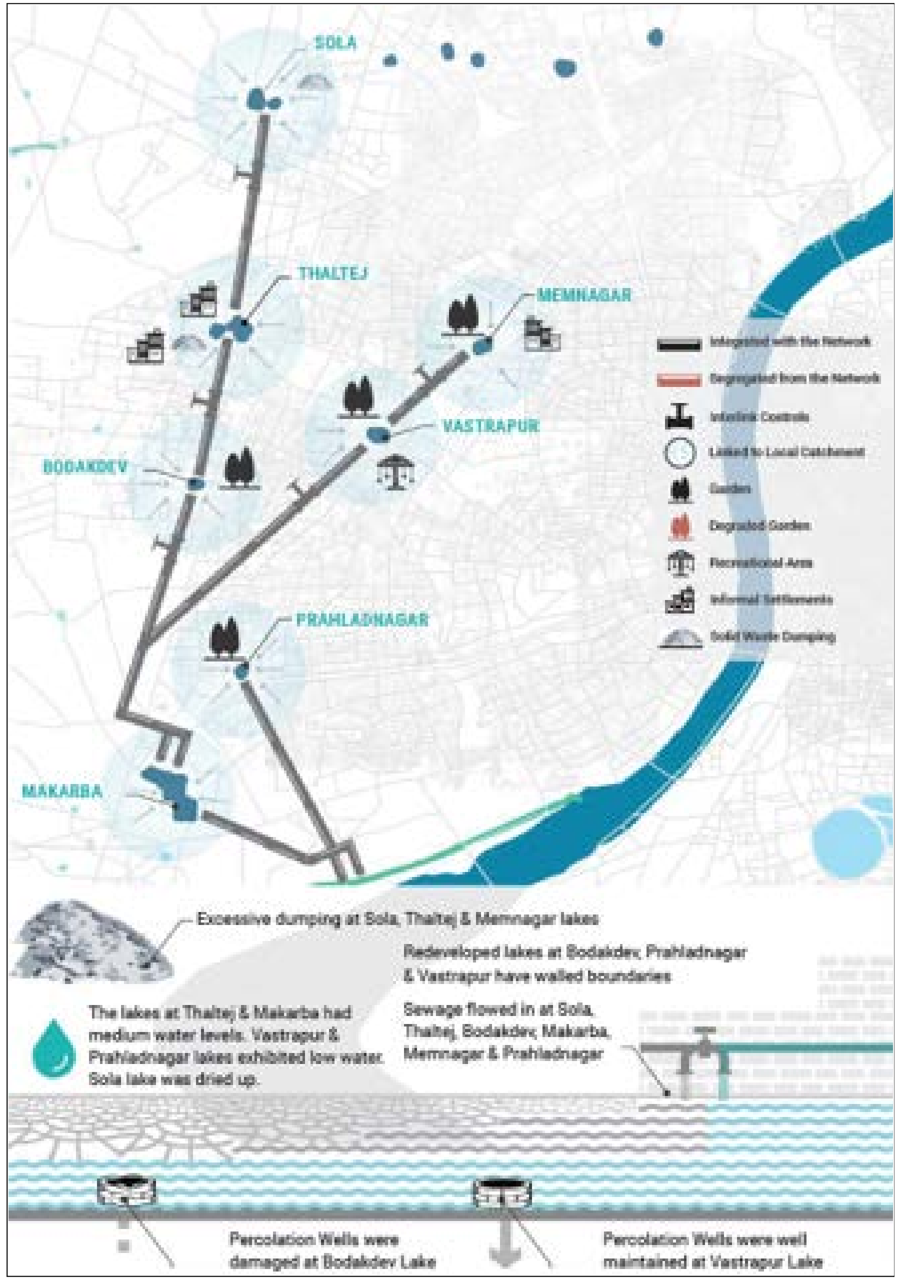
Appropriation of lake land for other purposes, informal settlements on lake land, and approval of building permissions under TP Schemes are some causes that triggered water-centric issues in the city. Most of these lakes were also found to be smaller than five hectares, limiting their capacity to store rainwater.

Thus, the Lake Redevelopment and Interlinking Project addressed water-related issues by integrating city-level infrastructure development with a sustainable urban water management system.

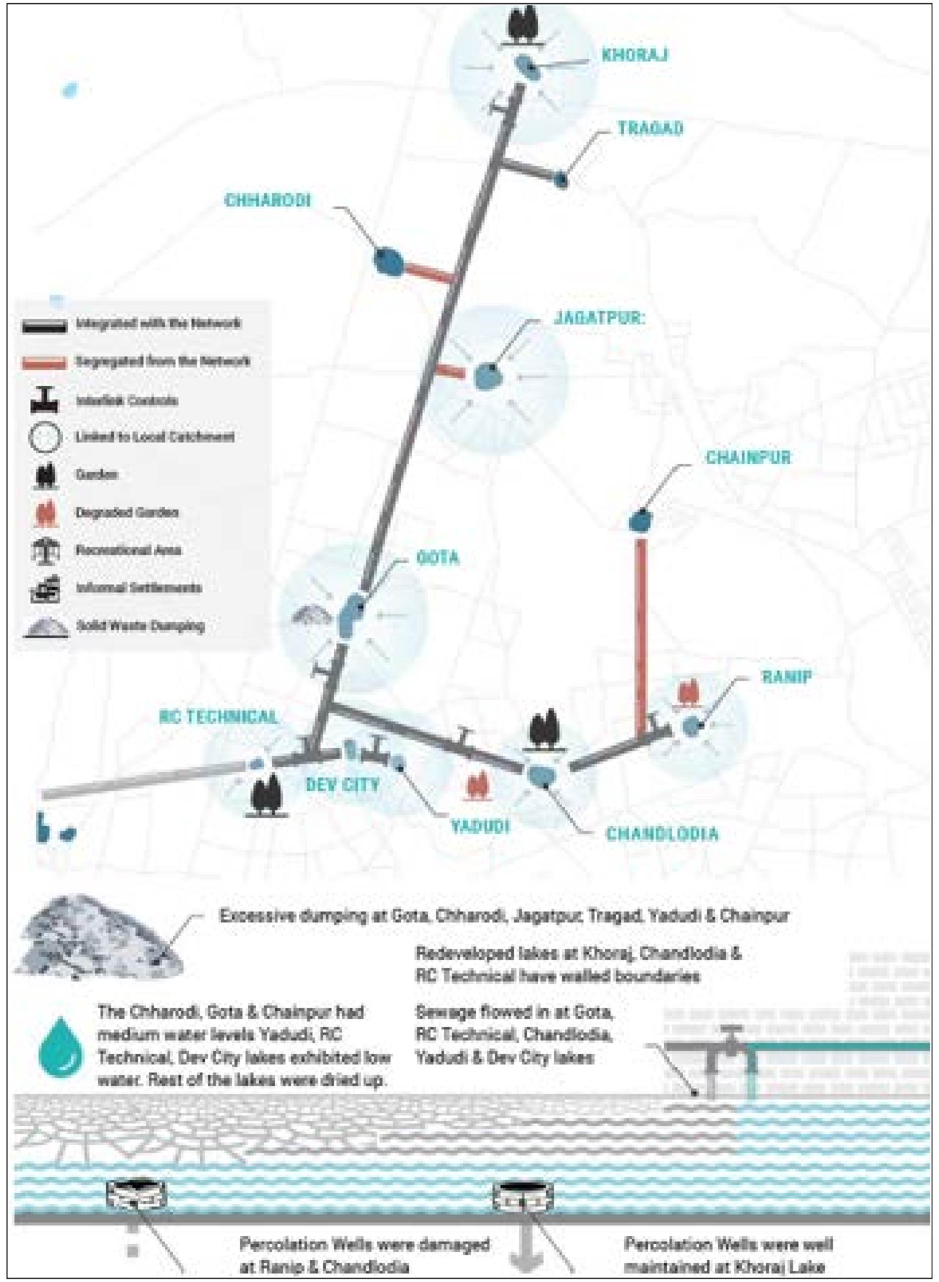


On the previous page: Kankaria Lake Redevelopment. Source: AMC, 2020

On this page: Representation of all the agencies involved in the lake development project. Source: CRDF, 2020



Cluster 1 for the interlinking of lakes in Sola, Memnagar, Vastrapur, Bodakdev, Prahladnagar, Makarba areas (Source: CRDF, 2020)



Cluster 2 for interlinking of lakes in Khoraj, Tragad, Jagatpur, Gota, Dev City, Yadudi, Chainpur, Ranip and Chandlodia areas (Source: CRDF, 2020)

Process Involved

The project was initiated and implemented by Ahmedabad Urban Development Authority (AUDA) and Ahmedabad Municipal Corporation (AMC) at the neighbourhood scale to have an interconnected system at the city-scale.

01 Redevelopment of lakes to create public recreational and green spaces at the waterfronts, that were accessible to all.

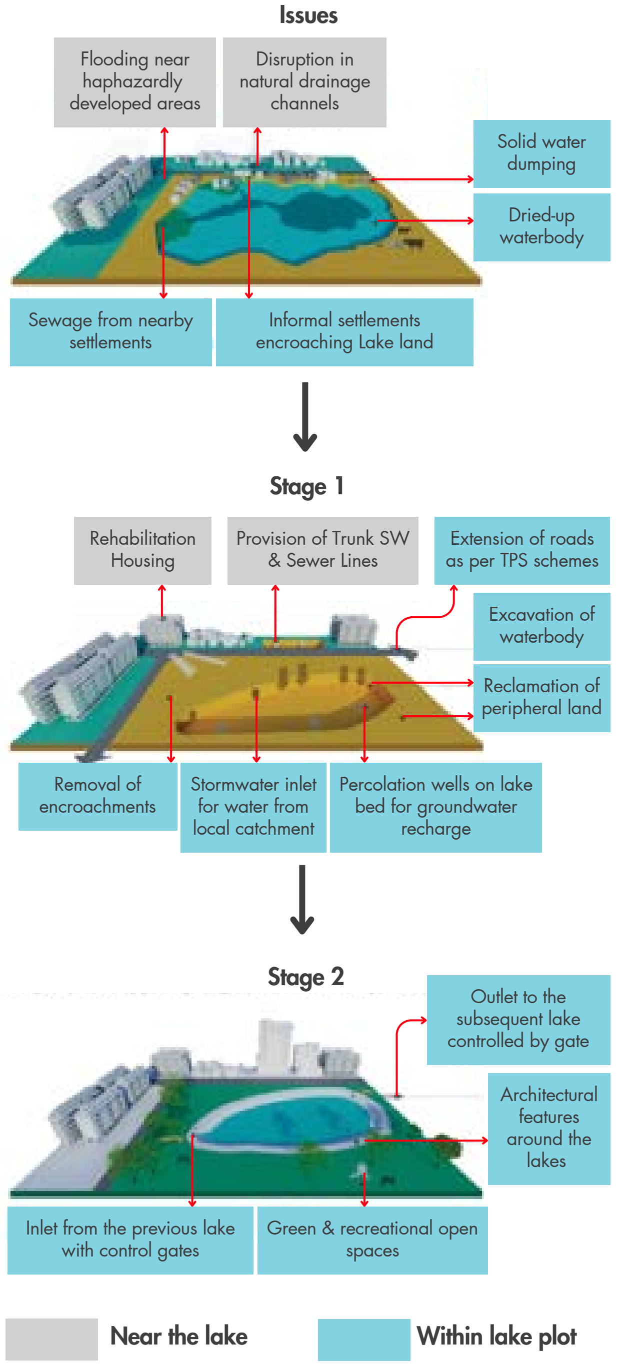
02 Interlinkage design was done to enable a system of small lakes that function together as a larger urban hydrological system in western Ahmedabad. Divided into two clusters, the first interlinking connects 7 lakes and the other connects 11.

03 Flow has been aligned to the natural slope and controlled using sluice gates and valves.

04 Sewerage system was developed near lakes to prevent sewerage disposal into them. Stormwater drains was constructed in the catchment to ensure stormwater outfall in the lake.

05 Lakebed was de-silted and deepened to enhance its capacity for carrying rainwater.

06 Wells, with diameter of 300-600 mm and up to 35 mm deep, were constructed for enhanced groundwater recharge.



On this page:
Project Components of the LRIL project (issues, stage 1, stage 2)
Source: CRDF, 2020

On the next page: Lake redevelopment.
Source: AMC, 2020

Impacts

Environmental

- Groundwater level increased at a rate of 0.71-2.2 m per year (2003-2019) around the two lakes
- Increase in green cover
- Reduction in flooding in some areas. Waterlogging continued in others due to issues with linkages
- Increase in lake water pH due to poor treatment of runoff

Social

- Vibrant public space adding to the quality of life
- Increased footfall in the lake area
- Rehabilitation provided quite far from lakes in most cases
- Issue of gentrification observed

Economic

- Rise in real estate value, which eventually stabilised because of maintenance of the lakes

Scale it Up!

Interlinking smaller water bodies to create an urban water-sensitive ecology holds strong potential for enhancing water security in cities, addressing flooding, loss of surface water bodies, and groundwater depletion. This project requires planning and implementation at both macro (city) and micro (neighborhood) levels, with efficient coordination among all involved agencies. When replicating this model in other cities, local challenges and potential drawbacks must be carefully addressed.

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04 INTEGRATED URBAN WATER MANAGEMENT OF THE HATIRJHEEL AREA THROUGH ENGINEERED AND NATURE-BASED SOLUTIONS (NbS)

Dhaka, Bangladesh

Key Details

Scale
Neighbourhood

Implementation Budget
Rs 36 Crore

Challenges catered
Pollution, Loss of Biodiversity, Urban Flood

Project Duration
7 years

Implemented by
RAJUK (Rajdhani Unnayan Kartipakkha)

Project USP
Integration of engineered solutions with NbS

Project Rationale

With an emphasis on both environmental issues and urban aesthetics, the Hatirjheel development project aimed to rebuild wetland ecosystems and bring water-edge elements into Dhaka. The project has contributed in managing stormwater, restoring the wetland, and reducing traffic congestion while also generating revenues for the city.

Introduction

Before the Hatirjheel development project began in 2009, the inhabitants in the area faced issues of unsanitary living conditions. Some of the main issues in the local areas were traffic congestion and uncontrolled disposal of waste from the neighbouring areas. The initiative has improved the diversity of aquatic life and the regulation of stormwater in Dhaka. This progress was facilitated through rehabilitation of the Hatirjheel Lake.

The initiative has provided micro-catchment for stormwater retention while rehabilitating the deteriorated ecosystem by turning its wastewater canal into a freshwater lake.

On the previous page: Hatirjheel Area with newly developed bridges and greenery.
On this page: Integration of Engineered solutions with blue infrastructure.
Source: Urban Nature Atlas, 2021

Process Involved

The project was initiated and implemented by RAJUK (Rajdhani Unnayan Kartipakkha), and it took 7 years to rejuvenate and restore Hatirjheel lake, which is now surrounded by a dense urban area.

01 The initial planning phase involved conceptualising the project, assessing the site, and obtaining necessary approvals and authorisations from relevant authorities.

02 Detailed design plans were developed, incorporating considerations for wetland restoration, water-edge features, stormwater management, and recreational facilities.

03 Excavation, construction of walkway, bridge and recreational amenities (like boating, water taxi, fishing, etc.) were carried out.

04 To manage stormwater, wetland restoration projects were started, along with the installation of drainage infrastructures.

On this page:
Top-Water Taxi System of Hatirjheel.
Source: The Confluence, 2023

Middle-Hatirjheel Amphitheatre
Source: The Confluence, 2023

Below-Restored Hatirjheel.
Source: The Daily Star, 2024

On the next page:
Locals fishing at the Rejuvenated Hatirjheel Lake.
Source: The Confluence, 2023

Impacts

Environmental

- Restored the Wetland Ecosystem of the *Jheel*
- Enhanced the stormwater storage potential of the area

Social

- Increased recreational avenues

Reduced traffic congestion of the adjacent areas

Economic

- Generation of revenues through interventions like water taxi and amphitheatre

Scale it Up!

Urban areas facing traffic congestion, environmental decline, and limited green spaces can implement tailored interventions by adapting approaches to local settings. Collaborative governance and community involvement are essential. Establishing recreational areas along waterfronts, incorporating blue-green infrastructure, and integrating these with built structures can make cities more water-sensitive.

Scan/Click to read more

05 RAJOKRI LAKE REJUVENATION PROJECT

Delhi, India

Key Details

Scale
District/ neighbourhood

Implementation Budget (Source)
Rs 1.78 Crore

Challenges catered
Urban flooding, ecological degradation

Project Duration
1 year (2017-18)

Implemented by
DJB, The Department of Irrigation and Flood Control

Project USP
Use of low-cost natural methods

Project Rationale

The Rajokri Lake Rejuvenation Project tackles several challenges in Delhi. By creating a reservoir, it aims to control urban flooding and also focuses on cleaning the lake, improving water quality, and aiding groundwater recharge. Additionally, ecological restoration will help bring back plants and animals. This initiative will benefit the society as well, through the creation of public green recreational space, which will improve residents' well-being.

Introduction

In 2018, Delhi faced a severe water crisis, prompting the government to explore solutions like reviving urban water bodies. The Rajokri Lake, a 2.33-acre water body near the Delhi-Gurgaon border, was chosen for a pilot project. Previously, it served as a breeding ground for mosquitoes and diseases due to sewage overflow. Lack of proper sewage management led to contamination from nearby neighbourhoods.

Recognising its cultural significance for Chhath Puja, the Delhi Jal Board initiated its rejuvenation. This project aimed to demonstrate sustainability and scalability through natural treatment methods, renewable energy, and rainwater harvesting, setting a model for future initiatives.

On the previous page:
Before and after images of the lake
Source: The Better India,2020

On this page:
Lake development plan and aerial image
Source: Urban water resource management: experience from the revival of Rajokri lake in Delhi (Ankit Srivastava, T.C. Prathna), 2021

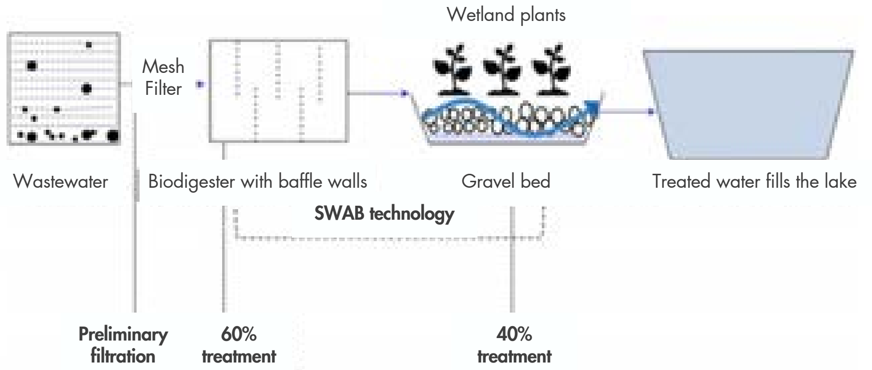
Process Involved

The project was initiated by the Delhi Jal Board for the rejuvenation of Rajokri Lake.

01 Natural Treatment System: The project adopted a "Scientific Wetland with Active Biodigester (SWAB)" system. This two-step process utilises microbes and plants for natural wastewater treatment, and includes a sedimentation tank, biodigester, and constructed wetland system for the treatment of water.

02 Constructed Wetland System (SWAB): The partially treated water flows through a 15-chamber SWAB system. This wetland uses layered stone aggregate of various sizes to provide habitat for microbes as a filter media. Papyrus, Umbrella Papyrus, and Canna Indica are planted throughout the SWAB to absorb nutrients and further purify the water, and 40 additional floating islands made of PVC pipes and mesh support papyrus plants were created for further nutrient removal and water purification.

03 Public Space Redevelopment: In addition to the wastewater treatment system, the project also involved revitalising the public area surrounding the lake for community use.



On this page:
Top- community at the rejuvenated lake.
Source: The Better India, 2020
Middle-Before and after images of the lake.
Source: Urban Nature Atlas, 2020

Below-Schematic diagram showing SWAB technology.
Source: Urban water resource management: experience from the revival of Rajokri lake in Delhi (Ankit Srivastava, T.C. Prathna), 2021

On the next page:
Aerial view of the lake after rejuvenation.
Source: The Better India, 2020

Impacts

Environmental

- Increased protection against flooding, stormwater management
- Improved water quality
- Restoration of freshwater ecosystems
- Increased green public space
- Habitat restoration and protection of flora and fauna species

Social

- Protection of historic and cultural heritage
- Promotion of an active lifestyle and recreational activities

Economic

- Reduced financial costs for urban management
- Stimulate development in deprived areas

Scale it Up!

To scale up, the project will add advanced filters and pumps. Impressed by Rajokri's success, the Delhi Jal Board plans to use this model on 159 lakes. However, this demands stronger collaboration between different stakeholder groups. Rejuvenation projects like these provide many social, environmental, and economic co-benefits to residents/users, and thus its principles can be used across many other water bodies across cities.

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KYALASANAHALLI LAKE REJUVENATION THROUGH COLLECTIVE COMMUNITY EFFORTS

06

Bengaluru, India

Key Details

Scale
Ward, Settlement

Implementation Budget (Source)
Rs 1.17 Crore
(Sansera Foundation)

Challenges catered
Habitat Degradation, Pollution

Project Duration
45 days

Implemented by
Anand Malligavad (Lakeman of India)

Project USP
Economic and Swift Implementation Process


Before


After

Project Rationale

The Kyalasanahalli rejuvenation exemplifies the power of collective community efforts in addressing sewage dumping, industrial waste, and invasive species like water hyacinths. Witnessing positive impacts post-monsoon, locals now value and protect the revived lake fervently. This initiative not only restores environmental health but also instils a sense of ownership among the community.

Introduction

With the decline in the number of Bangalore's water bodies from 262 to 81 since 1960, an ambitious initiative led by Mr. Anand Malligavad targets the restoration of 45 lakes by 2025. Focusing on the successful rejuvenation of Kyalasanahalli Lake, this case study highlights the collaborative approach that engaged the local communities to combat sewage dumping, industrial waste, and ecological degradation, which had caused the lake to disappear.

By prioritising the revitalisation of Bangalore's lakes, Anand has inspired a collective consciousness, driving communities towards active participation in the restoration and protection of lake ecosystems.

On the previous page: Kyalasanahalli Lake before & after restoration.
Source - Clean-Water (Sustainable Water Technologies, 2020
On this page: Kyalasanahalli Lake view
Source:
The Better India, 2019

Process Involved

01 Around 4 lakh cubic meters of mud was scraped from the lake and utilised to form islands, each with a width of 110 meters, across the lake. These islands are currently serving as nesting grounds for birds, with a large tree planted in the center for nests, as well as fruit-bearing and flower saplings planted nearby.

02 Two canals of a polluted drain were diverted 1.8 km away, and a separate area with a high embankment was created where this water was treated and aerated naturally. The monsoon that year restored the lake, which had been dead for decades.

03 The initiative culminated in the planting of seedlings and the establishment of two Japanese Miyawaki forests on the lake. Miyawaki is a Japanese planting technique that allows native seedlings to grow ten times quicker and denser than before. Utilising a distinctive approach, these forests covered approximately 25,000 square feet and comprised over 5,000 plants. Additionally, the surrounding land was planted with natural grass to address soil erosion.

04 In addition to Sansera's CSR funds for the rejuvenation of this lake, collaboration with Hikal Ltd. provided a fund of Rs 81 lakh, through a public-private partnership model.

05 The initiative attracted significant attention and support, with over 1,500 emails, 400 partnership requests, and 3,000 volunteers expressing interest in contributing.

06 Proactive engagement with over 70 organisations, including NGOs and corporates spread awareness about this unique initiative.

On this page:
Top-Margondanahalli Lake (taken up after Kyalasanahalli) mid-restoration.
Source: Reasons to be Cheerful, 2023

Middle & Below-Planting trees for the rejuvenation of Kyalasanahalli Lake.

On the next page: Aerial view of the rejuvenated lake.
Source: The Better India, 2019

Impacts

Environmental

- Restoring ecological balance
- Reducing pollution
- Recharging groundwater

Social

- Enhancing citizen-lake connect with over 3000 volunteers

Economic

- Creation of funding avenues with PPP model with a fund of Rs. 81 lakh

Scale it Up!

Cities can replicate Anand Malligavad's lake restoration approach by regularly assessing water bodies, engaging communities, and collaborating with partners to secure funding for restoring dried-up lakes. By raising awareness and involving citizens in monitoring progress, cities can foster shared accountability. Restoring degraded water bodies or natural drains can be achieved by diverting sewer pipes, treating water, and planting native species on a large scale using techniques like Miyawaki.

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WETLAND MANAGEMENT OF NEKNAMPUR LAKE THROUGH NATURE BASED SOLUTIONS (NbS)

07

Hyderabad, India

Key Details

Scale
District

Implementation Budget
Rs 0.45 Crore

Challenges catered
Pollution, loss of biodiversity, urban flooding

Project Duration
2 years

Implemented by
Dhruvansh NGO & Hyderabad ULBs

Project USP
Restoration of damaged ecosystems through NbS

Project Rationale

The Neknampur Lake restoration project combines ecological restoration with community well-being initiatives to preserve cultural heritage and ecological balance. By employing bioremediation and phytoremediation techniques, the project aims to improve water quality and restore biodiversity. It also promotes sustainable livelihoods for the local community and fosters sustainable peri-urban development.

Introduction

Neknampur Lake, also known as Ibrahim Bagh Cheruvu in Hyderabad, held historical significance as part of a water reservoir system. Urbanisation and sewage disposal led to ecological alterations in the lake. NGO 'Dhruvansh' adopted the lake in 2016 for restoration using various bioremediation & phytoremediation techniques. The organisation aimed to restore the lake, creating a sustainable model by promoting education, raising awareness, and supporting the local community.

On the previous page:
Floating wetland on Neknampur lake.
Source:
The Hindu, 2018

On this page:
Island made of 27 rafts on Neknampur Lake.
Source:
Lakes of India, 2020

Process Involved

01 Construction of a stormwater treatment pond at the inlet to restrict direct sludge and heavy metals, and a separate pond constructed for idol immersion.

02 Aquatic weed growth was managed using biological control methods, and aeration was facilitated through the installation of fountains, subsurface diffusers, and floating aerators. A sedimentation basin and a floating treatment island were developed.

03 Community-based interventions like weekly cleaning drives, cultural programmes, pottery workshops, and birdwatching activities.

04 Awareness Programs and activities by affiliated institutions such as WWF Telangana, People for Animals, and Hyderabad Birding Pals.

05 Co-governance efforts involved planting drives under Haritha Haram and HMDA plantation schemes, garbage cleaning, installation of electric poles, and the introduction of 20,000 fish for bioremediation support.

On this page:
Top-Floating wetland installed at the lake.
Source: Water Digest, 2023

Middle-Removal of weeds for safe reuse.
Source: Urban Nature Atlas, 2023

Below-Floating wetland and fountain for aeration.
Source: Money Control, 2022

Next Page- Island made of 27 rafts on Neknampur Lake.
Source: Lakes of India, 2020

Impacts

Environmental

- Restoring ecological balance
- Reducing pollution
- Recharging groundwater

Social

- Enhancing Citizen-Lake connect

Economic

- Creation of funding avenues

Scale it Up!

Such NbS for restoration efforts can enhance urban water resilience and biodiversity conservation. Partnerships with environmental organisations, local communities, and government agencies can spread awareness and mainstream adoption of innovative solutions. Leveraging funding from national and international sources for large-scale restoration projects, and capacity-building programs can empower local stakeholders to actively participate in restoration efforts.

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08

CREATION OF AN ARTIFICIAL LAKE USING TREATED WATER FROM PAPPANKALAN SEWAGE TREATMENT PLANT (STP) IN DWARKA

New Delhi, India

Key Details

Scale
Ward

Implementation Budget (Source)
Rs 56.5 Crore (Delhi Government)

Challenges catered
Water scarcity, groundwater contamination

Project Duration
7 Months

Implemented by
Delhi Jal Board

Project USP
Reuse of Treated Used Water for recharging Aquifers

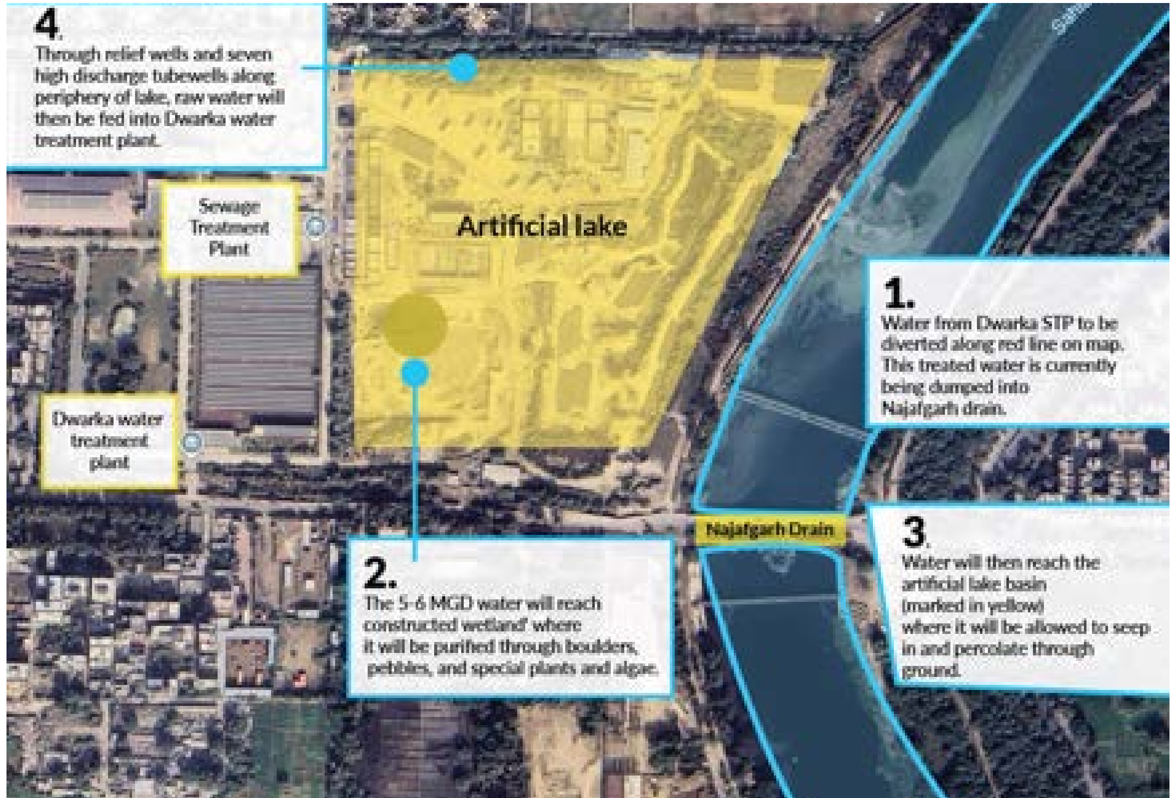
Project Rationale

The Dwarka area of Delhi suffers from water scarcity, and the treated water at Pappankalan STP had the potential to create an artificial lake for storage of water. By installing floating wetlands and aerators, the water quality was improved further, causing percolation of treated water through layers of soil to enhance groundwater quality of the nearby areas.

Introduction

The sewage water from Dwarka was previously discharged into the Najafgarh drain, but now it is treated at Pappankalan STP before it enters the lake. An artificial water body, spanning 25 acres, was constructed to utilise this treated water, enhancing groundwater recharge and quality. Advanced methods like floating wetlands and aerators were implemented to ensure that the effluent meets bathing quality standards.

Proximity to the Najafgarh drain had caused groundwater contamination in the area, but tertiary treatment and the floating wetlands at Pappankalan STP improved the water table and reduced contamination.

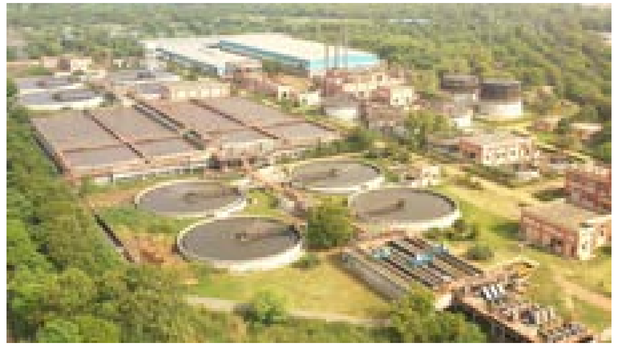


On the previous page:
Aerial view of the lake.
Source:
Times of India, 2022

On this page:
Processes involved in the creation of the artificial lake.
Source:
Times of India, 2018

Process Involved

01 A Sewage Treatment Plant (STP) of 20 MGD capacity was developed with a tertiary treatment system. The treated effluents meet tertiary quality standards: BOD 5 PPM, SS 7 PPM, coliforms 250-500 PPM after disinfection.



02 A 25-acre land area was excavated to a depth of 7-8 feet until it reached sandy strata. The debris was spread around the land of the water body, and a 1.5 m thick layer of impervious soil layer at the drain bed was replaced with sand and gravel to ensure percolation of water.

03 The groundwater quality was assessed at a 10 m depth, and the tertiary treated water (BOD 5 PPM, SS 5 PPM, coliform 250 PPM) was collected in the water body to its brim.

04 Floating wetlands and aerators were installed within the water body to further enhance the quality and prevent stagnation.

On this page:
Top-Pappankalan STP in Dwarka.
Source: Jagran , 2021

Middle-Aerators and floating wetlands.
Source: Gunraagh Talwar, Google Image., 2022

Below-Aerators of Pappankalan Lake
Source: Yes Pubjab.com, 2022

On the next page:
Aerial view of the lake.
Source: Times of India, 2022

Impacts

Environmental

- Significant rise in the groundwater table by 7 meters improving local water security
- Improvement in groundwater quality
- Improved the biodiversity
- 5-6 MGD water saved/regenerated, boosting Dwarka's supply

Social

- Provides recreational spots for local communities

Economic

- Increased property values in the surrounding areas

Scale it Up!

Cities can reuse treated water and create artificial wetlands to enhance their groundwater levels and quality. This case is especially helpful for cities that suffer from water scarcity in arid climatic zones, stormwater drain encroachment and so on. Implementing advanced treatment technologies such as tertiary filtration and floating wetlands ensures that the water meets the quality standards. Creating artificial lakes or wetlands in urban areas enhances local biodiversity and provides recreational spaces.

Scan/Click to read more

09 ROYAL BOTANIC GARDENS – WORKING WETLANDS ROYAL BOTANIC GARDENS BIRDWOOD AVENUE THROUGH STORMWATER MANAGEMENT

Victoria, Australia

Key Details

Scale
District/ City

Implementation Budget (Source)
Rs. 52 Crore (excluding maintenance). Maintenance Budget: 60 lakhs per year. (Australian Government)

Challenges catered
Water scarcity, buoyancy problems in floating wetlands

Project Duration
3 Years

Implemented by
Royal Botanic Gardens Melbourne.

Project USP
Innovative use of floating wetlands made from recycled materials.

Project Rationale

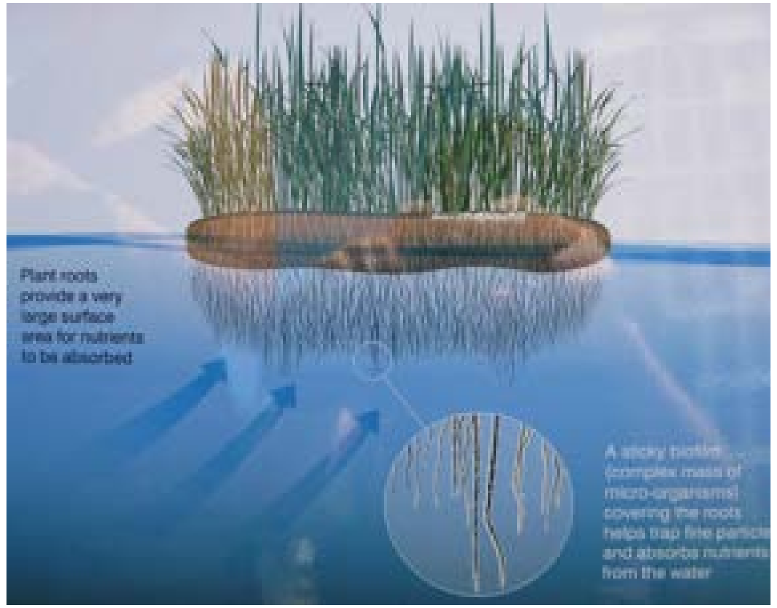
The project was launched under the Royal Botanic Gardens Melbourne's Strategic Water Plan to promote sustainable water management in response to a drying climate. The primary focus was to treat stormwater, improving water quality in the Gardens' lakes and the Yarra River while reducing reliance on potable water for irrigation. Additionally, the project secondary focus was to enhance wildlife habitats and raise community awareness.

Introduction

The Royal Botanic Gardens Melbourne, spanning 38 hectares along the Yarra River, initiated the "Working Wetlands" project in response to Melbourne's challenges with water scarcity and declining water quality due to a drying climate. As part of its Strategic Water Plan, the project aimed to reduce reliance on potable water by harvesting and treating stormwater through constructed and floating wetlands. This effort not only improved water quality in the Gardens' lakes and the Yarra River but also enhanced the landscape, supported wildlife habitats, and engaged the community through education, fostering a more sustainable environment in Melbourne.

On the previous page:
Aerial view of the Botanic Garden.

On this page:
Floating wetlands in Botanic Garden
Source:
Royal Botanic Gardens – Working Wetlands, Feb 2013

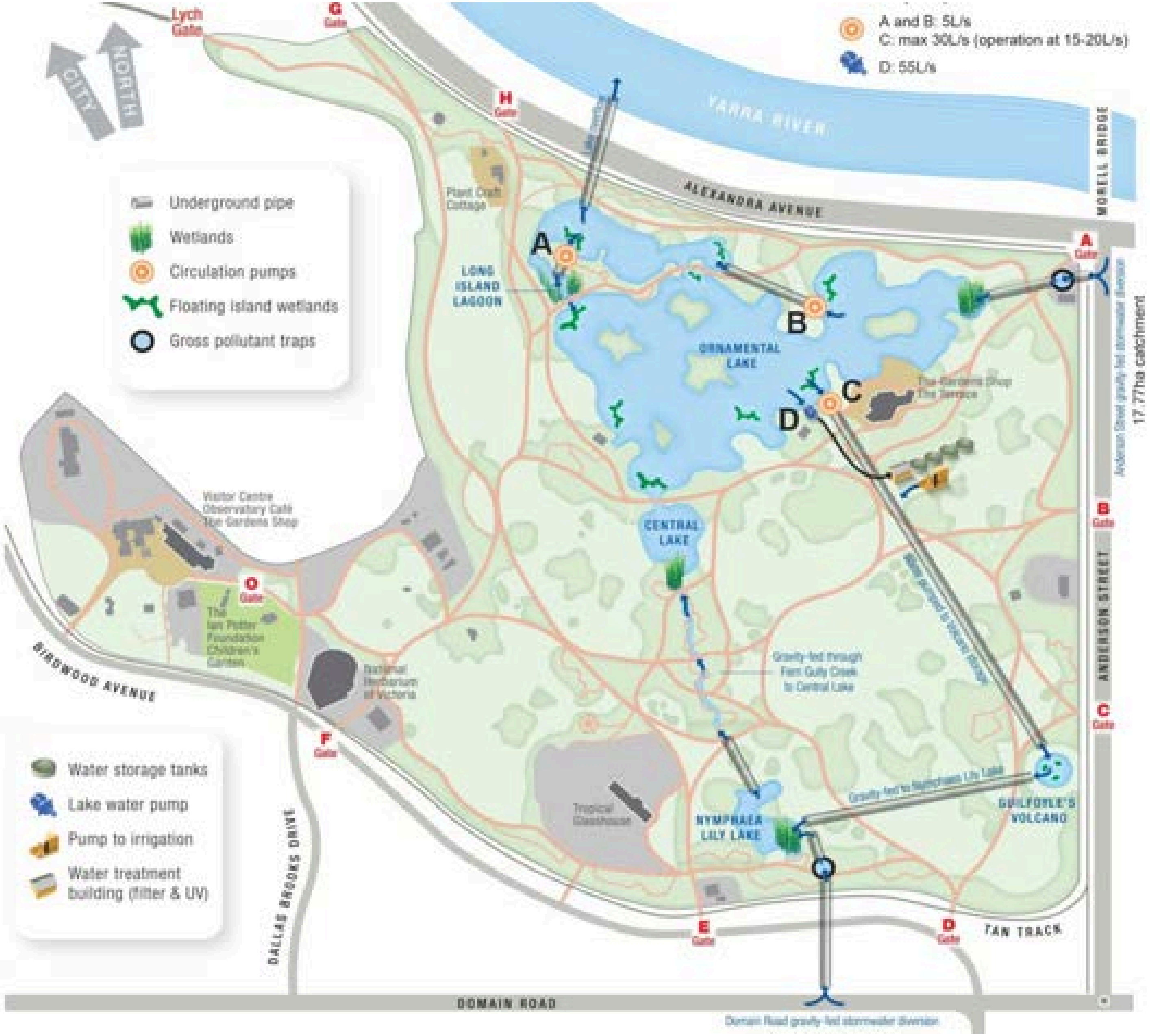


On this page:
Top - Seating Spaces in Royal Botanical Garden - working wetlands

Bottom - Educational sign at Guilfoyle's Volcano – Floating wetlands working principles

On the next page:
Garden Working Wetlands Site Plan

Source: Royal Botanic Gardens – Working Wetlands, Feb 2013



Process Involved

01 Storm Water is diverted from Anderson St and Domain Road drains and treated through gross pollutant traps and sediment ponds before entering the lakes.

02 The water is treated in sediment ponds and wetlands using both physical and chemical processes.

03 Water is circulated through a series of connected water bodies, including Ornamental Lake, Guilfoyle's Volcano, Nymphaea Lake, and Fern Gully Creek.

04 Floating wetlands Installed in two lakes, made from recycled PET plastic and planted with semi-aquatic plants, these wetlands improve water quality through nutrient uptake and fine particle trapping.

05 Treated water is stored in tanks and undergoes further treatment (disk filters, UV disinfection, pH adjustment, and chlorination) before being used for irrigation.

On this page:
Top - Desert Cacti Garden
Middle - Fern Gully in the Garden
Bottom - Entrance to the Royal Botanic Garden
Source: City of Melbourne, 2024

On the next page:
Aerial view of the Botanic Garden
Source: City of Melbourne, 2024

Impacts

Environmental

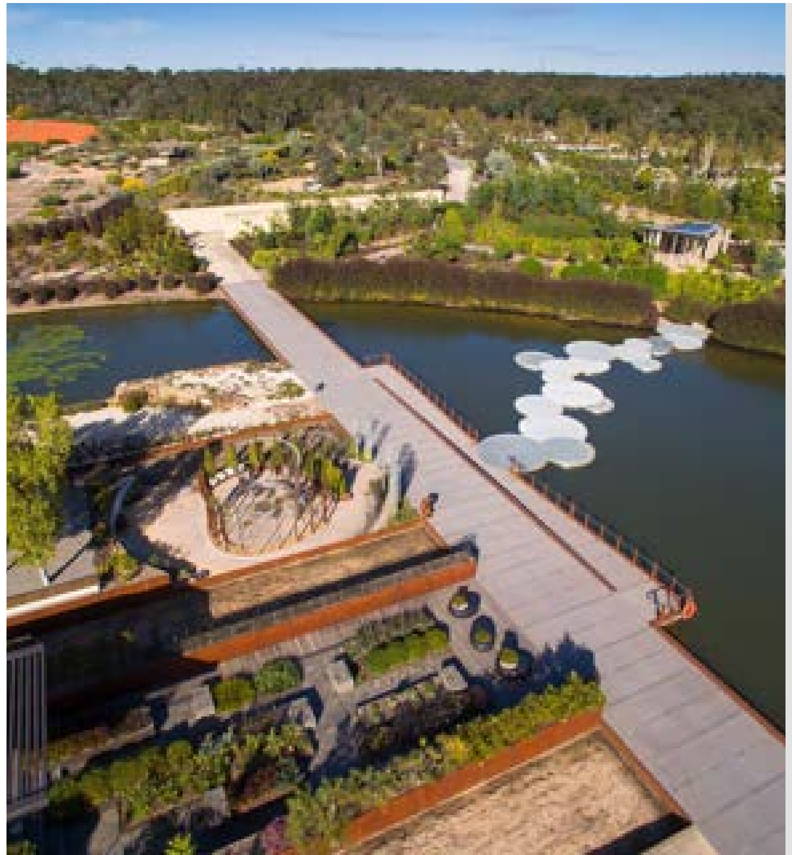
- 30–40% reduction in nutrient concentrations, improving water quality.
- Increased waterbird populations and new habitat creation.
- Up to 40% reduction in potable water use, with 1.6ML of lake water treated for irrigation overnight.
- Over 20,000 wetland plants added.

Social

- Enhanced public engagement through educational programs
- Improved garden amenities.
- Improved landscape aesthetics.

Economic

- The storm water harvesting system supplies up to 40% of irrigation water.
- Reduced maintenance costs
- Improved irrigation efficiency.



Scale it Up!

To effectively implement the "Working Wetlands" approach in any wetland cities like Udaipur, Bhopal, it is essential to conduct a thorough assessment of local wetlands, integrate them into the stormwater management system, engage the community, and secure policy and institutional support. By adapting the Royal Botanic Gardens Melbourne's successful model, cities can harness the power of wetlands to improve water quality, enhance biodiversity, and create sustainable urban environments.

Scan/Click to read more

REJUVENATION OF PARKES WETLANDS BY RETROFITTING OLD INFRASTRUCTURE

10

New South Wales, Australia

Key Details

Scale
Ward

Implementation Budget (Source)
Rs. 6 Crore
(New South Wales Govt. & Australian Federal Govt.)

Challenges catered
Unused Decommissioned Infrastructure, Habitat Loss, Poor Accessibility

Project Duration
2 Years

Implemented by
Parkes Shire Council
(through contractors)

Project USP
Repurposing sewage treatment ponds into a community-centered, ecologically rich wetland

Project Rationale

The Parkes Wetlands project was established to address the ecological and community needs arising from the decommissioning of old sewage treatment ponds. These ponds had long served as important habitats for local wildlife, particularly bird species. Rather than allowing the site to deteriorate, the project aimed to transform the ponds into a functional wetland. This initiative not only preserved and enhanced biodiversity but also contributes to flood mitigation and groundwater recharge. The project integrates the needs of the community with environmental restoration.

Introduction

The Parkes Wetlands Project aims to transform old sewage treatment ponds(constructed in 1960) into a vibrant wetland ecosystem, enhancing biodiversity and community engagement. Funded by the New South Wales Environmental Trust, the first stage was completed in late 2023, featuring major earthworks and initial revegetation efforts. This initiative has successfully attracted waterbirds, including rare species, back to the area. Future stages will include constructing pathways and bird hides to promote recreational activities and eco-tourism, supported by significant funding from the Federal and NSW governments. The project not only benefits local wildlife but also enriches the community's connection to nature.

On previous page,
Site after receiving its first rainfall
Source:
Parkes Shire Council, 2023

On this page,
One of the Water bodies at Parkes
Source:
The Parkes Phoenix, 2021

Process Involved

01 The project secured funding from various sources, including over $900,000 from the Federal Government's Growing Regions Program and an additional $100,000 from the New South Wales Government's Local Small Communities Allocation program. This financial support was crucial for the project's development and future stages

02 Major earthworks were completed in late 2023, converting the old treatment ponds into a hydrologically complex wetland. This included shaping the land to create diverse habitats that support a variety of native flora and fauna, particularly aquatic avifauna.

03 Initial revegetation activities were undertaken to plant native species and restore the surrounding Fuzzy Box Woodland, which is an Endangered Ecological Community.

04 The wetlands were filled with recycled water from the Council's Advanced Water Recycling Facility, marking the first time the site received water in over five years.

05 The next stage of this project is supposed to involve the construction of a gravel pathway around the wetlands to enable all abilities access to the site, and facilitate recreational activities such as walking, jogging and cycling around the site.

On this page,
Top - Former Sewage Treatment Ponds
Source: Parkes Champion Post, 2023
Middle - Water flowing into Parkes Wetland
Source: Parkes Shire Council, 2023
Below - Current and former condition of the Wetland
Source: Parkes Shire Council, 2023

On next page,
Community Efforts to vegetate Parkes Wetlands
Source: Parks Shire Council, 2023

Impacts

Environmental

- Habitat Restoration
- Improvement in Groundwater levels

Social

- Easy access from the town connecting the blue-green spaces
- Improvement in mental health and fitness of locals

Economic

- Improved liveability of the township of Parkes and the Shire
- Creation of tourism opportunities

Scale it Up!

The Parkes Wetlands project offers a valuable model for urban areas aiming to transform underutilized or decommissioned infrastructure into ecological and community spaces. To scale this approach, urban local bodies can identify similar sites, like old sewage treatment ponds or neglected water bodies, and evaluate their potential for conversion into wetlands. Securing funding through national or state grants and forming public-private partnerships are key to success.

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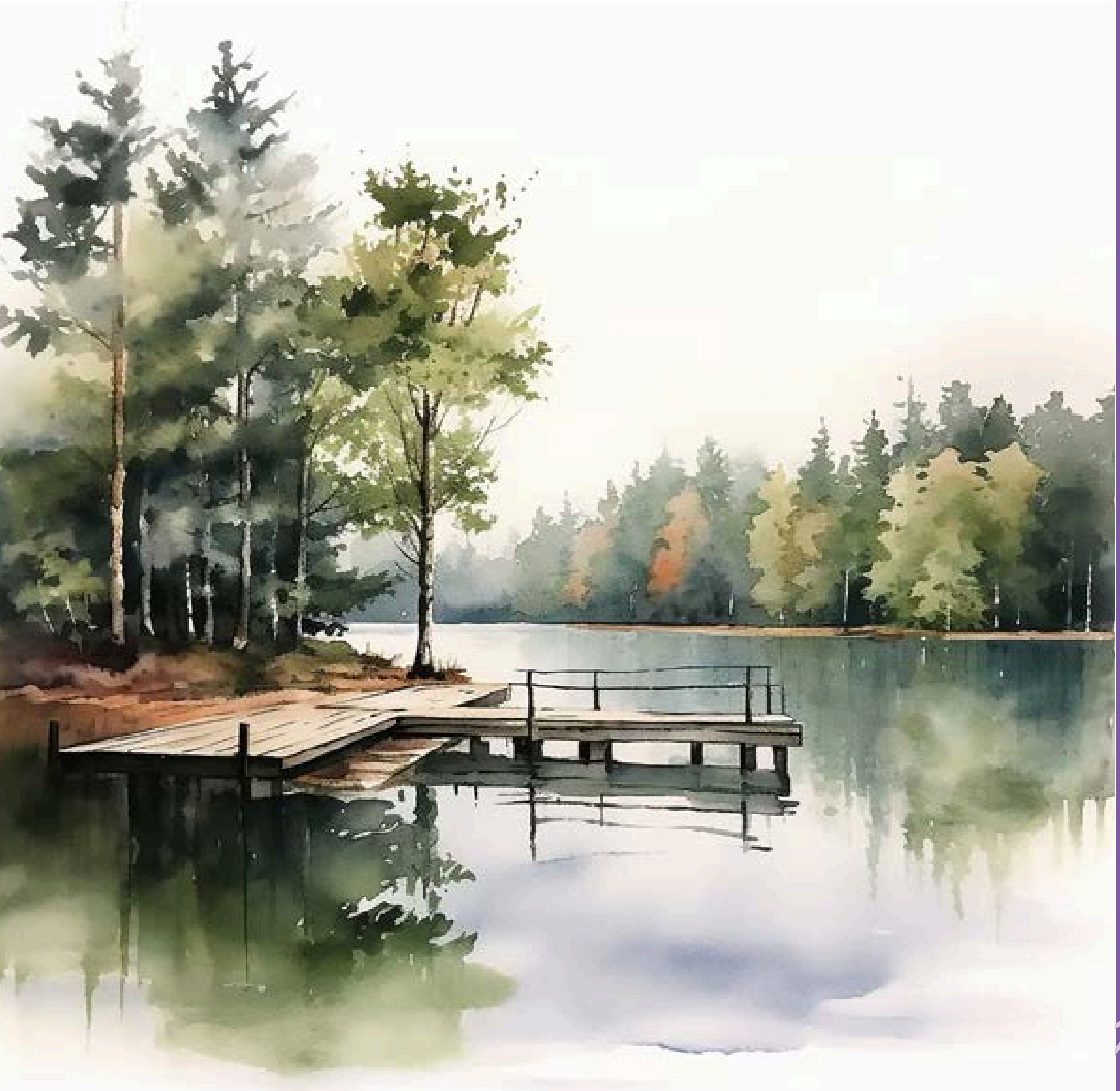


RIVER RELATED INITIATIVES

Explore the transformative potential of Water Sensitive Urban Design in 'Revitalising Urban Rivers'. This section delves into innovative approaches and practical strategies for restoring river ecosystems, enhancing water quality, and managing stormwater sustainably. By integrating ecological principles with urban planning, these initiatives aim to create resilient and vibrant river corridors that support biodiversity and provide valuable recreational spaces for communities.

11 RIVER RESTORATION AT THE BISHAN-ANG MO KIO PARK THROUGH THE ACTIVE, BEAUTIFUL AND CLEAN (ABC) WATERS PROGRAM

Singapore

Key Details

Scale
City/ward

Implementation Budget (Source)
Rs. 475 Crore (European Union's Horizon)

Challenges catered
Water insecurity and pollution, mosquito breeding

Project Duration
3 years

Implemented by
Public Utilities Board, National Parks Board

Project USP
Naturalisation of river flow, public participation

Project Rationale

Singapore saw a 22% increase in its annual rainfall from 1980 to 2012. This, coupled with a degraded stormwater management system, has burdened the country's water resources. The ABC Waters Program was implemented to restore the natural water bodies beyond their original drainage and storage functions. The strategy has ensured efficient draining and treatment of stormwater and has improved Singapore's water quality, especially in the dense urban areas.

Introduction

Bishan-Ang Mo Kio Park is located at the centre of the island and is surrounded by high-density residential development. Kallang River ran through it for 2.7 km in the form of a straight concrete channel that proved to be dangerous for people during rising water levels. The channel was restored into a meandering 3.2 km natural river by integrating Blue-Green Infrastructure with the dense urban environment for socio-ecological benefits.

The Project was successful as it involved people, to ensure the sustainability of scarce water resources and the conservation of biodiversity, responding well to the adverse effects of climate change.

On the previous page: Before and after images of the river restoration project.
Source: Pagoda shophouse- ownwork licensed under Creative Commons Attribution-Share Alike via MIT, 2022

On this page: Bioengineering techniques and natural cleaning process.
Source: Dreiseitl consulting, 2012

Process Involved

The project was initiated by the Public Utilities Board and the National Parks Board of Singapore, and the implementation was done with the help of community participation throughout the lifecycle of the project.

01 Bioengineering techniques like rocks and native plants helped mimic a natural river channel. When compared to the traditional concrete channel, it provides a more efficient self-repair and adaptation alternative and is also cost-effective to install and maintain.

02 Cleansing biotopes, made using 15 wetland cells and 4 terraces, help in natural water purification and treatment. After this, water is subjected to ultraviolet treatment to remove bacteria before returning it to the river.

03 Vegetated bioswales, comprised of mosquito-repellent plants, help capture and filter stormwater runoff from the surrounding area before it is channelled into the river.

04 Red markers are installed in the park to issue warnings during a rise in water levels. This ensures a safe environment for the public during floods.

05 Design features like a terraced riverside gallery, platforms, bridges, stepping-stone paths, a water playground, and a 'Recycle Hill' (a landmark built from blocks of concrete recycled from the old channel) help re-establish the connection between people and the river.

On this page:
Top-Restoring River and Redesigning the Park.
Below-Public participation in the restoration project.
Source: Dreiseitl consulting, 2012

On the next page:
Aerial view of the meandering river.
Source: My Liveable City,2014,

Before

After

Impacts

Environmental

- 48% reduction in flood-prone area from 2010 to 2019
- 40% increase in the water carrying capacity of channels
- Increase in meandering length slows down the water flow
- Prevention of soil erosion

Social

- Reduced diseases leading to improved public health
- Vibrant public space
- Increased connection between river and people

Economic

- 15% cost savings through the new re-design approach

Scale it Up!

Many cities in India still have concrete drain channels that can be naturalised using vegetated bioswales and cleansing biotopes. The project can leverage local socio-cultural associations between rivers and people to execute the public participation process. However, the implementation of a decentralised management system may result in a delayed execution of the project.

Scan/Click to read more

12 CREATION OF BEAD-LIKE WETLANDS WHICH REGULATE FLOODS THROUGH THE QIAN'AN SANLIHE RIVER ECOLOGICAL CORRIDOR

Hebei, China

Key Details

Scale
City/ward

Implementation Budget (Source)
NA

Challenges catered
Flood, drought and pollution, unregulated urban stormwater runoff

Project Duration
2 years

Implemented by
Construction Bureau of Qian'an City

Project USP
Low-maintenance native vegetation, collection and dissemination of urban stormwater runoff

Project Rationale

Located in Liupanshui City, this project revitalises the Shuicheng River through ecological restoration and urban open space improvements. It boosts the urban waterfront's land value and reclaims the landscape as essential ecological infrastructure. Over nearly three years, the polluted waterway was transformed into the city's lifeline using vegetation and natural embankments, offering crucial ecological services.

Introduction

The Shuicheng River in Liupanshui City, historically known as Lotus Leaf City, once encircled the city like a floating lotus leaf during the rainy season. However, with industrialisation, urbanisation, and mobilisation in 1966, the river was straightened and channelised with concrete embankments between 1975 and 1980. This transformation aimed to support industrial growth but compromised the river's flood control, self-purification, and stormwater management. Consequently, the river suffered continuous degradation and pollution from sewage and waste. Once a charming "Mother River," it became heavily polluted, necessitating urgent restoration.

1. 3D model of the Greenway and its transforming process: making use of different altitudes between the bed of Luan River and the city, the project creates a water-centered public space that integrates stormwater management, habitat restoration, recreational uses and art, and catalysts urban development.

On the previous page:
The Qian'an Sanlihe River Ecological Corridor.
Source - Pinterest, 2015

On this page:
The creation of water centered public space that integrates storm water management, habitat restoration, recreational uses and art, and catalysts urban development.

Source:Turenscape, 2013

Process Involved

This project is divided into three sections: the water source located upstream, the city section in the middle,, and the wetland park downstream. Specific processes and techniques were employed to rejuvenate each section.

01 Key design aspects included sewage management and ecological reconstruction. Household organic waste was used to shape landforms, and industrial waste was treated.

02 The design maximised natural elevation changes for directing the flow in Luan River water channels.

03 Bead-like wetlands were created to regulate floods by collecting stormwater runoff. They form a "Green River" with the remaining pools during low water levels.

04 Existing trees were preserved, and riverbanks were transformed into connected tree islands using low-maintenance native vegetation, lush water grasses, and self-reproductive wildflowers like Chinese Pennisetum and wild chrysanthemum.

05 Pedestrian and bicycle routes along the greenbelt enhance community access and are integrated with art, including an 800-meter folding paper sculpture, shelters, seats, a boardwalk, and lighting.

On this page:
Top-The revived river with native vegetation, lush water-grasses, and wild flowers.
Middle-Bicycle and pedestrian routes along the channel.
Below-Aerial view after the ecological restoration
.
On the next page:
Creation of an active and healthy open public space, which promotes walking and cycling.
Source: Turenscape, 2013

Impacts

Environmental

- Ecological restoration
- Wetlands purify river water for grey water use
- Natural waterways create diverse habitats for various species of flora and fauna including birds, abundant fish, and soft-shelled turtles

Social

- Northern "Steel city" rejuvenated into scenic locale
- Pedestrian and bicycle routes integrated with urban transportation network
- Artful and culturally holistic public space creation

Economic

- Cost saving through low-maintenance native vegetation, water-grasses, and wild flowers

Scale it Up!

India has some major rivers that experience disasters like floods and are polluted by sewage and other waste disposal from industries and domestic sources. Ecological restoration using low-maintenance landscape elements, such as the bead-like wetlands, can help regulate floods by collecting and disseminating urban stormwater runoff. Thus, these principles can be adopted to the local context across river basins in Indian cities.

Scan/Click to read more

13 YAMUNA BIODIVERSITY PARK: RESTORING ECOLOGY AND WATER SYSTEMS FOR A SUSTAINABLE CAPITAL

Delhi, India

Key Details

Scale
City

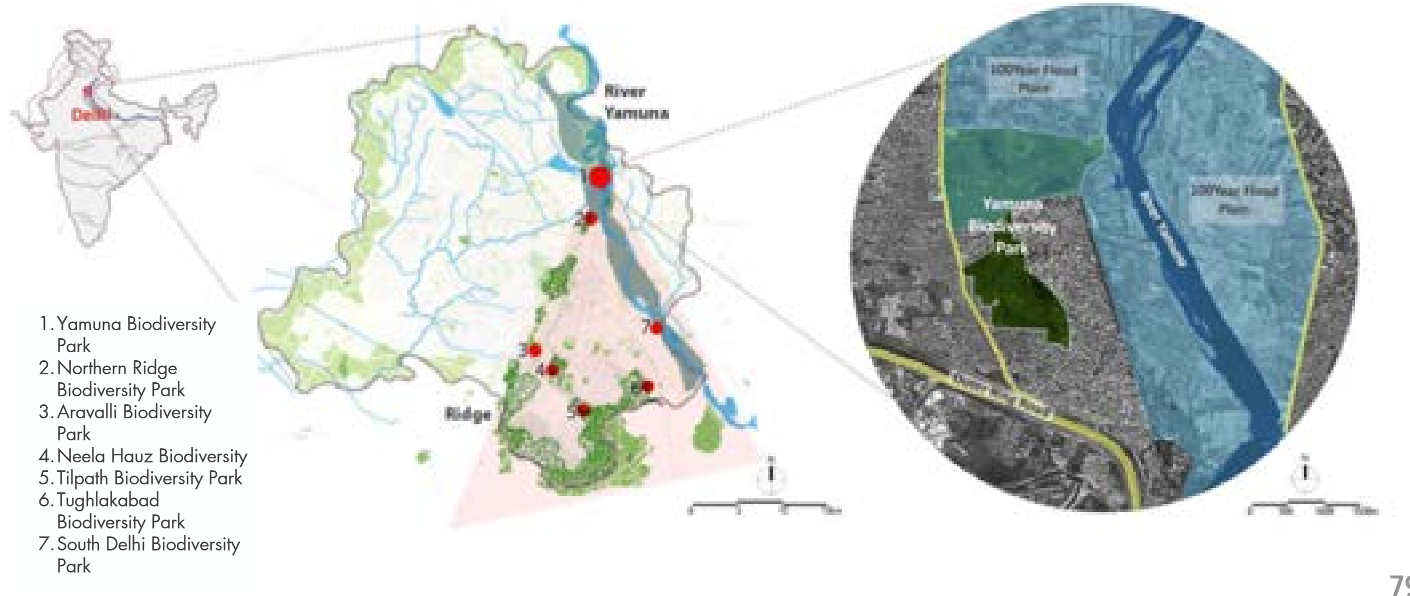
Implementation Budget (Source)
Approximately Rs. 12 Crore (Delhi Development Authority)

Challenges catered
River pollution, ecological degradation, flood risk, biodiversity & habitat loss

Project Duration
Ongoing since 2002

Implemented by
Delhi Development Authority, Centre for Environmental Management of Degraded Ecosystems (University of Delhi)

Project USP
Restoration of ecological and natural systems



Project Rationale

Revitalising the Yamuna River for a sustainable Delhi drives the Yamuna Biodiversity Park project. It aims to restore the river's ecology, promoting biodiversity and water quality. The park tackles Delhi's water issues by harvesting rainwater, replenishing groundwater, and storing floodwater. This green lung within the city fosters recreation, environmental education, and a connection with nature and also builds resilience against climate change by restoring natural systems.

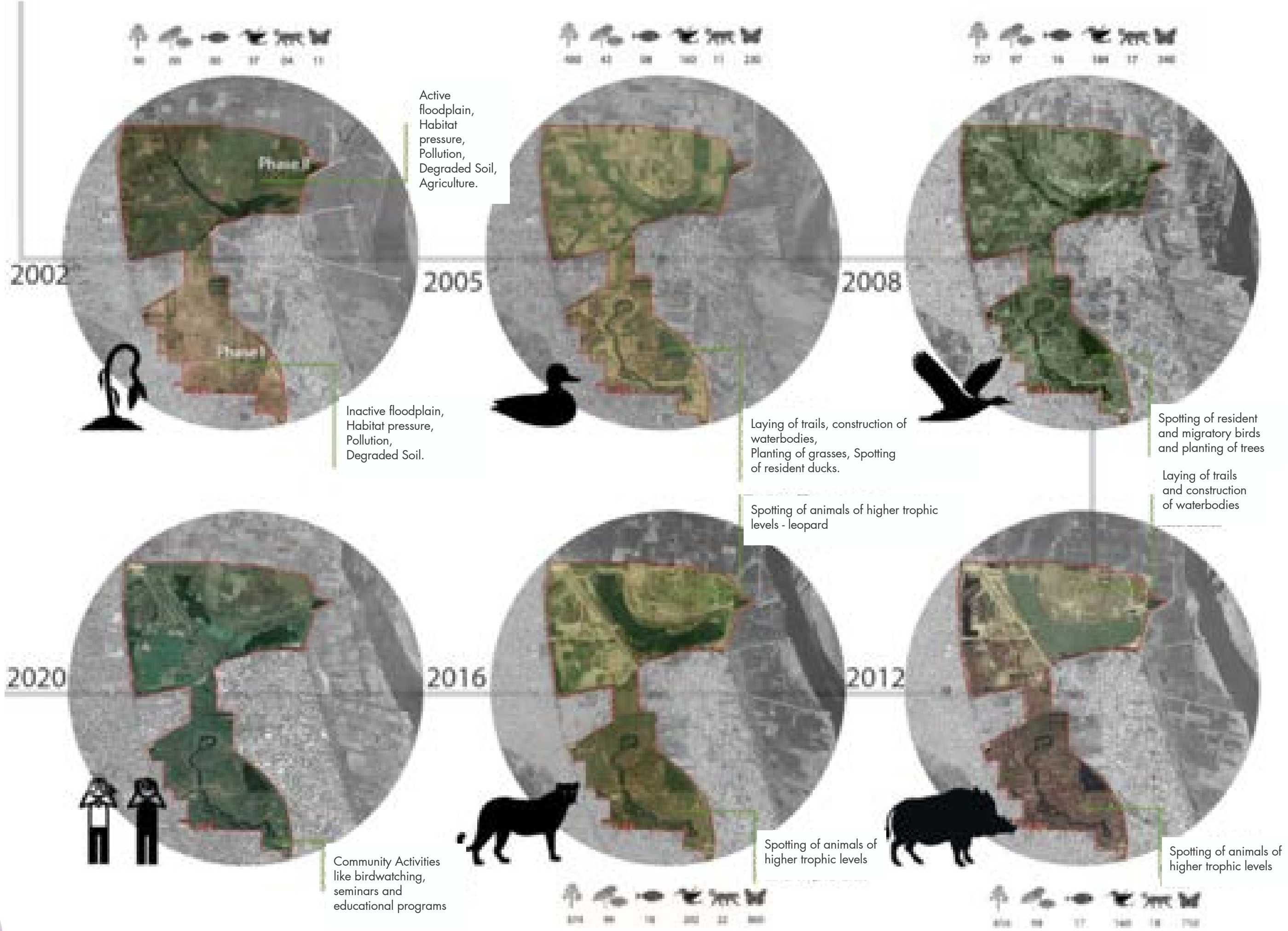
Introduction

The Yamuna Biodiversity Park in Delhi is a beacon of urban sustainability that has transformed from a barren land to a thriving 457-acre ecosystem. Pressing issues like flooding, drought, and pollution were addressed by restoring wetlands and diverse ecosystems. The park replenishes groundwater, improves air quality, and fosters biodiversity by recreating lost river ecosystems. As an educational and research hub, it attracts visitors and promotes environmental awareness. Part of Delhi's Biodiversity Parks network, it showcases innovative approaches to urban ecosystem restoration, offering ecological services and recreational opportunities.

Collaborating with the Centre for Management of Degraded Ecosystems, University of Delhi, these parks exemplify urban biodiversity conservation and sustainable development.

On the previous page:
Location map of Yamuna Biodiversity Park.
Source: Landscape & environmental planning department, DDA, 2021

On this page:
Aquatic species at the Yamuna Biodiversity Park.
Source: Delhi Biodiversity Foundation DDA, 2021



On this page:
Chronological development of the park.
Source: Landscape & environmental planning department, DDA, 2021

On the next page:
Master plan of Yamuna Biodiversity Park
Source: Landscape & environmental planning department, DDA, 2021

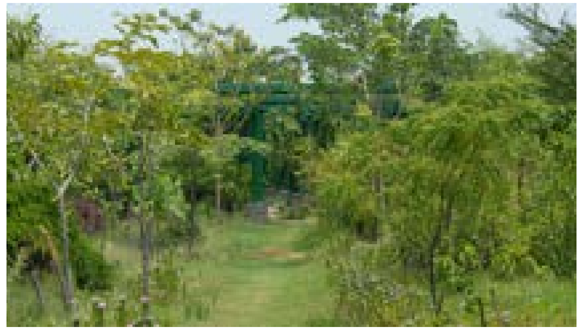
Process Involved

The park's development exemplifies successful collaboration between the Delhi Development Authority (DDA), the government agency responsible for urban planning and infrastructure, and the University of Delhi, providing scientific expertise and research support.

01 Wetland restoration: Three natural wetlands act as the park's core, controlling floods, purifying water, and recharging groundwater. They act as natural sponges, absorbing and storing excess rainwater and mitigating flood risks in surrounding areas. They also act as natural filters, removing pollutants and improving water quality within the park's water systems. It allows rainwater to infiltrate the ground, gradually replenishing local groundwater reserves.

02 Habitat creation: The biodiversity park offers a diverse range of ecosystems like forests, grasslands, and wetlands, which create distinct habitats for various native flora and fauna species that have now been restored.

03 Native species focus: Planting native flora promotes a self-sustaining ecosystem and restores lost biodiversity. Native plants are adapted to the local climate and require minimal maintenance, fostering a self-sustaining park environment.



On this page:
Top - Bamboo Bridge in Biodiversity Park
Middle - Herbal Garden in Biodiversity Park
Below - Project vision of Yamuna Biodiversity Park,2022.

On the next page:
Aerial view of the restored biodiversity park.

Source: Landscape & environmental planning department, DDA, 2021

Impacts

Environmental

- Groundwater replenishment
- Habitat and biodiversity restoration
- Creation of a healthy pubic space and improved air quality
- Adequate flood prevention and management

Social

- Improved awareness and educational opportunities for students and visitors at large
- Vibrant public space adding to quality of life

Economic

- Enhanced property values

Scale it Up!

Scaling up this Biodiversity Park model requires replicating the NbS, tailored to each city's needs. Collaboration between urban planners, environmental experts, and local communities for knowledge sharing is essential, along with advocacy efforts for broader adoption. Learning from Yamuna's success, cities worldwide can develop their green lungs, promoting ecological restoration, water security, and sustainable urban development, inspiring a network of healthy urban ecosystems along river basins.

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FLOOD MITIGATION IN ROHINGYA REFUGEE CAMPS THROUGH ECOLOGICAL RESTORATION

14

Dhaka, Bangladesh

Key Details

Scale
District/settlement

Implementation Budget (Source)
Rs. 3.65 Crore (UNHCR)

Challenges catered
Water scarcity, water pollution, environmental degradation, landslides due to deforestation

Project Duration
3 years

Implemented by
Centre for Natural Resource Studies (CNRS)

Project USP
Active collaboration among all stakeholders for NbS implementation

Project Rationale

Cox's Bazar, in southeast Bangladesh, is home to the Rohingya refugees in the highland district of Ukhyia Upazila. Approximately, 2,500 hectares of forest suffered from heavy degradation to make way for the refugees. The project used Nature-based Solutions (NbS) to restore a fifth of the forest (as of 2021).

Introduction

Large-scale deforestation to accommodate the refugees has caused environmental degradation in the area and an increased risk of landslides and slope instability. This has led to the issue of flooding during monsoon rains. Moreover, the *Madhur Chhara* watershed, which crosses 11 refugee camps, suffers from land use change along the stream, high solid waste load, and stream diversion. It has degraded the natural water dynamics and the riparian ecosystem along it. Thus, the NbS intervention aimed at restoring the *Madhur Chhara* watershed and helping refugees and host communities adapt to the climate stressors in the area.

On the previous page:
Settlement after restoration.

On this page:
Leveraging local participation for project implementation.

Source: UNHCR, 2021

Process Involved

Initiated by Centre for Natural Resource Studies (CNRS), the project was successfully implemented with the help of the resident community, experts and professionals, and various other government and non-government organizations.

01 Specific NbS interventions were designed by CNRS, encompassing the restoration of degraded Chhara reaches through deepening and widening, prevention of soil erosion through green cover development, and installing water reservoirs to facilitate groundwater recharge.

02 Bio-mechanical wastewater treatment plants helped in removing pollutants effectively from Chhara. This resulted in two constructed wetland systems.

03 Re-greening of stream banks was done using riparian and pollutant-absorbing block plantation with Vetiver hedging using local species.

04 Stabilizing stream banks targeted erosion-prone points with green approaches, such as slope terracing, compacting, and planting local grasses (bhadails, broom grass) supported by bamboo poles.

05 Community sensitisation through demonstrations on solid waste management, conservation agriculture, and engaging local stakeholders in stream management helped enhance environmental awareness. Additional initiatives involved piloting silt traps and construction of walkways.

On this page:
Top-Settlement before restoration.
Middle-Settlement after the restoration.
Below-Water reservoirs are built using biological processes.

On the next page:
Farmers benefitted from the project.

Source: UNHCR, 2021

Impacts

Environmental

- Water security through wastewater treatment and recycling
- 1,100+ acres of degraded land restored with mixed vegetation
- Reduction in erosion and damage from river floods
- 123% increase in biodiversity species
- Availability of surface water for longer periods

Social

- Awareness training provided to 3,000 refugees and support to 931 households for self-sustainability in growing vegetables
- Water reservoirs ensure water security for refugees to meet daily needs and provide water for wildlife and food production

Economic

- Economic benefits for the fishermen as diverse fish species colonise stream habitats
- Reduction in losses incurred due to flooding, erosion, and landslides

Scale it Up!

While Ukhyia Upazila is a unique case of a refugee camp, ecological degradation is commonly performed to clear land for informal settlements along nullahs and rivers in many cities. Ecological restoration using native plant species can be ensured through active partnerships across agencies and with the communities. Thus, using these core principles, long-term sustainability in terms of water and food security can be achieved for communities.

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BEIJING YONGXING RIVER GREENWAY THROUGH SPONGE RIPARIAN CORRIDOR AND DROUGHT-RESISTANT PLANTATION

15

Beijing Daxing, China

Key Details

Scale
Settlement/city

Implementation Budget (Source)
Rs. 195.8 Crore
(National Natural Science Foundation of China)

Challenges catered
Lack of stormwater management, habitat degradation, lack of public green spaces

Project Duration
5 years 5 months

Implemented by
Daxing Planning Bureau, Daxin District, Beijing Municipal Government

Project USP
Drought resistant plantation in the wetlands, sponge riparian corridor, use of recycled materials

Project Rationale

Beijing Yongxing River Greenway breaks from traditional flood control engineering by transforming a seasonal urban drainage into a water-resilient green sponge that retains and filters stormwater. It also creates an ecologically sound, productive, and community-building green infrastructure. This project highlights landscape as green infrastructure that provides holistic ecosystem services by regulating the hydrological environment, supporting native biodiversity, and fostering community vitality.

Introduction

The Yongxing River spans 37 kilometers and drains an area of over 300 square kilometers. Since the 1960s, it has been channelised and lined with concrete, leading to pollution from sewage and periodic monsoon flooding. Urban expansion and increased impermeable surfaces have increased the need for better flood retention. Local communities want a cleaner environment and more green spaces. Fortunately, land use planning has designated about 100 meters on the river's west side for public green space, allowing for potential expansion. The proposed drainage reconstruction project covers the upper 17 kilometers, totaling 150 hectares. Key challenges include finding alternatives to traditional channel-widening, ensuring the new system can manage floods, and creating recreational spaces. The project must also be cost-effective, technically feasible, and sustainable in terms of maintenance.

On the previous page:
A network of pedestrian paths with children's playgrounds, sports grounds, and plazas of various sized, integrated into the greenway.

On this page:
Bio-swales constructed along the linear green space to capture and filter urban runoffs.

Source:
Turenscape, 2019

Process Involved

To transform the flood control project into green infrastructure offering holistic ecosystem services, several strategies were implemented including:

01 All existing on-site trees, especially those along the former channel bank, were preserved and integrated into the new site plan.

02 A sponge riparian corridor, designed as a porous landform through cut-and-fill methods, created pits, mounds, islands, and shallow areas. Recycled materials from removed concrete linings formed the base of these features. Bio-swales were strategically constructed along the green space to capture and filter urban runoff.

03 Native vegetation, including various species for habitat diversity, was carefully introduced along the drainage slope to prevent soil erosion. Wetland plants were incorporated into the drainage and bio-swales, while drought-resistant fruit trees like Kaki and Crab Apple were planted on mounds. Self-reproductive meadows covered the ground, and canopy trees were planted along pedestrian paths and gathering areas.

04 A pedestrian walkway network was meticulously designed to connect all diverse habitats within the green space, overcoming barriers created by motorways. Playgrounds, sports grounds, pavilions, and plazas of varying sizes were seamlessly integrated into the greenway to enhance visitor experience.

On this page:
Top-The Yongxing River channelized and lined with concrete since the 1960s.
Middle-A porous landform creating pits and mounds on land
Below-Bioswales.

On the other page:
Pedestrian paths with seating areas

Source: Turenscape, 2019

Impacts

Environmental

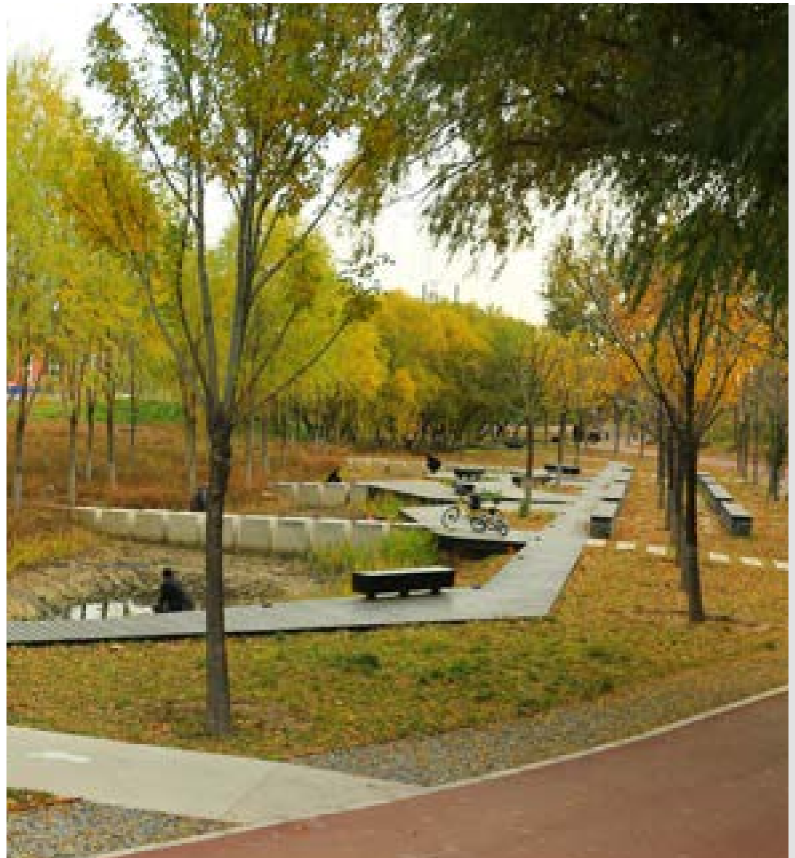
- Reconstructed drainage is flood-ready sponge corridor
- Native vegetation replaces former concrete slopes
- Bio-swales filter and cleanse urban runoff

Social

- Fruit trees add seasonal community excitement
- Over 13.5 km pedestrian paths encourage jogging. Dedicated bicycle path offers safe cycling and playgrounds and exercise spaces attract residents
- Five pavilions serve as rest spots
- Greenway became the city's popular public space

Economic

- 4 km of river developed cost-effectively



Scale it Up!

This project presents innovative solutions for challenges like stormwater management, habitat restoration, and limited public green spaces. By transforming flood control infrastructure into versatile green areas, it offers a sustainable approach to urban resilience and community welfare. Adapting this model to Indian cities requires sensitivity to local environments, cultures, and budgets. Strategic planning and community involvement can revitalize urban water systems and enhance biodiversity.

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16 URBAN FLOOD REGULATION IN MINGHU NATIONAL WETLAND PARK THROUGH TERRACED WETLAND SYSTEM

Liupanshui, China

Key Details

Scale
Settlement/city

Implementation Budget (Source)
NA

Challenges catered
Storm water management, native habitat and river water degradation, urban flooding

Project Duration
3 years

Implemented by
Liupanshui Municipality

Project USP
Terraced riverfront landscape, use of existing features for flood control & ecological restoration

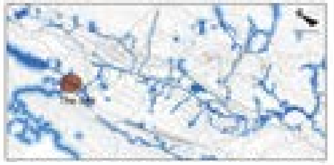
Project Rationale

Located in Liupanshui City, this project revitalises the Shuicheng River through ecological restoration and upgrading the urban open spaces. It aims to enhance the value of the urban waterfront and reclaim the landscape as a vital ecological infrastructure. Over a span of nearly three years, the once-polluted waterway has been transformed into a critical lifeline for the city, thanks to the implementation of vegetation and natural embankments that provide essential ecological services.

Introduction

The Shuicheng River in Liupanshui City, historically known as Lotus Leaf City, once encircled the city like a floating lotus leaf during the rainy season. However, with the onset of industrialisation, urbanisation, and mobilisation in 1966, the river underwent straightening and channelization with concrete embankments from 1975 to 1980. This initiative aimed to facilitate industrial growth but compromised the river's flood control, self-purification, and management of stormwater. Consequently, the river experienced ongoing degradation and pollution from sewage and waste. Once revered as a charming "Mother River," it became heavily polluted, necessitating urgent restoration efforts.

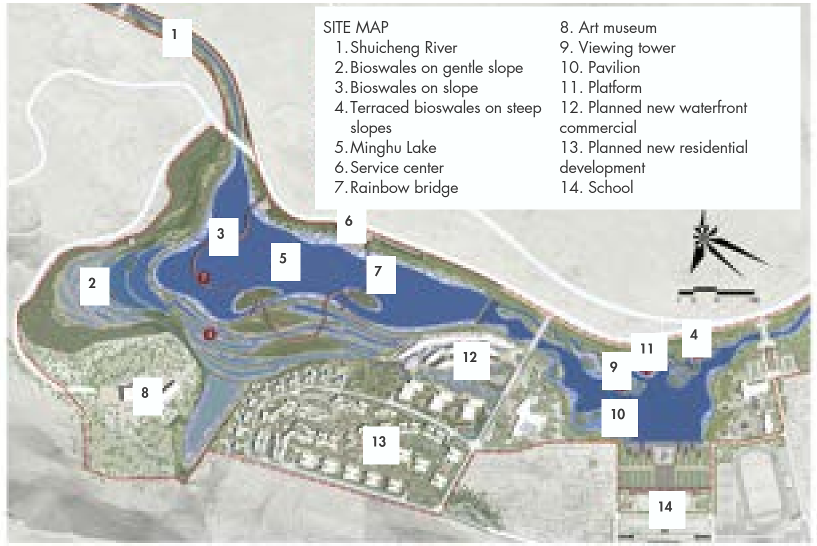
The surface flows of stormwater



The regional stormwater management system

Concept of regional ecological infrastructure

Regional ecological infrastructure



Bioswales on gentle slope

Terraced bioswales on steep slopes

On the previous page:
Terraced Wetland System of the Park.

On this page:
Site plan and details of the project.

Source:
Archdaily, 2015

Process Involved

The Liupanshui Minghu Wetland Park project spans 90 hectares and revitalises the Shuicheng River drainage basin through landscape strategies at macro and micro scales. This enhances the ecological, recreational, and social value of the Mother River.

01 Integrating existing features such as streams, fishponds, and low-lying areas into a flood control and ecological purification system fosters diverse wetlands.

02 Replacing concrete embankments with natural riverbanks enhances riparian ecology and self-purification. Aerating cascades aid in bio-remediation.

03 Developing continuous pedestrian and bicycle paths along the river enhances urban recreational spaces and accessibility.

04 Integrating waterfront development with river restoration drives urban renewal, blending ecological infrastructure with urban amenities.

05 Micro-scale strategies include targeted sectional approaches for river segments based on the masterplan, terraced riverfront landscapes for water regulation, and wetland systems. Landmark bridges and pedestrian paths serve to connect visitors to the area's natural and cultural significance. An emphasis on native species promotes a low-carbon landscape and ecological sustainability.

On this page:
Top-Pedestrian paths and bicycle routes.
Middle-Steel Rainbow bridge and public interaction spaces.
Below-Social and recreational environment for the people.

On the other page:
Aerial view of wetland park.
Source: Archdaily, 2015

Impacts

Environmental

- Revitalisation led to growth of wildflowers
- Flood regulation and water recharging
- Ecological health and biodiversity recovery
- Improved storm-water retention and quality

Social

- Harmonizes human-nature relationship
- Popular social and recreational spot
- Universal access to amenities
- National Wetland Park designation (2013)

Economic

- Increased land value and vitality
- Transformed wasteland into valuable space

Scale it Up!

The Minghu Wetland Park project reinvigorates urban landscapes by restoring the Shuicheng River into a thriving ecological corridor. The blending of environmental sustainability with urban development fosters biodiversity, enhances recreational spaces, strengthens community bonds, and transforms degraded water systems into vibrant public assets. It symbolises harmonious coexistence between humans and nature, offering a model for sustainable urban regeneration across diverse landscapes and cities.

Scan/Click to read more

17

CANAL REHABILITATION THROUGH GREEN INFRASTRUCTURE IN ATLASVILLE

Johannesburg, South Africa

Key Details

Scale
Ward/Settlement

Implementation Budget (Source)
Rs. 13 Crore (Municipality)

Challenges catered
Flooding and Pollution

Project Duration
1 year

Implemented by
Fourth Element Consulting

Project USP
Addressing floods through Nature-based solutions

Project Rationale

By integrating nature-based solutions for water treatment with flood management, the project resulted in reduction of floods, a healthier ecosystem, and enhanced water quality. An assessment of grey vs green infrastructure was conducted, which resulted in green infrastructure to be more cost-effective. Extensive planning allowed for community engagement and idea-sharing, leading to the Atlasville community's support for green infrastructure.

Introduction

Atlasville residential area was developed by draining a trench in a wetland for development in the 1970s. Backfilling the wetland with rubble and sediment led to the degradation of topsoil, and the Atlas Spruit canal confined the wetland flow. Regular dredging of the canal to maintain the hydraulic capacity resulted in ecological damage. In 2006, severe flooding caused by the canal's inability to handle runoff led to sewer overflows, health hazards, and damage to properties. The method chosen for flood alleviation was to use a nature-based solution to improve the Atlas Spruit, both hydraulically and ecologically.

On the previous page:
The Atlas Spruit and surrounding park.
Source: University of Cape Town, 2018

On this page:
A pile of grass cuttings before the rehabilitation of Atlas Spruit Park.
Source:
The Citizen, 2021

Process Involved

01 The project was segmented into two phases, with Phase 1 focusing on a 1.3 km segment of the stream to fulfil 100-year flood relief criteria. Currently, in the design phase, Phase 2 aims to meet similar flood relief objectives along a 2.2 km section.

02 After the removal of reeds, biodiverse vegetation was selected based on their ability to meet hydraulic requirements, provide habitats, and requiring low maintenance.

03 Construction activities included the placement of a geomat, referred to as the 'MacMat', to conserve the topsoil and prevent soil erosion prior to vegetation establishment.

04 Maintenance involves minimising reed growth to maintain the optimal hydraulic capacity of the canal.

On this page,
Top, Before the rehabilitation of the Atlas Spruit Park.
Middle, One of the surrounding parks of Atlas Spruit.
Source: The Citizen, 2021

Below, Reed uptake in Atlas Spruit
On the next page, View of the rehabilitated canal.
Source: University of Cape Town, 2018

Impacts

Environmental

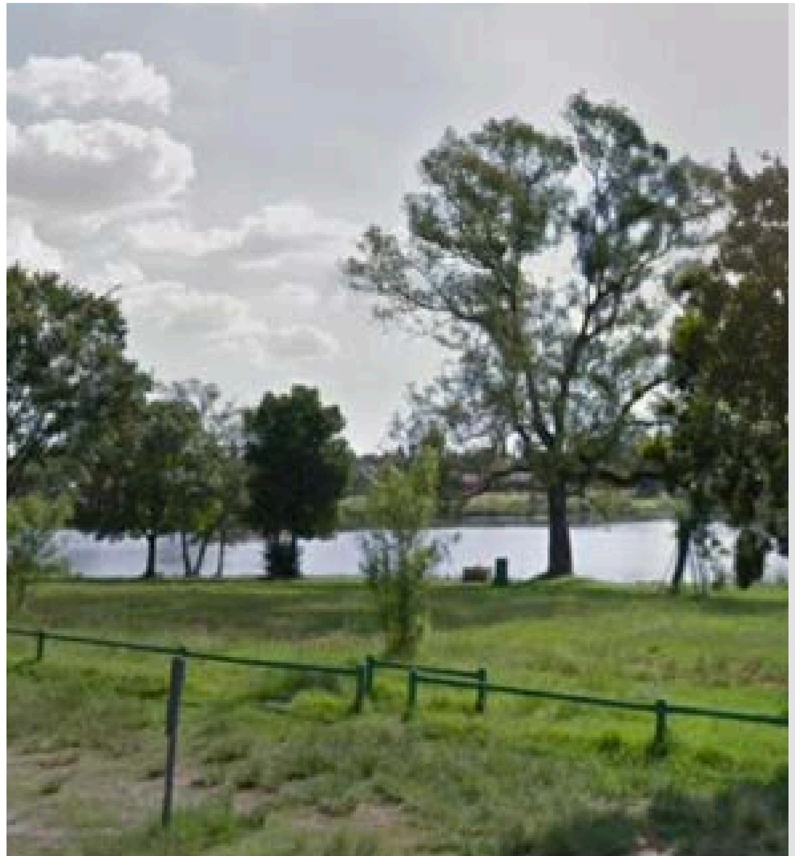
- Increased flood protection
- Improved water quality in the surrounding areas
- Prevention against soil erosion

Social

- Reduced diseases, leading to improved public health
- Vibrant space, enhancing the quality of life

Economic

- Sharp increase in property prices due to improved ecology



Scale it Up!

In numerous communities and urban villages across Indian cities, where wetlands have been reclaimed for settlement purposes, the persistent issue of flooding poses significant challenges. Implementing nature-based solutions for stormwater management can mitigate the health risks associated with the contamination of stormwater by sewage. It can help maximise hydraulic efficiency and increase the capacity of the drainage network by desilting drains and reducing the growth of invasive species.

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18 RESTORATION OF THE SMALL CREEK CONCRETE CHANNEL TO A MORE NATURAL WATERWAY, CO-DESIGNED WITH THE COMMUNITY

Queensland, Australia

Key Details

Scale
City/Settlement

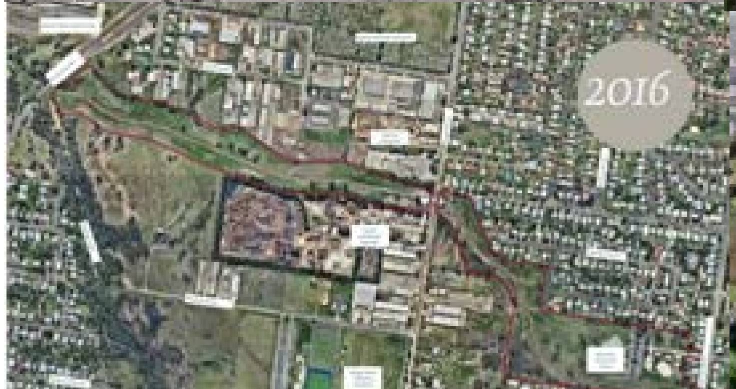
Implementation Budget(Source)
Rs. 73.68 Crore

Challenges catered
Flooding, mosquito breeding, loss of habitat and Degrading water Quality

Project Duration
5 years

Implemented by
Ipswich City Council
Landscapology
Bligh Tanner
Streamology

Project USP
Transformation of Small Creek from a concrete drain into a natural waterway.



Project Rationale

The Small Creek naturalisation project is one of Australia's most significant waterway restoration projects, aimed at transforming a concrete drainage channel into a natural, healthy waterway. This case study highlights the profound impact of integrating ecological restoration, stormwater management, and enhancing community interaction with the environment. The project's design integrates biodiversity, flood resilience, drainage, and health and safety considerations, delivering substantial environmental and social benefits to the local community.

Introduction

Small Creek, located in Raceview, Queensland, is a former natural stream that was transformed into a concrete drain in the early 1980s. This modification led to various ecological and social issues, such as poor water quality, loss of habitat, increased flood risk, and diminished community engagement with the natural environment. The need for intervention arose due to the degradation of water quality in downstream Deebing Creek, the presence of stagnant water fostering mosquito breeding, and limited access for recreational activities. The restoration project aims to reinstate Small Creek as a functional and vibrant natural waterway, improving environmental health and providing a valuable recreational space for the community.

On the previous page:
Project extent showing existing Small Creek 1946 & 2016.
Source: Big plans for Small creek ,2016

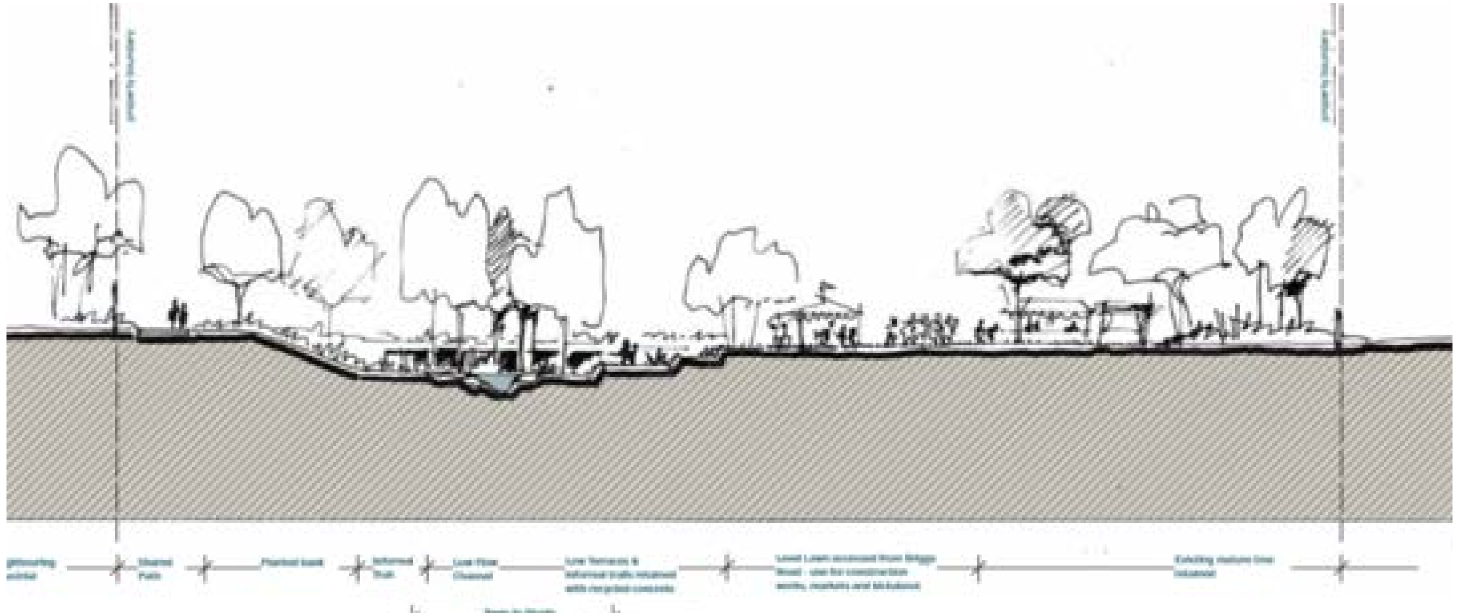
On this page:
View of Small Creek
Source: Small creek- Bligh Tanner projects 2016

On this page,
Top - Small Creek Naturalisation 2086 Proposal

Bottom -Stepping stones along informal paths

Source: Small Creek Naturalisation,2017
Landscapology, 2017

On the next page,
Plan & section of the Small Creek Naturalisation
Source: Landscapology, 2017



Process Involved

01 The project began with Design Your Creek Week" and involved over 180 participants, addressing concerns like snakes, mosquitoes, and flooding. Community feedback, including Indigenous representation, was integrated into the design.

02 Transformed 1.6 km of concrete channel into a natural waterway with native vegetation, pools, and shallow sections. Design features included shared paths, a chain of ponds, native tree planting like Melaleuca and Eucalyptus trees for canopy cover, sedge planting Lomandra (for erosion control), and Phragmites for water filtration and cultural elements.

03 This project was executed in four stages over five years, from downstream to upstream, to ensure ecological continuity with Deebing Creek. Earthworks occurred during the dry season (July-October) and planting in late November.

04 Extensive flood modeling was done to ensure no additional flood risks.

05 Involved multiple stakeholder collaborations like Ipswich City Council, landscapology, Bligh Tanner, streamology, geomorphologists, landscape architects and Community engagement was vital for fostering ownership and pride.

On this page,
Top - Extensive revegetation along the creek
Middle - Community Engagement

Below - vegetation colonising the drain
Source: Small Creek Naturalisation,2017

On the next page:
Life along the creek corridor
Source: Landscapology, 2017

Impacts

Environmental

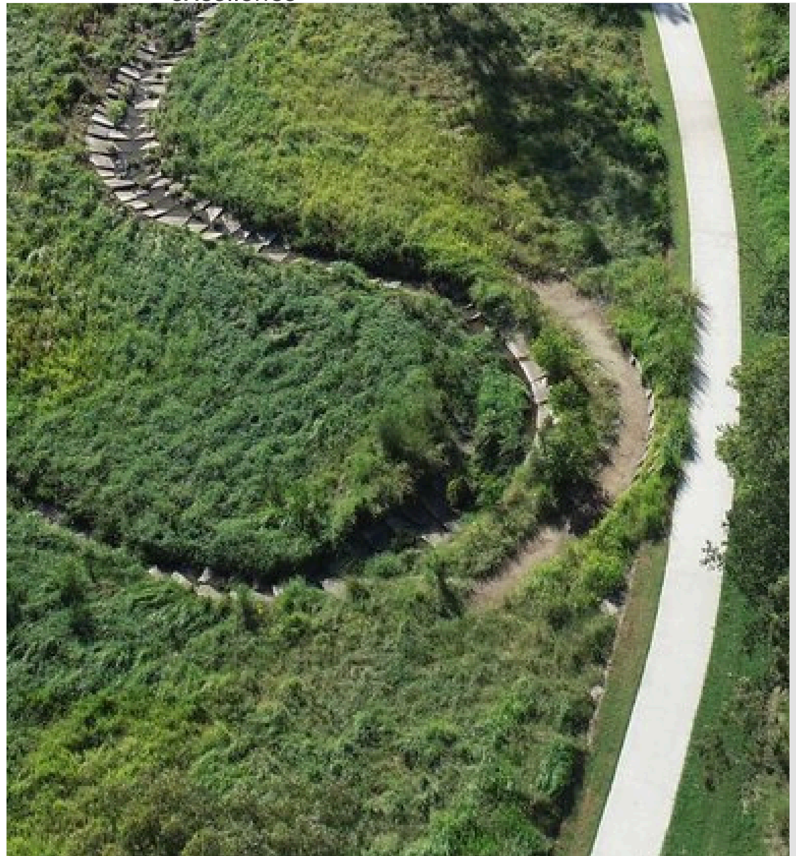
- 970 kg/year nitrogen reduction
- 61 bird species sightings
- Erosion control with native vegetation
- Restored natural hydrology
- 56,000 m^2 carbon sequestration.
- Won various awards for its environmental excellence

Social

- High community engagement
- New walking and cycling paths
- Cultural and educational opportunities
- Improved aesthetics and well-being.

Economic

- ₹14-21 lakh property value increase
- Cost-effective maintenance.
- Boosted tourism and local business



Scale it Up!

Scaling up of the Small Creek Naturalisation project in Indian cities requires a tailored approach, it's essential to identify heavily polluted rivers like the Mithi or Yamuna. Community engagement can help gather local insights and concerns. Key steps will include transforming concrete channels into natural waterways with native vegetation, implementing phased construction to minimize disruption, integrating stormwater management, and enhancing biodiversity. Collaboration among stakeholders and incorporating cultural elements will ensure success and community ownership.

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19

ANGUS CREEK STORMWATER AND REUSE SCHEME THROUGH NATURAL AND MECHANICAL TREATMENT PROCESSES.

New south Wales, Australia

Key Details

Scale
Neighbourhood

Implementation Budget(Source)
Rs. 522.02 Crore
(Australian Government, NSW Government and Blacktown City Council)

Challenges catered
Drought, degradation of aquatic ecosystems, increased Algal Blooms

Project Duration
4 years

Implemented by
Blacktown City Council and Optimal Stormwater Pvt. Ltd

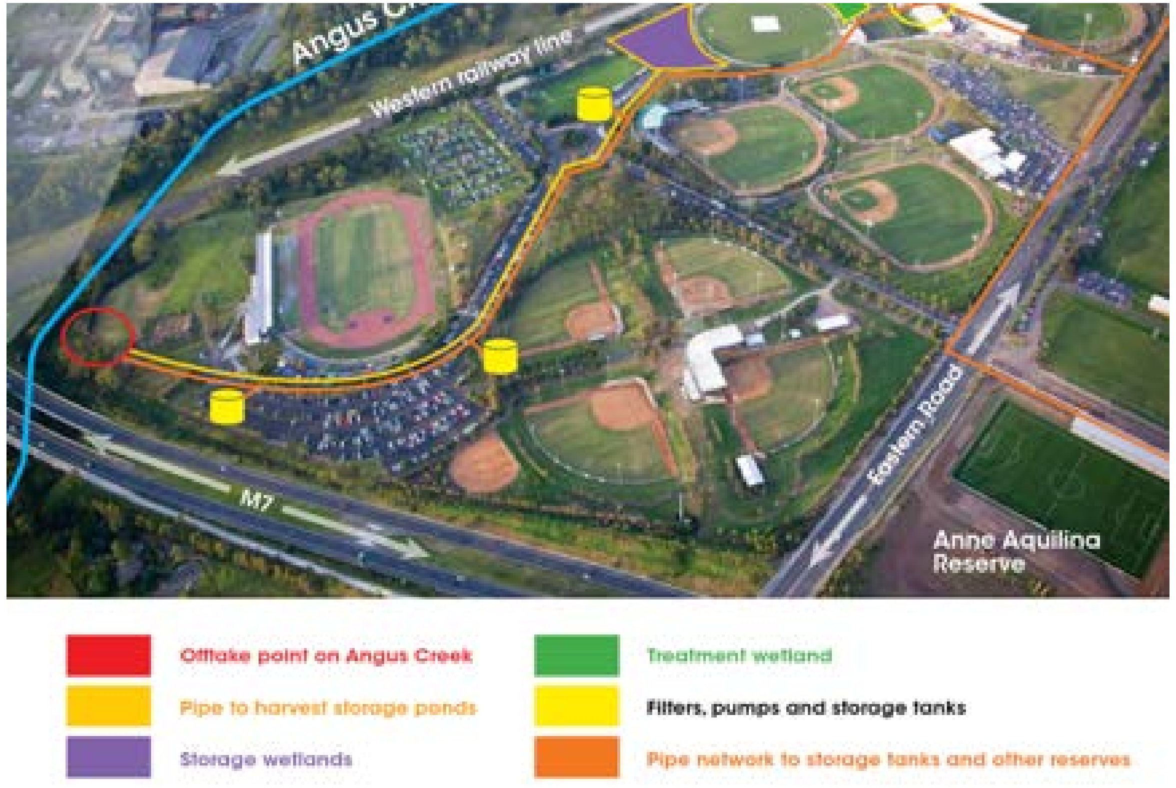
Project USP
Integration of stormwater harvesting with natural and mechanical treatment processes.

Project Rationale

The Angus Creek Stormwater Harvesting and Reuse Scheme was developed to secure a reliable water supply for the Blacktown International Sportspark during droughts, protect Angus Creek from stormwater pollution, and provide a sustainable, cost-effective irrigation alternative. By harvesting and treating stormwater, the project ensures drought resilience, environmental protection, financial sustainability, and carbon neutrality.

Introduction

The Angus Creek Stormwater Harvesting and Reuse Scheme is located at the Blacktown International Sportspark in Rooty Hill, NSW, an area characterized by a growing urban landscape and increasing vulnerability to drought. The 655-hectare Angus Creek catchment, which drains stormwater from the surrounding suburbs, was contributing to pollution and erosion in local waterways. This environmental degradation, coupled with the need for a sustainable water supply, prompted the intervention to develop a stormwater harvesting system. The project aimed to address these issues by providing a reliable, environmentally friendly alternative water source, improving waterway health, and ensuring the long-term viability of the Sportspark's facilities.



On the previous page: Ponds in foreground and wetland in background. Source: Cooperative Research Centre for Water Sensitive Cities, September 2018

On this page: Angus Creek Stormwater Harvest Aerial View. Source: Angus Creek Stormwater Harvest Slideshare, 2016.

Process Involved

01 The scheme's main storage consists of three ponds with floating wetlands, storing 8ML of Stormwater and serving as flood detention basins for the Sportspark.

02 An event-based approach manages peak Stormwater velocities, mimicking rural stream conditions. Stormwater is harvested only when flow exceeds 10 L/s, while the initial 10 L/s passes downstream.

03 Flow diversion structures and a 1 ML harvest pool treat Stormwater before storage in 1800 kL tanks. MUSIC and Goldsim models simulate flow management to reduce peaks and maintain base flows.

04 Adjustable tilting weirs manage the flow without restricting flushing or high flows.

05 Pumps with a 45 L/s flow rate are controlled by variable speed drives, and eco-hydrological monitoring allows adaptive management.

06 Installation and calibration of the SCADA system to gather and analyse real-time data from the main components of the Scheme

On this page:
Top- Inlet to the storage pond, including floating wetland rafts
Source: Cooperative Research Centre for Water Sensitive Cities, September 2018
Middle-Water Storage Tank
Source: Bettinatan Projects, 2018
Below: Storm water collection pond
Source: Bettinatan Projects, 2018

On the next page:
Aerial view of Storm water Treatment
Source: Djcoregon, 2022

Impacts

Environmental

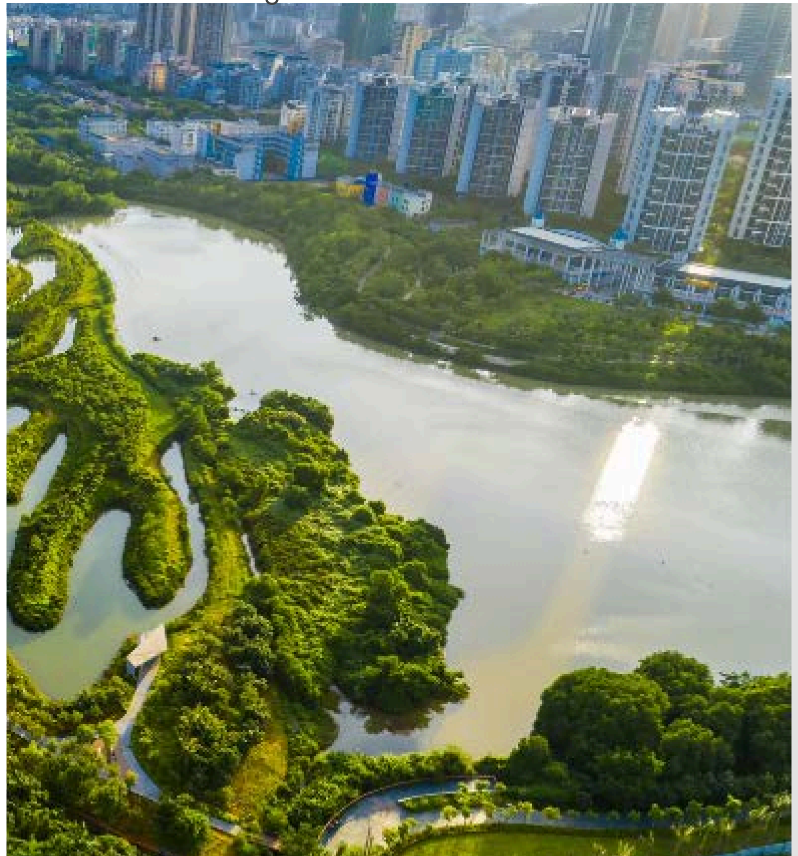
- Reduced pollutant loads downstream
- Mitigated creek bank erosion
- Reduced stress on aquatic ecosystems.
- Improved drought resilience through reduced reliance on main water.
- Carbon-neutral operation through solar energy offsetting.

Social

- Community Support and Engagement
- Enhances local waterways and aesthetics, contributing to improved community liveability.
-

Economic

- Saves 200 megalitres of potable water annually
- Reduces potable water costs by 20% compared to Sydney Water.
- Self-funded operation & maintenance through internal sales of water.
- Eases financial strain on public resources.



Scale it Up!

To scale up projects like Angus Creek in Indian cities such as Mumbai, an event-based Storm Water harvesting approach can be adopted. This involves diverting and storing excess water while allowing initial flows to pass naturally, using flow diversion structures, a central harvest pool, and treatment systems like wet basins and floating wetlands. Hydrological modeling helps manage peak flows and preserve base flows, while adjustable flow control structures and smart technology, such as SCADA systems, and adaptive management tailored to urban creeks in Indian cities.

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20

SLACKS CREEK CATCHMENT RECOVERY PROJECT

City of Logan, South East Queensland, Australia

Key Details

Scale
City

Implementation Budget (Source)
NA

Challenges catered
Community Disconnection, Pollution, Habitat Loss

Project Duration
4 Years

Implemented by
Logan City Council

Project USP
Comprehensive approach to ecological restoration with strong community involvement

Project Rationale

This project restored the creek's ecological functions, transforming it into a thriving, natural space within an urban setting. Besides implementing riparian restoration, constructed wetlands, improving fish passage, the initiative also exemplifies community involvement. The project's integrated approach also led to recreational and educational opportunities. The active participation of over 2,000 community members in various activities has already showed positive results, enhancing both the water quality and the sense of local ownership.

Introduction

The Slacks Creek Catchment Recovery Project was established to address the severe environmental degradation that occurred in the Slacks Creek area due to rapid urbanisation since the 1970s. Urban development led to a decline in water quality, ecosystem health, and a loss of community connection to the creek. Recognising the ecological and social importance of this catchment, the project was initiated to restore and enhance the health of Slacks Creek, increase wildlife habitats, and reconnect the community with this vital natural resource. Through extensive rehabilitation and community engagement, the project transformed two creeks, Slacks Creek and Scrubby Creek into a water-sensitive urban area, enhancing the ecological and recreational value of the catchment.

On previous page, Connected Waterways of the Creek.

On this page, Boardwalk and Viewing Deck of Shailer Pioneer Park.

Source: Logan City Council, 2023

Process Involved

01 The recovery process was initiated after community concerns were raised at the 2011 Logan Waterways Summit. A collaborative approach to urban creek renewal was adopted, which resulted in increased support from local councils and stakeholders.

02 The project began with riparian restoration, including the planting of 90,000 native species and the removal of invasive weeds across 2.5 kilometers of the creek corridor.

03 Constructed wetlands like the Shailer Pioneer Park wetland were established to treat stormwater runoff using natural water treatment processes. The wetland's design enhanced recreational amenities with boardwalks, viewing decks, and interpretive signage, while also supporting threatened species like the tusked frog.

04 Public artworks and parkland activations, such as the "Slacks Track" public art trail, helped reconnect residents with the creek.

05 Improved biodiversity through the construction of the Paradise Road fishway. It enhanced aquatic connectivity, enabling native fish populations to thrive

On this page,
Top - Rehabilitation planting along Creek Line
Middle - Drone shot of Riparian Corridor
Below - sunloungers along the path with yellow shelter

On the next page, Origami Crane statues at night dining precinct.

Source: Logan City Council, 2023

Impacts

Environmental

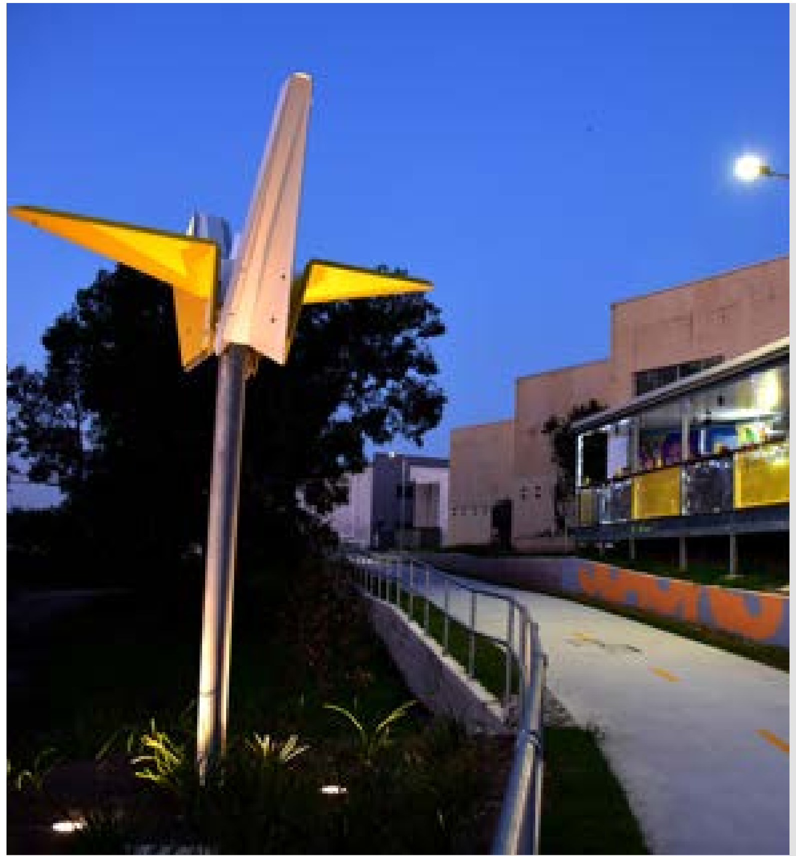
- Improvement in water quality of the entire catchment
- Improved biodiversity
- Restoration of ecosystems around it

Social

- Enhanced community resilience
- Creation of safe and accessible green-blue spaces

Economic

- Attracted investments from local and state governments



Scale it Up!

To holistically restore and rejuvenate river systems, implementing interventions such as riparian vegetation and constructed wetlands enhance water quality and support biodiversity, hereby improving the ecosystem. Engaging local communities through citizen-driven initiatives and public art can enhance community ownership and mainstream sustainable practices. Additionally, establishing fishways and interactive blue-green corridors can ensure the project's success, transforming degraded urban spaces into resilient, ecologically rich areas.

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S-3

PARKS AND PUBLIC SPACES

Explore the potential of Water Sensitive Urban Design (WSUD) in ‘Revitalising Parks and Public Spaces’. This section delves into strategies that merge sustainable water management with urban design, transforming green areas into vibrant, resilient spaces. Discover how WSUD enhances biodiversity, improves water quality, and creates enriching recreational environments, fostering a harmonious balance between nature and urban life.

21

TRANSFORMATION OF BENJAKITTI FOREST PARK THROUGH WATER-QUALITY REMEDIATING WETLAND

Thailand, Bangkok

Key Details

Scale
City/ward

Implementation Budget (Source)
Rs. 68.67 Crore

Challenges catered
Urban flooding, inadequate drainage infrastructure, groundwater exploitation

Project Duration
2 years 3 months

Implemented by
Finance Ministry of Bangkok, Thailand

Project USP
Low-maintenance regenerative system, wetlands with mini-islands

Project Rationale

The transformation of a former tobacco factory site into a low-maintenance regenerative system at Benjakitti Forest Park intercepts stormwater, filters contamination in the runoff, and establishes wildlife habitats. As downtown Bangkok's largest recreational space, it embodies the city's vibrant culture. Completed within 18 months, the project presents a cost-effective, replicable urban engineering model that revitalised barren concrete into a resilient ecosystem.

Introduction

Bangkok, home to over 10.5 million residents, is situated in the flat terrain of the Chao Phraya River Delta, and has low elevation. Originally a swampland, it was drained for agriculture, leading to severe subsidence from groundwater extraction. Climate change exacerbates flood risks, overwhelming drainage systems during heavy rainfall. Located in central Bangkok's Khonti District, on a 102-acre former tobacco factory site, the project addresses these challenges. Surrounded by contaminated canals, an urban expressway, an artificial lake, and prominent facilities, the area suffered from poor connectivity and pollution from runoff and sewage. The transformation of this space into a regenerative system intercepts stormwater, filters contamination, and provides wildlife habitat, offering a resilient solution to Bangkok's urban challenges.

On the previous page:
Aerial view of Benjakitti Forest Park.

On this page:
Aerial images showing the stages of development of the forest park.

Source:
Turenscape, 2023

Process Involved

To address the challenges of the site and its dense urban surroundings, the project was envisioned as a central park, providing holistic ecosystem services and offering public space for recreation and cultural activities. Four strategies guided the work:

01 Existing trees and main roads were preserved through reuse and recycling efforts. Old factory buildings were repurposed into a sports center and museum, and demolished concrete was recycled for earthwork foundations and paving.

02 Cut-and-fill techniques were employed to create porosity and wetlands, including mini-islands that retain stormwater, transforming impermeable ground into a porous landscape. A linear wetland was designed to enhance water quality and sustain wetlands through dry seasons. Major roads were modified with permeable bio-swales and flower beds, transforming spaces originally designed for heavy truck traffic into more human-friendly environments.

03 The concept of "Messy Nature" was embraced, creating diverse micro-environments with low-maintenance vegetation that enriches the area with native species.

04 Visitors can enjoy an immersive spatial experience with features such as boardwalks along shallow wetlands and a skywalk through tree canopies, offering unique natural perspectives in the midst of a dense urban area.

On this page:
Top-Processes involved in the transformation.
Middle-Mini-islands, and pedestrian boardwalk.
Below-The repurposing of existing factory structure (before and after).

On the next page:
Creation of a public forest park in a dense urban context.

Source: Turrenscape, 2023

Impacts

Environmental

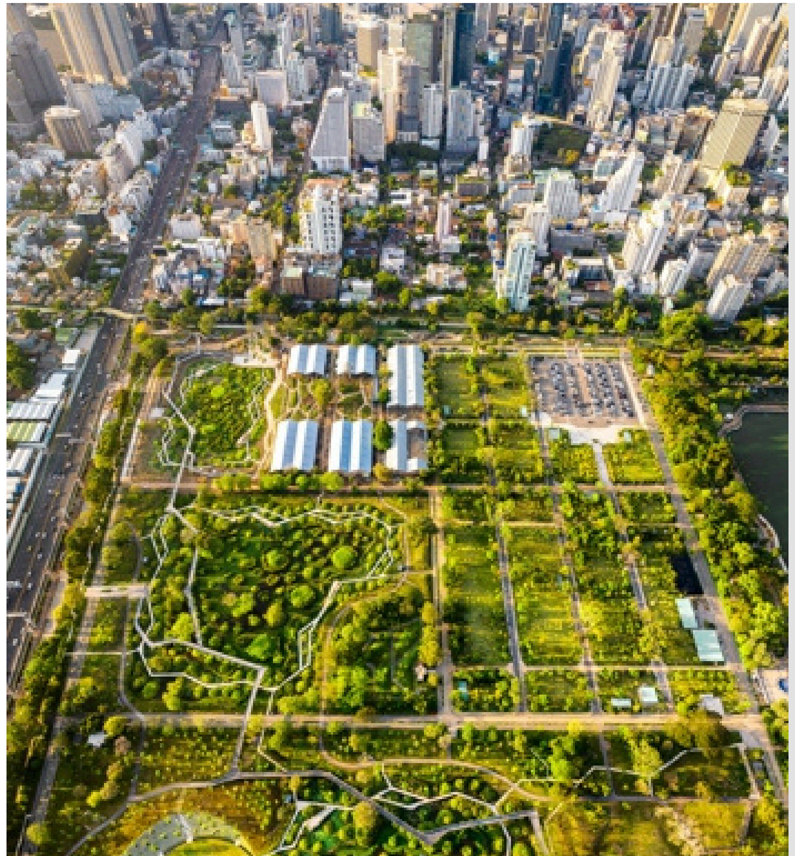
- Flood mitigation, despite the heavy Bangkok rain
- Wetland retention, even through the dry season
- Diverse habitat creation

Social

- Largest green space in central Bangkok
- Promotes active lifestyle and is popular for jogging, cycling, and family outings
- Has become a landmark, iconic destination in Bangkok

Economic

- Economic benefits due to timebound execution of the project within 18 months



Scale it Up!

This approach mitigates flooding and also promotes sustainability, creating lush, permeable landscapes that improve urban resilience and enhance the quality of life for the residents. Recycling and creation of low-maintenance landscapes is the need of the hour across dense urban cities of India. By transforming parks into wetlands with mini-islands, stormwater can be effectively captured and managed to mitigate urban flooding and improve water security, while also creating recreational and actives spaces for residents.

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22

NANCHANG FISH TAIL PARK FOR FLOOD RESILIENCE

Nanchang, China

Key Details

Scale
City/ Neighbourhood

Implementation Budget
Rs. 83 Crore

Challenges catered
Flooding and Habitat Degradation

Project Duration
1-2 years

Implemented by
Turenscape Institute

Project USP
Using Landscape Architecture to revitalise the Environment

Project Rationale

Functioning as an innovative flood management solution, the Floating Fish Tail Park in Nanchang is a former dumping ground and fish farm that has been transformed into a dynamic urban green space. By integrating natural elements such as wetlands and islets, the park acts as a resilient buffer against floods while enhancing biodiversity and providing recreational opportunities.

Introduction

The Nanchang city faced the adverse impacts of flooding and degrading water quality. The 51-hectare site was once a fish farm amidst natural wetlands but is now reclaimed and repurposed from coal ash dumping grounds. Despite water pollution from coal ash, fish feed, and urban runoff, the area is characterised by dense urban development. Embracing these challenges, the city aimed to craft a resilient urban oasis that contributes to flood regulation, enhancing biodiversity, and creating recreational spaces.

On the previous page:
Aerial view of Nanchang Fish Tail Park.

On this page:
Site Plan of the Park.

Source: Turenscape, December 2021

Process Involved

The process was characterised by five types of interventions:

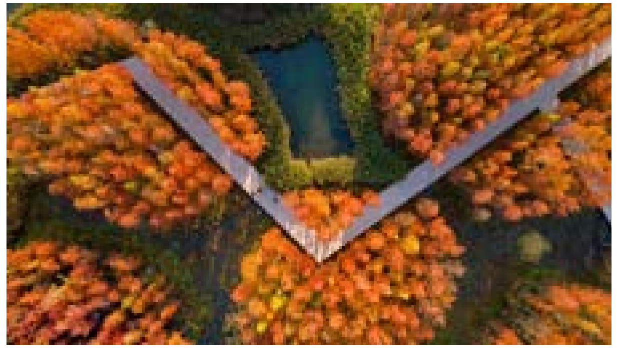
01 Transformation of the landscape was inspired by ancient marshland farming and floating garden system. Coal ash was recycled with dirt to create islets. A lake was made to catch storm water inflow with a capacity of 1 million cubic meters.

02 Planting of native species was done, especially, perennial and annual wetland plants were planted to combat exposed muddy shorelines, caused by water level fluctuations. Lotus plants were also planted to provide effective lake cover.

03 A recreational waterfront was designed for 20-year floods, providing recreational areas like playgrounds, beaches, fountains, lawns, etc. Terraced wetlands helped filter urban runoff.

04 Flood resilient boardwalks, in the form of circular paths for pedestrians and cyclists, are designed at an elevation above the flood line for 20-year events. The boardwalks and platforms, constructed from prefabricated concrete, are either detached or floating above the water and allow for easy cleaning post-submersion.

05 Contemporary design was used to strategically position bridges, platforms, pavilions, and viewing towers, which serve as captivating landmarks. A cafeteria at the entrance overpasses a six lane road, connecting this park to a neighbouring park, The Aixi Lake Park.



On this page:
Top & below-Elements of Nanchang Fish Tail Park.
Middle-Before and after images of the Park.

On the next page:
Aerial view of the Park.

Source: Turenscape, 2021

Impacts

Environmental

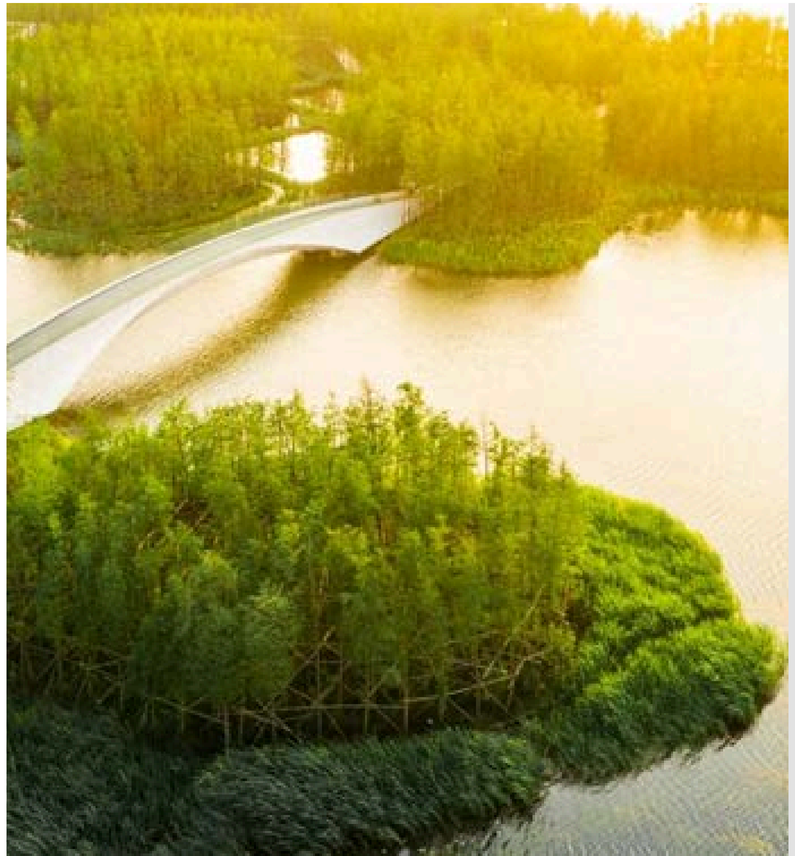
- Increased stormwater storage potential upto1 MCM
- Enhanced biodiversity
- Reduced pollution

Social

- The central submerged forest provides opportunities for nature exploration during monsoon floods

Economic

- Served as a catalyst for development of the New District



Scale it Up!

By incorporating features like stormwater absorption, and ponds and channels within urban parks, cities can efficiently regulate surplus rainwater, especially during monsoon. This approach can reduce the impact of flooding, restore groundwater levels, and induce habitat restoration. The adoption of such measures in cities facing urban floods can improve their resilience to climate-related disasters.

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23 ADYAR ECOLOGICAL RESTORATION PARK

Chennai

Key Details

Scale
City/
Neighbourhood

Implementation Budget (Source)
Rs. 23 Crore (Chennai River Restoration Trust)

Challenges catered
Habitat degradation, flooding, and pollution

Project Duration
2 years

Implemented by
Pitchandikulam Forest Consultants and Idea Design

Project USP
Holistic restoration, sustainable maintenance, and environmental education

Project Rationale

The project focused on managing stormwater runoff and treating sewage and wastewater using ecological planning techniques. Simple nature-based interventions such as creating mounds using excavated earth to support vegetation, and planting indigenous species serve multiple purposes including habitat creation, biodiversity enhancement, and erosion control. Enduring drainage systems encourage infiltration, reduce runoff, and improve groundwater replenishment. The project also promotes environmental education and awareness with interactive learning spaces and programs.

Introduction

Adyar River serves as a stormwater outflow for the watershed surrounding the Creek, particularly for Mandaveli. Stormwater enters the creek via drains and Adyar Park serves as a retention and infiltration area, with surplus spills going into the estuary. It also acts as a tidal water storage, but faces issues like disposal of sewage and solid waste. In the first phase of a larger programme undertaken by Chennai River Restoration Trust, various experts worked on water management, habitat mapping, ecology, architecture, and landscaping of Adyar Park. The park also showcases sustainable technology models like a demonstration windmill, a wastewater treatment plant that reuses treated water, and several others to raise awareness.

On the previous page:
Before and after images of the restoration.

On this page:
View of the Adyar Ecological Restoration Park.

Source:
Idea Design, 2021

Process Involved

Six vegetative elements, such as trees, shrubs, herbs, grasses, climbers, and aquatic plants, were planted in various zones (core, peripheral, inland, littoral, and aquatic zones, water margins). A total of 1,10,161 plants from 172 native species were planted to create a green cover surrounding water bodies.

01 Excavation has been done to increase water spread area, and debris and sludge removal has led to a significant increase in water spread.

02 Sewage discharge from the surrounding was diverted into sewer pipelines with the help of City's Water supply Board and City Municipality.

03 Excavated soil was used to build mounds around the water body, supporting coastal vegetation like mangroves, reeds, and terrestrial plants.

04 Designated arrival and orientation area has been established to help visitors navigate the Poonga, along with maps, signs, and artifacts showcasing various aspects of the ecological park.

05 Solar lighting system has been set up in various locations to showcase green energy along with a demonstration windmill for water pumping.

06 Demonstration wastewater treatment plant has also been built to recycle water for irrigation.

07 A nursery has been developed with medicinal and indigenous plants with signage to describe the medicinal properties of the plants. An Environmental Education Centre has been built, where programs for school children are conducted.

On this page:
Top-Before and after images of the park.
Middle-Solid waste disposal at the park before restoration.
Below-View of the park post restoration.
Source: Idea Design, 2021

On the next page:
View of the park post restoration phase 1.
Source: Chennai Rivers Restoration Trust, 2020

Impacts

Environmental

- Maintaining e-flow: increase in water spread from 5.53% to 59%
- Providing habitat for birds and other animals in the creek ecosystem. 100 bird species, 100 fish species, 56 butterfly species, and 25 reptile species reported post restoration
- Improved water quality in the surrounding areas

Social

- Awareness and capacity building about importance and conservation of wetlands
- Vibrant public space for the local community

Economic

- Empowerment and skill development for making informed environmental decisions

Scale it Up!

Comprehensive wetland restoration using indigenous species can be implemented in many Indian cities. Natural drainage systems, like Delhi's Najafgarh, have suffered from urbanization and become dumping grounds. Clearing waste and using the topsoil for large-scale planting of native species can improve water quality and river flow. The restored areas can also serve as knowledge hubs with public facilities.

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24 URBAN WATER MANAGEMENT THROUGH SPONGE CITY CONSTRUCTION IN QINGSHANGANG WETLAND SPONGE PROJECT

Wuhan, China

Key Details

Scale
City/ward

Implementation Budget
Rs. 20 Crore

Challenges catered
Urban flooding, water pollution and water scarcity

Project Duration
N/A

Implemented by
Water Affair Bureau of Qingshan District, Hubei Design Branch of Pan-China Construction Group Co. Ltd.

Project USP
Rejuvenation of degraded area using sponge techniques

Project Rationale

Sponge City Construction initiative is designed to address the impacts of rapid urbanisation in China that have led to flooding, degraded local water quality, and water shortages. It encourages the adoption of permeable surfaces and green infrastructure to help address the problems by mimicking the natural hydrology in urban areas.

Introduction

Qingshan district is located in Wuhan. The river channel in Qingshangang area was congested with silt and wastes that reduced the drainage capacity and water mobility in the area. Moreover, the sewage water was being discharged directly into the water body causing heavy pollution, biodiversity loss, and eutrophication in the channel.

The sponge renovation project aimed at enhancing the drainage capacity, improving the ecological environment, and developing a connected public recreational park. It was designed to capture 85% of the annual rainfall on-site and reduce at least 70% of water pollution.

On the previous page: Aerial view of the Qingshangang Wetland Sponge Project.

On this page: Before and after of the Qingshangang Wetland Sponge Project.

Source: Grown Green Project, 2021

Process Involved

The project was initiated by the Water Affair Bureau of Qingshan District and implemented by Hubei Design Branch of Pan-China Construction Group Co. Ltd.

01 Separation of sewage and rainwater pipes, followed by the use of pollution control treatments including ecological drainage, floating islands, wetlands, and subsurface wetlands.

02 Treatment of combined sewer outflows leveraging the 8-metre elevation. Further, the green space along the canal is where the sewage water was discharged through sponge techniques rather than directly into the water bodies.

03 Channel dredging was done to improve water quality and flow capacity. Aquatic plants were planted to restore the water ecosystem.

04 Transformation of streets and residential areas into sponge-like areas to reduce pollution at the source. This has resulted in several grass swales, rainwater gardens and infiltration pavement, and rainwater storage modules in the area.

On this page:
Top and Middle-Sponge infrastructure in Wuhan.
Below-Schematic of the grass swale.

On the next page:
Sponge construction of demonstration project – the Gangcheng No.2 Middle School in Wuhan.

Source: Grown Green Project, 2021

Impacts

Environmental

- Black and odorous water bodies were eliminated
- Drainage capacity in the catchment was improved
- 85% annual runoff control rate
- Coping mechanism for a 50-year rainstorm

Social

Urban greenways connecting parks has created an interconnected recreational area for citizens

Economic

- Renovation and upgradation driven in surrounding areas

Scale it Up!

Scaling up the sponge city concept in Indian cities can greatly enhance water resource management, reduce pollution, and create sustainable urban environments. This approach uses green infrastructure—like permeable pavements, green roofs, rain gardens, and wetlands—to absorb, store, and purify rainwater, mitigating flooding and replenishing groundwater. These strategies have already transformed urban areas, showing promising benefits for other cities in India.

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25

STORMWATER MANAGEMENT AT LEIDSCHE RIJN

Utrecht, Netherlands

Key Details

Scale
Settlement/city

Implementation Budget (Source)
Approximately Rs.17,000 Crore

Challenges catered
Housing shortage, urban development, environment, and transportation issues

Project Duration
Ongoing since 1997

Implemented by
Utrecht Municipality

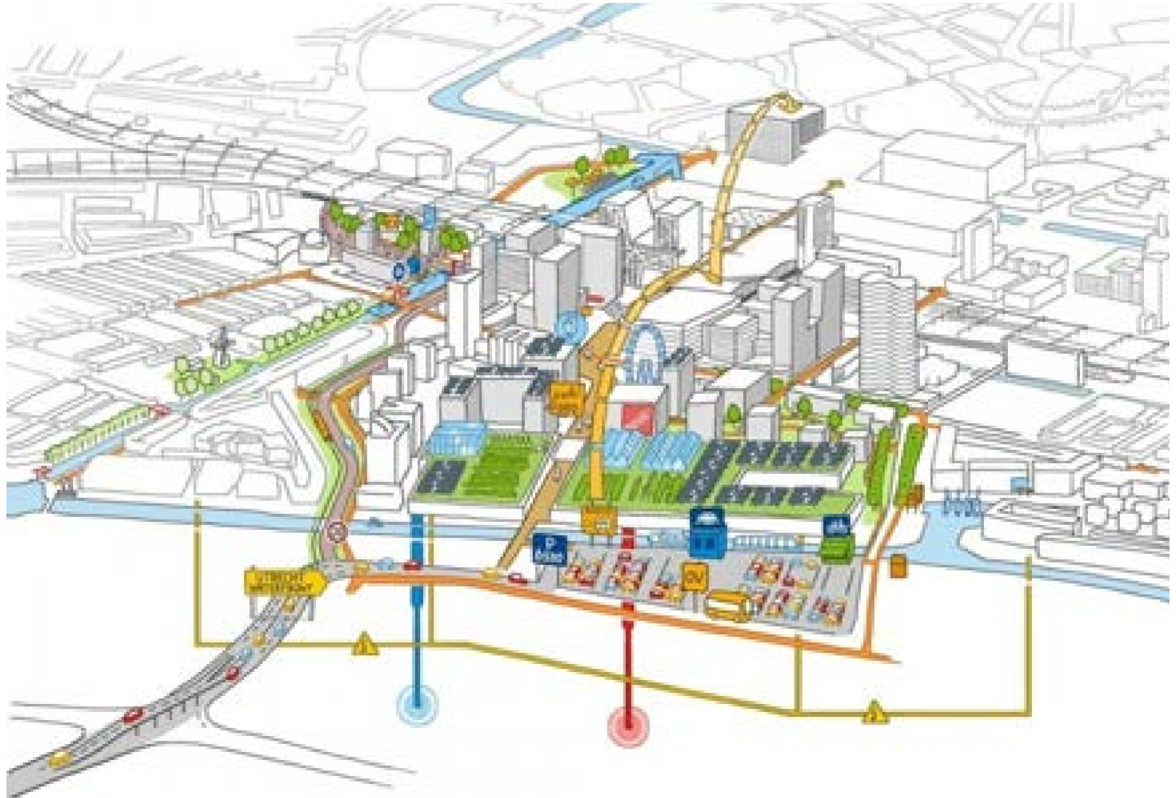
Project USP
Integration of green spaces, sustainable housing, efficient public transport, water management

Project Rationale

The Leidsche Rijn project is a pioneering model of sustainable urban development, notably in stormwater management. It tackles environmental issues while elevating the quality of life of residents. Prioritising open stormwater systems and minimising external water sources fosters long-term resilience and community ownership. Effectively retaining stormwater mitigates flooding risks, maintains water quality, and preserves groundwater, creating a healthier ecosystem.

Introduction

Leidsche Rijn, located in the western part of Utrecht, Netherlands, covers 2100 hectares, with 11% of its area comprised of surface water. The district is being developed gradually, with distinct identities assigned to different neighbourhoods. With a focus on sustainable housing development, the project addresses issues such as stormwater management and water quality. The hydrology of the area varies, with higher grounds facilitating stormwater infiltration and lower grounds requiring alternative management strategies. The intervention, prompted by historical agricultural practices disrupting natural groundwater levels, underscores the necessity for comprehensive solutions to effectively manage water resources amidst limited land availability and increasing urbanisation pressures.



On the previous page: Greening of streets to capture and infiltrate runoff.
Source: Urban Nature Atlas, 2021

On this page: Diagrammatic representation of Utrecht's water sensitive management system.
Source: Network Nature, 2020

Process Involved

The project was implemented after analysing topography, soil types, and groundwater levels to identify suitable areas for storm water management using selected design elements such as canals, wadis, and green spaces based on hydrological conditions.

01 Enhanced water retention and infiltration through integrated canals, wadis, green spaces, permeable pavements, infiltration beds, and a 40 m deep lake.

02 Integration of a closed-loop system to retain stormwater within the area and minimise external water intake, prevent flooding incidents while promoting groundwater recharge.

03 Implementation of water quality management measures like incorporation of vertical flow reed beds to filter phosphates and maintain water quality.

04 Ensured continuous water circulation through canals to prevent stagnation and algae growth.

04 Consideration of social and environmental impact through educational initiatives to promote understanding of stormwater management practices and responsible behaviour, such as banning pesticides and limiting carwash activities, in order to protect water quality and enhance community engagement.

On this page:
Top-Canals in the city.
Middle-Greening of streets to capture and infiltrate runoff water.
Below-Sustainable urban drainage system of Utrecht

On the next page:
Greening of building facades.

Source: Urban Nature Atlas, 2021

Impacts

Environmental

- Efficient phosphorus removal reduces algal blooms
- Stormwater infiltration enhances groundwater recharge, reduces flooding

Social

- Educational programs increase resident awareness and engagement
- Water features and community involvement activities foster cohesion

Economic

- Reduced reliance on external water sources saves costs
- Sustainable design enhances property values and attractiveness

Scale it Up!

Applying these principles to Indian urban areas requires tailoring innovative strategies to local contexts. Implementing wadis, permeable pavements, and infiltration beds can enable effective stormwater management, flood reduction, and groundwater recharge. Community engagement, educational programs, and local initiatives can foster public participation. Pilot projects can showcase benefits and encourage broader adoption, enhancing resilience to climate change and urbanisation challenges.

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26

SPONGE PARKS FOR WATER RETENTION

Chennai

Key Details

Scale
City/
Neighbourhood

Implementation Budget (Source)
Rs. 7 Crore (Chennai Municipal Corporation)

Challenges catered
Flooding and groundwater depletion

Project Duration
1 year

Implemented by
Chennai Municipal Corporation (through contractors)

Project USP
Easy-to-implement strategy to manage stormwater and recharge groundwater

Project Rationale

With Chennai facing recurrent flooding as well as water scarcity, interventions on city-wide sponge parks are being implemented to increase the permeable surface cover and infiltration of excess water. For this, pond-like structures are being created and excess water from surrounding areas is directed here for absorption. During the rainy season, this park serves as a collection point for runoff, facilitating natural infiltration into the ground. This approach enables effective flood mitigation and groundwater recharge.

Introduction

To address the frequent recurrence of floods, stormwater pipes were laid out, which led to an improvement in the drainage system. This nudged the municipal corporation to transform the city into a 'sponge city' by creating drainage facilities in parks and public spaces. The initiative is being implemented in phases, with 57 parks selected for the establishment of sponge park systems in the first phase.

On the previous page:
Sponge Park in Perambur Murasoli Maran Park
Source:
Tamil.oneindia.com, 2024

On this page:
View of the pond-like collection space for capturing and infiltrating water.
Source:
The Hindu Tamil, 2023

Process Involved

The implementation of sponge parks in Chennai involved several key processes to ensure their effectiveness and sustainability:

01 The sponge parks are being developed after assessment of the site, road layout, and soil composition.

02 They are characterised by pond-like formations and channels that capture and infiltrate rainwater in urban settings.
.

03 Channels divert water from adjacent roads into the pond through storm drains. The pond is encircled by a stone barrier topped with a protective railing.

04 These parks are also designed to support the growth of trees in their vicinity and equipped with rainwater harvesting tanks.

On this page:
Top and Middle-Sponge infrastructure under construction.
Source: Vikatan, 2024 and The Hindu, 2023

Below-Sponge parks in Chennai for floor resilience: Before and after images of Ambattur sponge park following Cyclone Michaung.
Source: Times of India, 2023

On the next page:
Park on VGP Selva Nagar Second Main Road in Velachery.
Source: The Hindu, 2023

Impacts

Environmental

- Increased flood protection
- Groundwater recharge
- Improved water quality in the surrounding areas

Social

- Protecting neighbouring communities from floods

Economic

- Cost effective intervention to address local floods

Scale it Up!

Leveraging city's existing parks for rainwater harvesting tanks can serve as a dual-purpose solution for waterlogging and groundwater depletion. By strategically installing tanks in parks around areas prone to flooding, excess rainwater can be captured and stored for beneficial use during its dry summers. These retention ponds can also be used for recreational purposes.

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27 RESTORATION OF JAMBURI PARK FOR STORMWATER MANAGEMENT, FLOOD RESILIENCE AND RECLAIMING OPEN PUBLIC SPACES

Chittagong, Bangladesh

Key Details

Scale
Neighbourhood

Implementation Budget (Source)
Rs. 18 Crore (Public national budget)

Challenges catered
Illegal land use, lack of open & green spaces

Project Duration
2 years

Implemented by
Ministry of Housing and Public Works of Bangladesh

Project USP
Capitalising on open spaces & creating a functional green area

Project Rationale

The restoration of the barren Jamburi Park in Chittagong involved repurposing the abandoned land, formerly used for illegal activities, into a viable urban green area. This initiative not only improved the city's green infrastructure, but also provided opportunities for outdoor recreational activities to the communities.

Introduction

Due to the endeavors of the Public Works Department (PWD) to reclaim the area, Jamburi Park, previously an abandoned land in Chittagong, was converted into a vibrant green space. With a prime goal of addressing the dearth of open areas in the densely populated Agrabad district, the park aimed to offer locals a venue for recreational activities using natural elements. Spanning 8.55 acres, the park boasts a diverse landscape featuring 65 species of trees and a sprawling 50,000 sq. ft. lake. Besides providing recreational opportunities, the park enhances microclimate by facilitating stormwater management systems and developing flood resilient structures.

On the previous page:
Day-time aerial view of the park.
Source:
Wikipedia, 2023

On this page:
Night-time aerial view of the park.
Source: Daily Sun, 2018

Process Involved

Jamburi Park was designed with features like rain gardens, wetlands, permeable pavements, and vegetated swales to manage stormwater.

01 The park covers 8.55 acres and has a 50,000 square-foot amoeba-shaped constructed lake in the centre. It has elements like a fountain, seating benches, bushes, etc. to enhance the aesthetics of the park.

02 It provides 8 km of walkways, and two public restrooms, and has two maintenance and electrical blocks.

03 Recreational Waterfront: The waterfront is designed for 20-year floods, providing recreational areas like playgrounds, beaches, fountains, lawns, etc. Terraced wetlands filter urban runoff.

04 The park has its own decentralised drainage system and is developed 3 feet above the ground.

On this page:
Top and Middle-Aerial view of Jamburi Park
Source: Urban Nature Atlas, 2023

Bottom-Creation of active green spaces in the city.
Source: MD. Gazi Mijan, Google Photos, 2020

On the next page-Aerial view of the park.
Source: Wikipedia, 2023

Impacts

Environmental

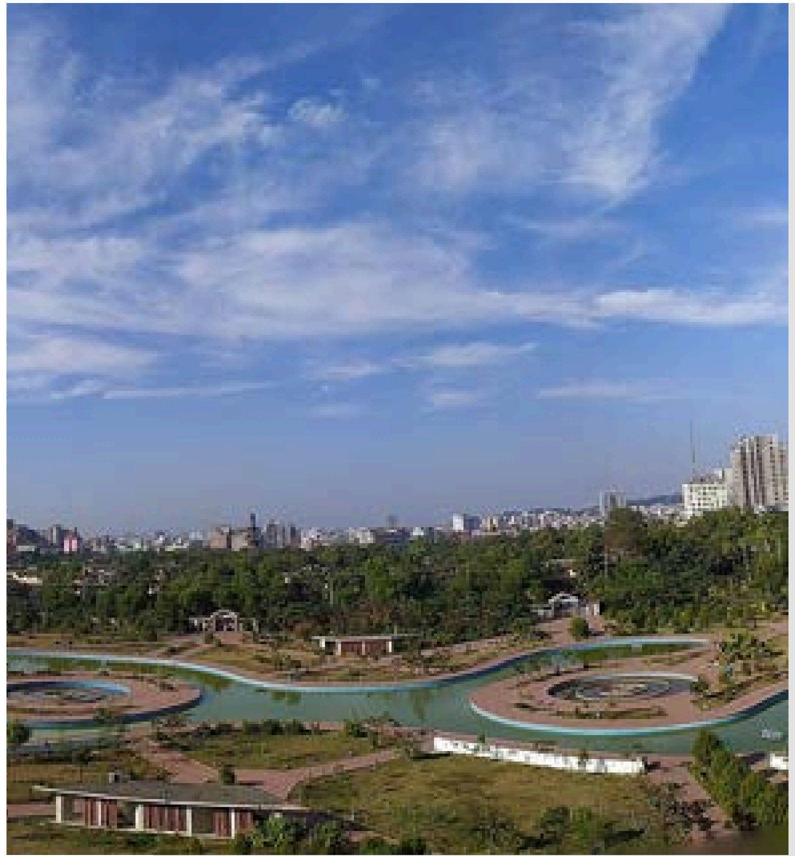
- Increased flood protection of the local areas
- Aids Solid Waste Management

Social

- Provides recreational space
- Improves community health & well-being

Economic

- Increase in property values in the surrounding areas



Scale it Up!

Urban local bodies should create green spaces in crowded areas by identifying abandoned or underutilised urban spaces and transforming them into recreational areas for public use. Such a park should have interventions like planting trees, implementing blue infrastructure, and creating green spaces for biodiversity conservation.

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28

GARDENS BY THE BAY: BIOPHILIC DESIGN OASIS

Singapore

Key Details

Scale
City

Implementation Budget
Rs. 8352 Crore (estimated)

Challenges catered
Limited land availability

Project Duration
Operational since 2012

Implemented by
National Parks Board, Singapore

Project USP
Nature + Tech Vertical Gardens; Biophilic Innovation

Project Rationale

Singapore's Gardens by the Bay tackles a multifaceted challenge by creating a thriving urban oasis on reclaimed land in a warm and humid climate. The project utilises innovative cooling systems and water features while showcasing sustainable practices like water conservation and resource management. Furthermore, the Gardens embrace biophilic design to foster a connection with nature and promote visitor well-being.

Introduction

Gardens by the Bay is an award-winning project in Singapore that exemplifies the power of biophilic design to transform urban landscapes. Nestled on reclaimed land, it blends futuristic super-trees with diverse plant life, creating a biophilic haven for residents and visitors alike.
This project goes beyond aesthetics; it incorporates innovative features like cooling and water features to achieve microclimate regulation and water conservation. This project is also an example of integration of sustainability goals with various urban recreational activities.

Gardens by the Bay enhances Singapore's "City in a Garden" image and sets a global benchmark for sustainable urban design.

On the previous page:
Aerial view of Gardens by the Bay.

On this page:
Site plan of Gardens by the Bay.

Source: Grant Associates/Archdaily, 2012

Process Involved

An international masterplan competition was held to develop an innovative concept for the gardens. Sustainable practices are a key consideration throughout the design process, including rainwater harvesting and energy-efficient cooling systems.

01 the winning design proposed three distinct waterfront gardens, namely Bay South Garden, Bay East Garden, and Bay Central Garden, to create three distinct areas.

02 Integration of iconic super trees - Vertical gardens housed within steel structures were incorporated as a signature design element. They served multiple purposes during the design phase, namely aesthetic landmark, vertical garden space, and sustainable cooling system integration.

03 Biodiversity focus through use of lush plant species, which were chosen to represent diverse climates, created a unique garden experience. Water features for cooling and habitat including ponds, canals, and mist generators were introduced.

On this page:
Top-Super trees, Gardens by the Bay.
Below-Innovative biophilic design.

On the next page-View of the elevated pedestrian walkway through the gardens.

Source: Grant Associates/Archdaily, 2012

Impacts

Environmental

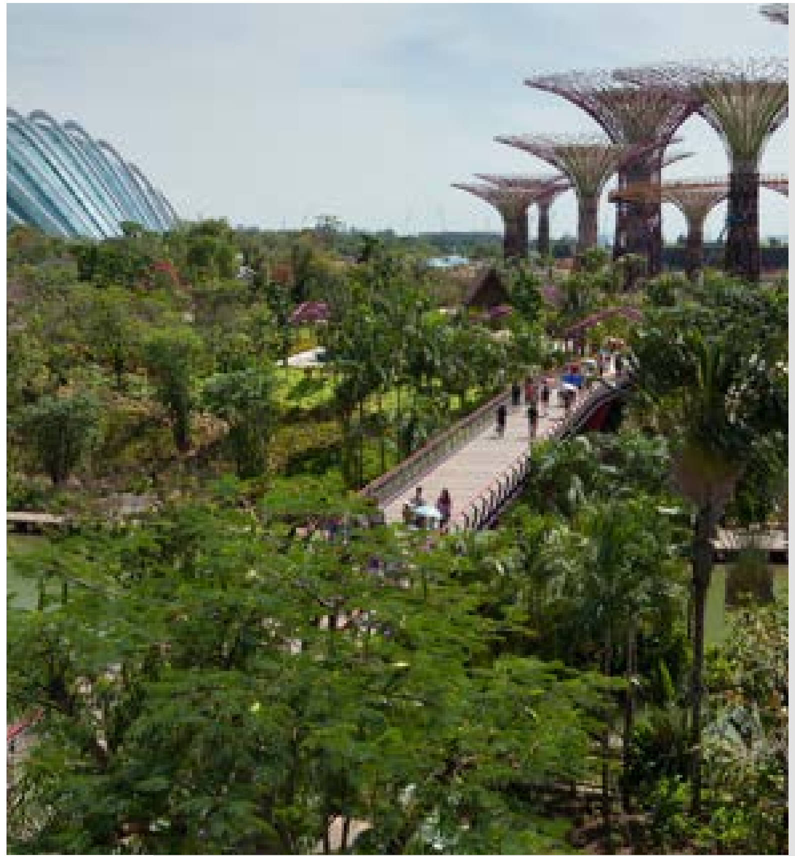
- Public space and biodiversity creation in a dense urban area
- Ambient micro-climate and diversity of species
- Water conservation and energy efficiency

Social

- Improved awareness about sustainable practices and environmental issues
- Vibrant public space for both residents and tourists

Economic

Tourist landmark, increased per-capita tourist expenditure, boosting local economy



Scale it Up!

Biophilic design principles can be adopted in diverse climates to prioritise sustainable practices for the creation of public spaces in dense urban areas. Further, the scope of public open spaces in cities worldwide can be expanded to attract a variety of visitors, and support diverse activities and functions that are a blend of sustainable practices and recreational significance.

Scan/Click to read more

29 LUXURY MEETS NATURE: EXPLORING BIOPHILIC DESIGN AT THE ITC GRAND CHOLA

Chennai, India

Key Details

Scale
Building

Implementation Budget (Source)
NA

Challenges catered
Lack of humidity control and water management

Project Duration
Completed and operational

Implemented by
ITC Hotels Ltd.

Project USP
Biophilic design adaptation for a luxury experience

Project Rationale

Chennai's climate and a desire for sustainable luxury drove the ITC Grand Chola's biophilic design. It offers a unique experience by celebrating South Indian heritage through natural elements like water features. These features enhance aesthetics and contribute to water conservation efforts, fulfil environmental responsibility, and contribute to the guest well-being and experience in the tropical city.

Introduction

This case study illustrates the seamless integration of biophilic water design principles into a luxury hotel project, enhancing guest experiences while promoting sustainability. It exemplifies a commitment to responsible luxury and environmental consciousness, blending South Indian heritage with grandeur.

The hotel is in Chennai and draws inspiration from the region's natural water bodies and lush greenery. With Chennai's warm and humid climate, averaging 25°C to 32°C (77°F to 90°F) annually, the hotel's biophilic water features are carefully designed to harmonise with the climatic context, creating tranquil and immersive guest experiences.

On the previous page:
ITC Grand Chola Hotel - View of the courtyard.

On this page:
Landscaping underneath Nala.
Source:
ITC Hotels, 2023

Process Involved

The project involved collaboration between architects, landscape architects, water feature specialists, and sustainability consultants. Careful consideration was given to water sourcing, usage, and treatment to ensure efficient and responsible management.

01 Development of a central water court, a cascading waterfall surrounded by native plants, and reflecting pools creates a calming atmosphere while also providing a stunning visual and auditory connection to water.

02 Floating gardens, accessible from guest rooms, are created as elevated landscaped terraces, which offer panoramic views of the water court and provide a serene outdoor space for relaxation and connection with nature in the hotel's urban context.

03 Water features like reflecting ponds and fountains are strategically placed throughout the hotel, offering pockets of tranquility and enhancing the biophilic experience.

On this page:
Top-Outdoor spaces with plantation and water features.
Below-Access to floating gardens and terraces from each room.

On the next page:
Blending of biophilic and heritage architectural elements in the design.

Source: ITC Hotels, 2023

Impacts

Environmental

- Reduced water usage (potential benefit due to biophilic design encouraging water conservation practices)
- Environment conscious luxury experience

Social

Enhanced guest experience and well-being through connection with nature

Economic

- Industry benchmark - attracting guests seeking sustainable practices and increasing revenue
- LEED Platinum certification and GRIHA 5-star rating - cost savings on energy and water bills

Scale it Up!

ITC Grand Chola is an example of a project achieving sustainability goals without compromising on the luxury experience. Projects across various urban centres can take inspiration from this core idea and expand the scope of biophilic design to achieve maximum human comfort and well being. Environment-conscious luxury experiences are the way forward for climate adaptation of all activities in our cities.

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30 TRANSFORMATION OF INDUSTRIAL BROWNFIELD LAND TO A MULTIFUNCTIONAL LIVING SYSTEM, SHANGHAI HOUTAN PARK

Shanghai, China

Key Details

Scale
Settlement/city

Implementation Budget (Source)
Rs. 130.7 Crore (Urban Waters)

Challenges catered
Flooding, water pollution, environmental degradation

Project Duration
3 years

Implemented by
Shanghai World Expo Land Development Co., Ltd.

Project USP
Constructed wetland, flood protection, urban agriculture, integrating existing industrial structures

Project Rationale

Houtan Park, built on a former industrial brownfield along Shanghai's Huangpu riverfront, is a regenerative living landscape. Its constructed wetland, ecological flood control, use of repurposed industrial structures and materials, and urban agriculture form a comprehensive restorative design strategy. This approach treats polluted river water and rejuvenates the degraded waterfront in an aesthetically pleasing manner.

Introduction

The site, a narrow 14-hectare strip along Shanghai's Huangpu River waterfront, was formerly a brownfield used mainly as a landfill by a steel factory and shipyard. The park design aimed to create a green Expo space, accommodate large visitor numbers from May to October, showcase green technologies, and transition into a permanent public waterfront park. The project faced three primary challenges: severe pollution needing environmental restoration, the necessity to enhance flood control beyond the rigid, uninviting concrete floodwall to handle 1000-year flood events, and accessibility issues caused by daily tidal fluctuations. Additionally, the site's narrow, elongated shape, flanked by the river and an urban expressway, posed significant design challenges in making it a safe and pleasant public space.

On the previous page:
Aerial view of the Houtan Park.

On this page:
Huangpu River and the dense urban context of Shanghai Houtan Park.

Source:
Turenscape, 2017

Process Involved

Regenerative design transformed the site into a living system that provides ecological services such as food production, flood control, water treatment, and habitat creation, all within an educational and aesthetic framework. Key strategies included:

01 A 1.7 km constructed wetland, 5-30 meters wide, utilises regenerative design with cascades and terraces to revitalise the waterfront and treat contaminated water from the Huangpu River.

02 The wetlands function as a water treatment facility and flood protection buffer while offering recreational and educational opportunities. Wetland plants absorb various pollutants from the water, and habitat-friendly riprap replaced the concrete floodwall, promoting native species growth and controlling shoreline erosion.

03 Terraces, reflecting Shanghai's agricultural heritage, double as urban farms and provide agricultural education. Reclaimed industrial structures and materials were repurposed into hanging gardens and overlook platforms, celebrating the site's industrial history.

04 The pedestrian network includes a main loop, perpendicular paths bisecting the wetland, and footpaths through the terraces, connecting gathering spaces and exhibition areas while integrating art and industrial relics.

On this page:
Top-Brownfield site before the project.
Second-View of the site after project completion.
Third-Repurposing of existing industrial structures.
Below-Pedestrian pathway through the revitalised park and wetland.

On the next page:
Recreational and educational opportunities in the park.

Source: Turrenscape, 2017

Impacts

Environmental

- Houtan Park showcases a multifunctional living system
- Implements innovative ecological water treatment methods
- Treats over 2,400 tons of water daily

Social

- Provides premier educational opportunities about urban agriculture
- Creates a productive landscape linking past and future
- Fosters community connection through historical integration

Economic

- Embraces low-maintenance, high-performance landscapes
- Prioritises economic sustainability with aesthetic appeal

Scale it Up!

Scaling up the Houtan Park model in Indian cities can transform industrial brownfields into green spaces, improving pollution control, flood management, and water treatment. Integrating urban agriculture and habitats boosts ecological services, education, and recreation. This approach fosters resilient, vibrant urban ecosystems while preserving cultural heritage and engaging communities.

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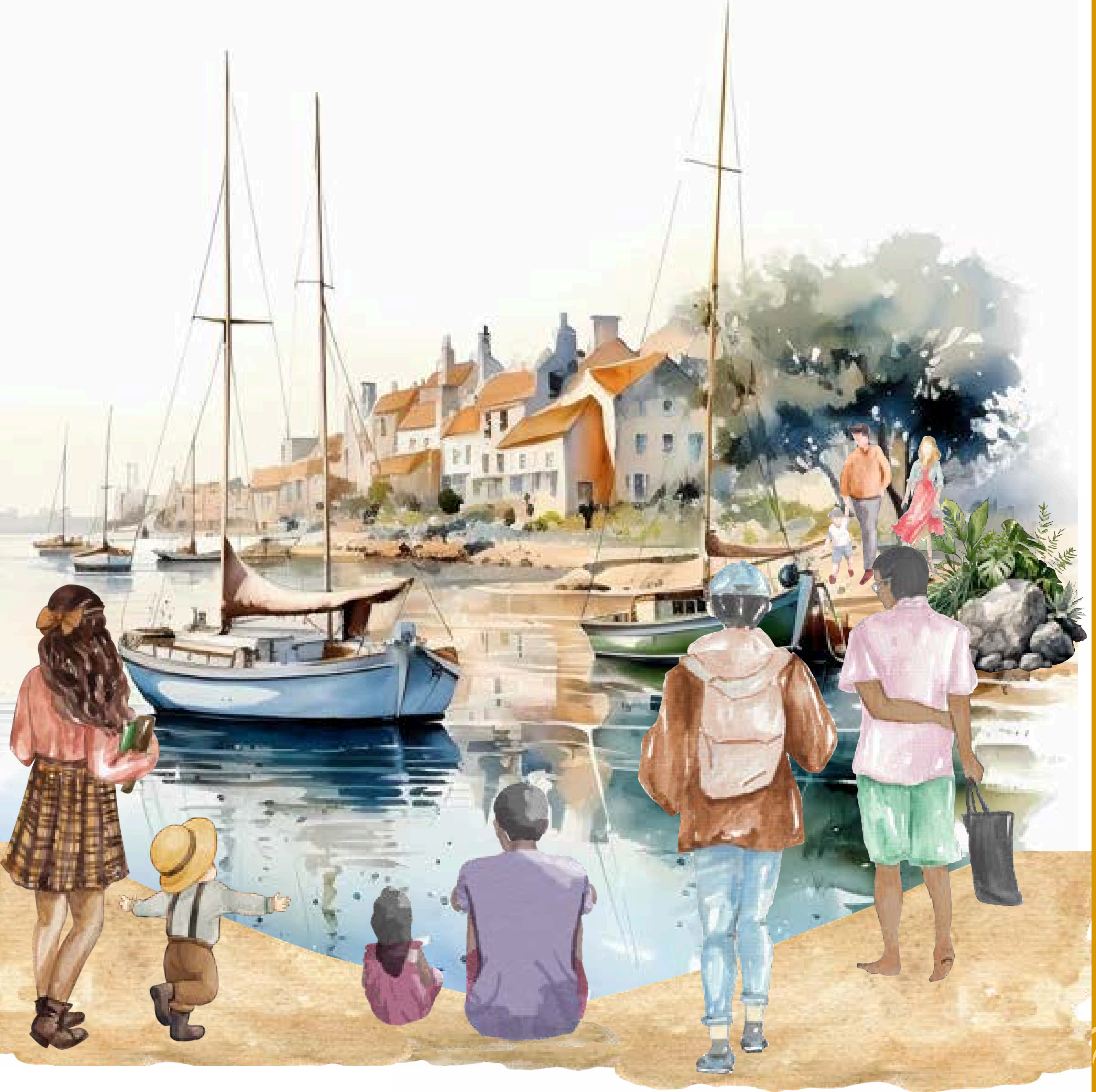


COMMUNITY CENTRIC INTERVENTIONS

Delve into 'Community Centric Interventions' with Water Sensitive Urban Design and discover how local actions can drive transformative change. This section highlights grassroots strategies that empower communities to manage water sustainably, enhance local ecosystems, and build resilient neighborhoods. Learn how community engagement and participation in WSUD can foster environmental stewardship and create thriving, sustainable urban spaces.

31 COMMUNITY INCLUSIVENESS - WATER AND SANITATION INTERVENTION

Cuttack, India

Key Details

Scale
Ward/Settlement

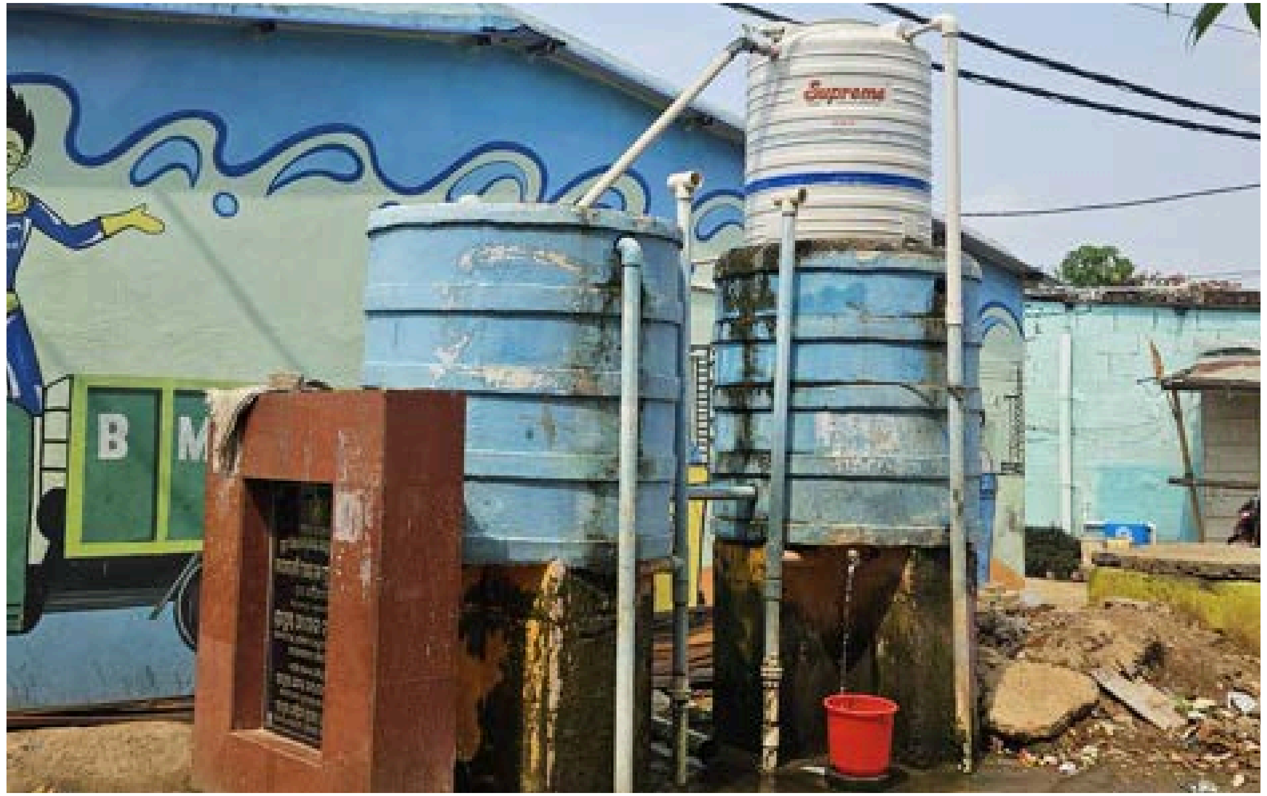
Implementation Budget (Source)
NA

Challenges catered
Inadequate water infrastructure, poor health conditions, and unemployment

Project Duration
2009-ongoing

Implemented by
National Foundation for India

Project USP
Community empowerment, especially for women, to ensure long-term sustainability



Project Rationale

The existing policies and initiatives proved inadequate in ensuring fair access to the fundamental water supply and sanitation services. The primary objective of the project was to empower marginalised communities, with a particular focus on women, for decentralised management of their water and sanitation requirements, by means of community participation, collaboration, and local resource administration. By spreading general awareness of civic responsibility and sustainable methodologies, the intervention aimed to enhance health, societal interactions, and environmental circumstances.

Introduction

The community-based water management initiative in Cuttack, Orissa, which began in 2009, addresses the basic challenges in water and sanitation facilities for the urban poor. The four peri-urban wards along the Mahanadi River had inadequate policies and service delivery standards. The initiative is a comprehensive approach towards water management, which aims to empower communities and proliferate the agenda of sustainable development, placing a strong emphasis on women's active participation. This intends to improve local collaborative governance, resource management, and the general well-being of citizens by establishing organised, cohesive, and empowered communities.

On the previous page:
Community water tank in Cuttack.

On this page:
Community access to water in Cuttack.
Source: NIUA, 2021

Process Involved

01 Improvement of Existing Water Infrastructure: Digging new wells and improving existing ones using low-cost technology to reduce iron content and make water potable.

02 Underground Community Water Filters: Designing and constructing community water filters to ensure clean drinking water; involving children and youth groups in managing these water filters to promote awareness and proper usage.

03 Pervious Well Protection and Enhancement: Covering wells and paving surrounding areas to prevent contamination; installing small hand pumps connected to wells to ease water drawing and reduce contamination risks.

04 Sanitation Facilities: Constructing individual toilets through women's self-help groups; using local materials to build ecologically sustainable sanitation facilities.

05 Rainwater Harvesting and Use: Installing cisterns for rainwater collection, with some volume used for household purposes and the rest drained to stormwater drains.

06 Community Engagement and Education: Organising small inclusive groups comprising women, youth, and people with special abilities and conducting educational programs on general health, hygiene, environmental issues, and water conservation.

On this page:
Top-Community Water Filter
Below-Community Mobilisation
Source: Water & Society, Vol 153, 2011

On the next page:
Community water tap in Cuttack.
Source: NIUA, 2021

Impacts

Environmental

- Reduction in iron contamination of water
- Replenishment of water table

Social

- Community empowerment in planning, implementing, and maintaining water and sanitation infrastructure
- Increased awareness and practice of hygiene and sanitation

Economic

- Creation of job opportunities for local residents through construction and maintenance work
- Enhanced skills and employability of communities

Scale it Up!

Cuttack's project highlights how empowering local communities, especially women, in managing water resources can achieve holistic urban water management. Emphasizing regular engagement, collective decision-making, and eco-friendly technologies, the initiative is replicable across India. Active citizen involvement fosters ownership and responsibility, leading to improved maintenance and longevity of infrastructure.

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STORMWATER MANAGEMENT THROUGH RAIN GARDENS IN RENFREW CLOSE

32

London Borough of Newham, London, United Kingdom

Key Details

Scale
Settlement

Implementation Budget (Source)
Rs. 1.05 Crore (Environment Agency, Groundwork London, London Borough of Newham)

Challenges catered
Flood risk, addressing community capital

Project Duration
1 year

Implemented by
London Borough of Newham Council

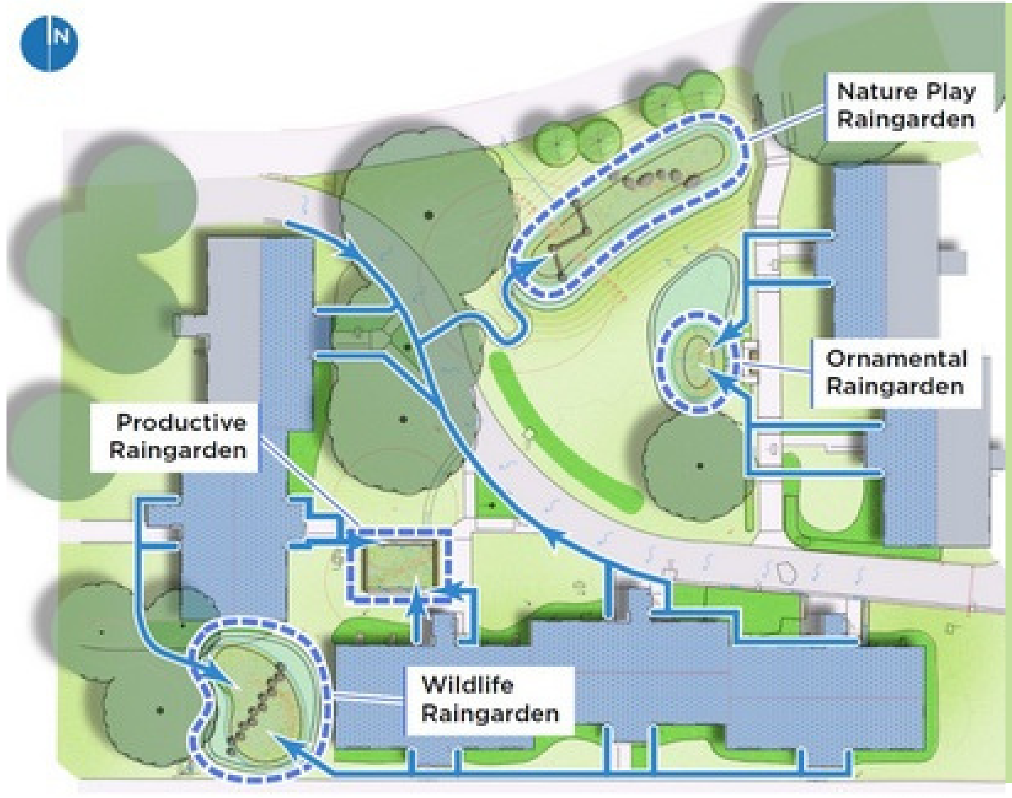
Project USP
Skill development in landscaping and horticulture, creating employment

Project Rationale

The Renfrew Close Rain Garden is a community-scale retrofit project. It includes four rain garden basins, designed on a city-owned social housing estate. The success of the project can be attributed to the willingness of the local council to execute the project and a collaboration between the city and the community. It was executed under a partnership between the local authority, NGO, University, and Defra Arm's Length Body.

Introduction

The Project was designed as a pilot to demonstrate the application of Water-Sensitive Urban Design in developed areas. Key project components are rain gardens, shallow rainwater conveyance channels, shallow detention basins, and conveyance channels. The disconnected roof downpipes and the conveyance channels carry water to rain gardens from rooftops and impermeable ground surfaces, respectively. This reduces the volume of rainwater from the site to the sewer network. One rain garden is designed on a nature play theme with balance beams and boulders. The second is an ornamental one that adds aesthetic value to the site. The third is a wildlife rain garden that increases local biodiversity, and the fourth is designed to provide residents with space to grow their plants and vegetables.



Demostration Project Details:

4 Raingarden design styles

750 sq.m. roof area

165 sq.m. road area

All raingardens accomodate a **1 in 10** rainfall event

Wider grass basins accomodate **1 in 100 + 30%** rainfall event

On the previous page:
Rain garden.

On this page:
Site plan showing rain gardens.

Source: SUSDrain, 2015

Process Involved

The project was initiated by London Borough of Newham Council to demonstrate and promote water-sensitive urban design at the neighbourhood scale.

01 Redirection of runoff from existing paved road to a natural low point where it crosses the road in a grated channel.

02 Conveyance channels divert this water from the sewer system into the rain gardens. They are built using paving blocks, and lined vegetated and unlined grass channels.

03 An overflow outlet connected to the basins provides a safe overflow of water from the rain gardens to the sewer in the unlikely event of design exceedance.

04 The site is underlaid with high permeable soils for the water to infiltrate into the subsurface in the unlined channels. This reduces the total volume of water leaving the site from hard surfaces.

05 Three rain gardens are interlinked as protection from exceedance flooding. High infiltration capacity of the rain gardens leaves them dry for most of the year. Hence, they are planted with wildflower and ornamental mixes that are capable of tolerating both dry and flooding conditions. Stepping stones, balancing beams, and boulder features are used to add playfulness in the rain gardens.

On this page:
Top-Water-sensitive landscaping.
Below-Grass-lined channels.

On the next page:
Paved conveyance channels.

Source: SUSDrain, 2015

Impacts

Environmental

- Reduced stormwater load on existing sewers
- 413.21 kL of stormwater captured and prevented from entering surface water sewer over the first 12 months. Water is diverted from a non-permeable area of 915 sq. m. (750 sq. m. roof and 165 sq. m. road)
- Enhanced biodiversity and aesthetic value to the area

Social

- Rain gardens provide active vibrant green spaces for the community
- Improved resident's perception of the neighbourhood

Economic

- Successful pilot project, which was used as a case study to implement 300 other rain garden projects in London

Scale it Up!

These strategies using rain gardens can be used for many cities and can effectively address the city's flood risks while enhancing community engagement and skill development. Additionally, involving unemployed residents in landscaping and horticulture will boost local skills and community ownership. Implementing this model across other cities will significantly improve flood management, increase green spaces, and foster community resilience and engagement.

Scan/Click to read more

33

NATURE-BASED SOLUTIONS (NbS) FOR COMMUNITY RESILIENCE

Onyika Settlement, Namibia

Key Details

Scale
Settlement

Implementation Budget (Source)
NA

Challenges catered
Flash floods, lack of basic services and sanitation, environmental vulnerability of informal settlements

Project Duration
Ongoing since 2019

Implemented by
Multilateral organisations

Project USP
Nature-based solutions for community resilience and climate adaptation

Project Rationale

The Onyika Settlement faces several climate change related vulnerabilities like flash flooding and a lack of access to basic resources. The project aims to provide targeted solutions like bioswales and rainwater harvesting, capacity building among residents, and skills training and workshops on adaptation strategies to ensure social equity and achieve long-term sustainability by utilising local resources and cost-effective solutions for empowering communities and building resilience.

Introduction

The Onyika informal settlement in Okuryangava, Windhoek, Namibia, home to approximately 330,000 people, faces critical challenges due to rapid urban growth and vulnerability to climate change. About 30% of Windhoek's population resides in informal settlements, where residents struggle with inadequate access to essential services and frequent losses due to flash flooding.

Responding to these threats, a community-led initiative launched in July 2019 aimed to create a climate-resilient community in partnership with local authorities, donors, and climate experts.

On the previous page: Riverbed with riparian vegetation
Source: Amayaa Wijesinghe (University of Oxford), 2019

On this page: "Learning Labs" - participants included elected senior officials, researchers, and representatives of city departments, youth organisations, and NGOs working In informal settlements.
Source: Liz Daniels / SEI, 2019

Process Involved

The local inhabitants of the informal settlement, Onyika, paired with local authorities, donors and climate change experts to embark on a long-term community-led process for becoming climate resilient.

01 Nature-based solutions that combine traditional engineered elements (grey infrastructure) with natural elements (green infrastructure) to manage stormwater runoff and create a more sustainable system.

02 Creating new riverbank/lakeside greens, community gardens, and allotments throughout the community can help absorb stormwater runoff, improve air quality, and provide recreational space for residents.

03 Stormwater management using bioswales to collect, filter, and store stormwater runoff and reduce the risk of flooding. The filtration process also improves the quality of water that reaches surface water bodies, reducing water pollution.

04 Ecological restoration of degraded ecosystems to develop climate-resilience through native vegetation growth, soil stabilisation, measures to improve air and water quality, and provide habitat for wildlife.

On this page:
Top-Assessment of sites for bioswales.
Middle-Bioswale construction in the neighbourhood.
Below-Promotion of vegetable gardens for food self-sufficiency.

On the next page:
Use of digital mapping.

Source: GIZ Namibia, 2020

Impacts

Environmental

- Improved waste management system
- Enhanced water management and flood protection
- Increased green spaces and improved ecological balance
- Restoration of derelict areas

Social

- Enhanced social justice, improved safety, and community cohesion
- Community participation in the management and maintenance of green public spaces
- Equitable access to basic resources like food, water, and sanitation

Economic

- Minimisation of losses due to flooding
- Increase in real estate values

Scale it Up!

The Onyika Settlement project provides universally applicable lessons. Cities facing climate threats like extreme heat and water scarcity, such as Delhi, can replicate its principles at the neighbourhood scale and tailor them to local challenges. Scaling-up through knowledge-sharing and advocacy empowers residents and establishes healthy and resilient settlements worldwide, ensuring a more secure future amidst climate and environmental uncertainties.

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34

SUSTAINABLE URBAN DRAINAGE SYSTEMS (SUDS): NATURE-BASED SOLUTION FOR FLOOD MITIGATION & ENVIRONMENTAL RESTORATION

Johannesburg, South Africa

Key Details

Scale
Building/ Neighbourhood

Implementation Budget (Source)
NA

Challenges catered
Flooding, poor water quality, lack of green space, rapid densification

Project Duration
1 year

Implemented by
Johannesburg Department of Environment

Project USP
Nature-based solutions for all-round efficient water management

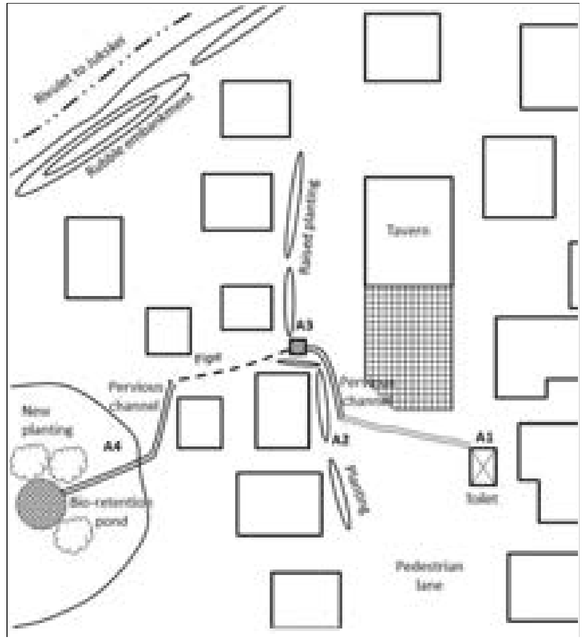
Project Rationale

Diepsloot's flooding and water quality issues are addressed with Sustainable Urban Drainage Systems (SUDS). Mimicking nature, SUDS reduces flood risk and filters stormwater and rainwater, improving surface and ground water quality. Rain gardens and new green spaces boost livability. Cost-effective and sustainable, the project involves residents in planning and maintenance, empowering them to build a more resilient Diepsloot.

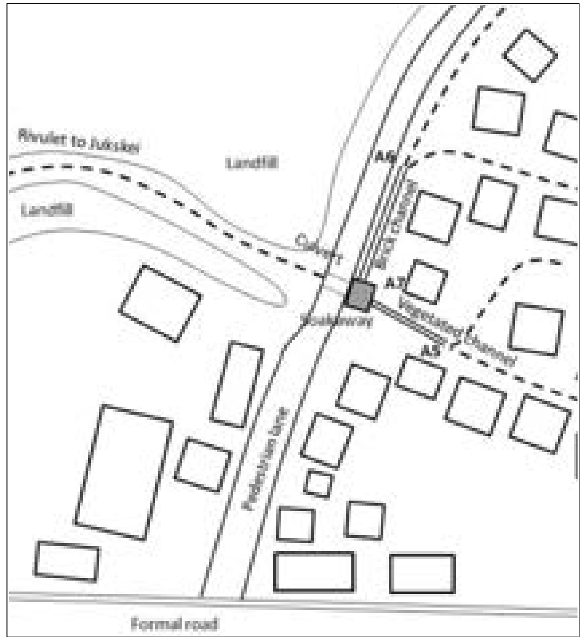
Introduction

Diepsloot is an informal settlement in Johannesburg, facing challenges like flooding and fast shrinking of its open green spaces due to rapid densification. An SUDS project was implemented to address these issues with the aim of improving water management, especially flood control, by developing green infrastructure for ecological benefits, in collaboration with researchers, the local community, and NGOs.

Based on the site assessments and community inputs, the appropriate SUDS solutions were adopted as per the local requirements, integrated with existing infrastructure, to minimise disruption to residents, provide accessibility for maintenance, and incorporate native and drought-tolerant plants for aesthetics and habitat creation.



Site 1 interventions



Site 2 interventions

On the previous page: Before and after images of clearance of vegetation in drains. Source: GCRO, 2019

On this page: Schematic interventions plan for Sites 1 and 2. Source: Anne Fitchett, 2017

Process Involved

The project carried out a thorough environmental impact assessment, followed by gaining the required environmental approvals for seamless implementation of SUDS.

01 Site assessment to understand rainfall patterns and intensity, soil characteristics (infiltration potential), topography and existing drainage patterns, and locations most affected by flooding.

02 Community engagement through workshops and meetings to educate them about SUDS benefits, gather feedback on design preferences and concerns, identify community champions, and promote ownership.

03 SUDS selection and design based on the site assessment and community input, selection of appropriate SUDS components for at-source control (rain barrels, porous paving), conveyance (swales, channels to direct water flow slowly), treatment (bioretention basins, vegetated filters to remove pollutants), and infiltration.

04 SUDS integration with existing infrastructure, to minimise disruption to residents, provide accessibility for maintenance, and incorporate native and drought-tolerant plants for aesthetics and habitat creation.

On this page:
Top-Vegetation planted for surface water management.
Middle-Implemented soakaway.
Source: Anne Fitchett, 2017

Below-View of Diepsloot after intervention.

On the next page:
Aerial view of the settlement.
Source: Clive Hassall, Anne Fitchett and Jennifer van den Bussche/GCRO, 2017

Impacts

Environmental

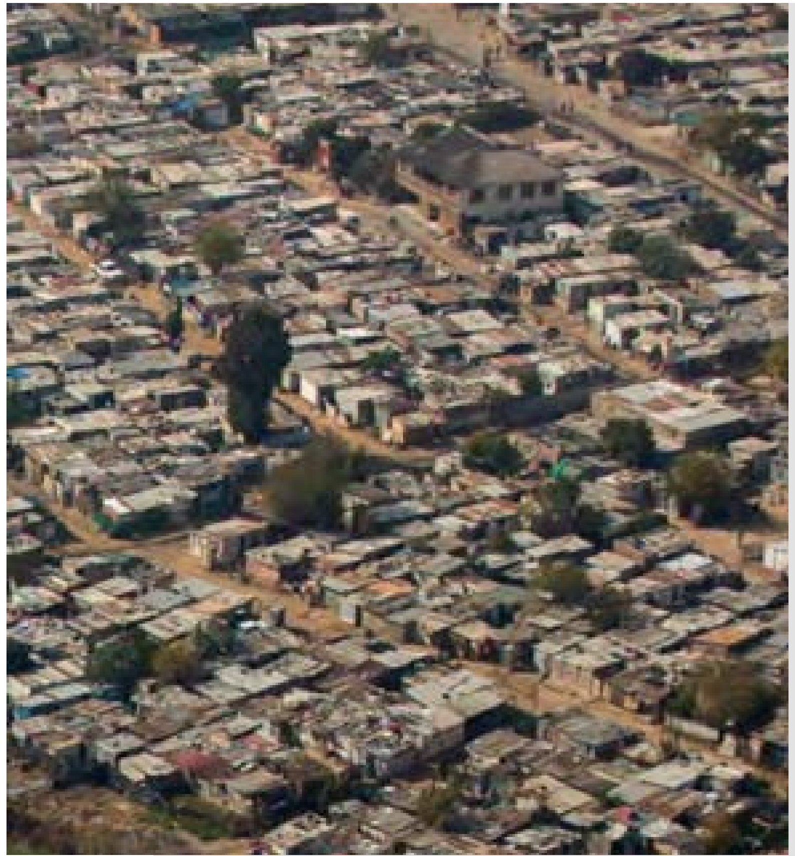
- Lowered local temperatures
- Enhanced carbon sequestration
- Improved water quality and stormwater management
- Creation of public green spaces

Social

- Improvement in liveability and social cohesion
- Increased involvement of locals in managing green spaces
- Raised awareness about the benefits of Nature-Based Solutions (NbS)

Economic

- Cost savings by integration of SUDS with existing infrastructure
- Reduction in losses due to flood damage



Scale it Up!

Expanding Diepsloot's SUDS success involves customising solutions to address diverse community needs worldwide. Cities can integrate SUDS, fostering flood-resilient communities, with improved water quality and green spaces and enhanced urban landscapes globally.

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35 INTEGRATED WATER BALANCE AND QUALITY MODEL - RESTORATION & REHABILITATION OF KHAJRANA TALAB & LASUDIYA MORI TALAB

Indore, India

Key Details

Scale
Neighbourhood

Implementation Budget (Source)
Rs. 45.17 – 18.068 Crore
(Direct Funding from NGO)

Challenges catered
Flooding, stormwater and rainfall management, poor water quality, biodiversity degradation

Project Duration
3 years

Implemented by
Rockefeller Foundation and Indore Municipal Corporation

Project USP
Integrated water balance and quality model

Project Rationale

The main objective of this project was "ensuring availability of local water resources during emergencies", through the development of a replicable model for peri-urban lake rejuvenation and conservation. The expected outcomes of the project include a stakeholder-managed process for stabilising/improving the water quality of the restored lakes and generating interest among multiple stakeholders to conserve urban lakes.

Introduction

Urbanisation and the increase of impermeable surfaces reduced the capacity for groundwater recharge. The climate change risks indicate increasing rainfall variability and more intense and/or more frequent storms as well as an increase in dry periods. With less permeable soils, the city needs to optimally use existing lakes to capture runoff, creating buffer supplies and helping to increase groundwater recharge. The major focus was on the management of rivers and other blue areas with ecological restoration of degraded ecosystems. The project has revived lakes that has helped groundwater recharge, aesthetic enhancement of the area, cool microclimate, and possible livelihood restoration.

On the previous page:
Lasudiya Mori Talab deepened.
Source: NIUA, 2016

On this page:
Lasudiya Mori Talab.
Source: Dainik Bhaskar, 2020

Process Involved

Mapping of urban and peri-urban lakes in Indore was done to create an integrated water balance and quality model. Awareness building on water-related issues with stakeholders along with development of water modeling iterations to identify intervention options was carried out.

01 Protect lakes through better management of catchments that are undergoing rapid urbanisation and to increase residents' resilience to water scarcity.

02 Engaging with multiple stakeholders, especially the community, to reduce the flow of untreated sewage into the lakes.

03 Improve the micro-climatic condition and reduce the rapid growth of weeds, increase the fish production as well as the variety of ducks and wild birds seen.

04 Activities undertaken include renaturalisation of rivers and other water bodies, and rehabilitation and restoration of damaged or destroyed ecosystems.

05 Fencing of lake embankments to create walking tracks and diversion of sewage paths to keep lakes clean.

06 Management is structured for co-governance with governmental and non-governmental actors.

On this page:
Surveys conducted for the restoration of the lakes
Top-Water quality survey.
Middle-Lake area survey.
Below-Community household survey.
Source: NIUA, 2016

On the next page:
Rainwater capturing mechanism in Indore.
Source: NIUA, 2016

Impacts

Environmental

- Improved waste management
- Improved water quality
- Increased protection against flooding
- Enhanced protection and restoration of freshwater ecosystems
- Reduced biodiversity loss

Social

- Equitable opportunities for marginalised and indigenous groups
- Community-driven management of green spaces and opportunities for recreation and exercise
- Increased awareness of environmental and cultural heritage
- Increased awareness of NBS and their benefits

Economic

- Stimulated development in deprived areas

Scale it Up!

This lake rejuvenation model can address urban water scarcity, enhance groundwater recharge, and improve water quality. Engaging communities and stakeholders ensures sustainable lake management, creating resilient urban ecosystems. This approach can be replicated across Indian cities, promoting environmental sustainability and community well-being.

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36

ECO-SANITATION TRANSFORMATION BY ENHANCING WATER EFFICIENCY AND GREEN SPACES FOR SPECIAL NEEDS EDUCATION

Lima, Peru

Key Details

Scale
Neighbourhood/ building

Implementation Budget (Source)
NA

Challenges catered
Water scarcity

Project Duration
1 year 8 months

Implemented by
Rotária del Perú, Lima, Peru, Centro Educativo Básico Especial (education centre) "San Christoferus", Lima, Peru

Project USP
Innovative sanitation solutions with sustainable water management in arid urban areas

Project Rationale

This case study highlights the transformative impact of sustainable sanitation and water reuse systems in a desert urban area of Lima, Peru. The project showcases innovative solutions to water scarcity, particularly benefiting a school for handicapped children. By reducing water consumption, improving the microclimate, and demonstrating effective wastewater reuse, this initiative sets a precedent for similar environments in urban cities.

Introduction

Located in one of the driest regions on Earth, Lima, Peru, faces extreme water scarcity with an annual rainfall of just 9 mm. In this arid environment, the Centro Educativo Básico Especial "San Christoferus," serving 35 handicapped pupils and staff, undertook a project to address critical water and sanitation issues. The school, situated in Chorrillos, an urban area of Lima, experienced significant challenges related to water usage and waste management. Prior to the intervention, the school's wastewater was disposed off in the public sewer system, contributing to environmental degradation and posing health risks. The primary goals were to reduce water consumption, enhance green spaces to mitigate dust and improve aesthetics, and demonstrate sustainable water reuse systems suitable for arid urban areas.

On the previous page:
Urban agriculture at school, irrigated and treated blackwater.

On this page:
Vertical flow constructed wetland (reed bed) for treatment of liquid phase of blackwater.

Source: Sustainable Sanitation Alliance, 2009

Process Involved

Key processes involved to combat water scarcity in the arid area of Lima include the following sustainable water management practices:

01 Interventions like the installation of a constructed wetland for greywater treatment, compost filter for blackwater treatment, and introduction of double-vault urine diversion dehydration toilets (UDDTs).

02 Design elements include constructed wetland with vertical flow, sub-surface wetland planted with papyrus, treating greywater from laundry, bakery, and kitchen.

03 Compost filter with double-chamber system using custom filter bags filled with straw, treating blackwater from toilets and greywater from bathrooms.

04 Vermicomposter for secondary treatment of solids using earthworms.

05 Greywater pre-treatment by use of grease traps and pumps to manage effluent before wetland treatment.

06 Blackwater pre-treatment using compost filters to separate solids and liquids, followed by wetland treatment for liquids.

07 Reuse systems for treated water stored for irrigation, composted solids used for soil improvement, and urine applied as fertilizer.

On this page:
Top-Soccer field irrigated with blackwater.
Middle-Outdoor UDDT with gravel filter bed for greywater.
Below-Vertical flow constructed wetland for greywater treatment.

On the next page:
Reed beds.

Source: Sustainable Sanitation Alliance, 2009

Impacts

Environmental

- Significant reduction in potable water usage
- Improved wastewater treatment and reuse

Social

- Enhanced green spaces and outdoor activities for handicapped children
- Increased awareness and education on sustainable sanitation

Economic

- Reduced costs for water consumption
- Additional income from the sale of vegetables and fruits grown using treated wastewater

Scale it Up!

The replication of eco-sanitation initiatives from Lima in urban arid areas in parts of Rajasthan, Gujarat, and Maharashtra entails adopting sustainable water management practices to address water scarcity and sanitation challenges. These initiatives, including constructed wetlands, greywater treatment, and dry sanitation systems, offer solutions for cities grappling with water scarcity and inadequate sanitation infrastructure. Through similar projects, urban areas can enhance environmental resilience.

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37

INFORMED AND IMPROVED URBAN WATER MANAGEMENT FOR NEW INFILL DEVELOPMENT IN WHITE GUM VALLEY

Perth, Australia

Key Details

Scale
Settlement

Implementation Budget (Source)
Rs. 25.01 Crore (Development WA, City of Fremantle)

Challenges catered
Water stress due to urbanisation, lack of water literacy

Project Duration
13 years

Implemented by
City of Fremantle, Western Australian Department of Water and Environmental Regulation (DWER)

Project USP
Informed urban water management within new developments in cities

Project Rationale

Under the Waterwise Perth Action Plan, White Gum Valley's medium residential estate has been consciously developed to improve urban water management. Residents are required to follow design guidelines created by LandCorp (Development WA). These guidelines guarantee inventive water management. The design and technological innovations have made the project a successful case study for other local government authorities.

Introduction

White Gum Valley is located 3 km from the Fremantle City Centre in Perth and is spread across 2.2 hectares. While Perth is already among the worst affected dry climate areas in the world with a significant decline in rainfall in the last two decades, its water demand is projected to double in the next 40 years. The infill precinct is developed to increase housing density in Australia to combat urban sprawl and infrastructure pressure. The homes in the new development target a 60-70% reduction in water consumption across various typologies by tracking and monitoring measures. Key water-saving initiatives include a community bore irrigation supply for use in both public and private gardens, and a lot-scale rainwater harvesting system for toilets and washing machines. Additionally, internal water fixtures were required to exceed the minimum water-efficient ratings under the Building Code of Australia.

On the previous page:
Infill and greening of residential estate at White Gum Valley.

On this page:
Aerial image showing greening at the plot level.

Source: Development WA, 2021

Process Involved

The project was initiated by City of Fremantle, Western Australian Department of Water and Environmental Regulation (DWER) and involved the following processes:

01 Honeycomb stackable soak cells were used as a solid base that allowed the water to infiltrate quickly and efficiently. The ground-level of site was raised for it to mimic the nature of a soak well.

02 Dual plumbing to support rainwater harvesting system within each home. A plumbed rainwater tank (minimum 3,000 litres) was installed to augment the rainwater-ready plumbing.

03 Community feedback shaped the landscaping of shared public spaces. Water-sensitive landscaping was integrated in both public and private realm. This includes waterwise trees and lawn varieties, passively irrigated street trees that direct water from the road to the roots, permeable landscaping surfaces, etc.

04 A community bore using a superficial aquifer was created for irrigation of public and private greens.

05 Water use is metered at each lot to monitor water use. Homeowners were offered a 100 litre pot size semi-mature shade tree for their backyard to be managed by LandCorp for the first year.

On this page:
Top-Dual plumbing.
Middle-Honeycomb stackable soak cells.
Below-Urban greening.

On the next page:
Bioswales as per urban greening guidelines.

Source: Development WA, 2021

Impacts

Environmental

- 65% reduction in mains water use across various typologies- 51% in detached homes, 73% in attached homes and 75% in apartments
- Mains water consumption reduced to 37kL per person per year, as compared to Perth average of 106kL per person per year
- High performance of the landscaped infiltration basin

Social

- Landscaped infiltration basin has reduced the fear of risk among residents
- Water literacy and resident consultants ensure informed society

Economic

- Learnings taken to develop similar infill projects that aim to progress the vision of a Waterwise Perth

Scale it Up!

Large-scale medium to high-density townships is being constructed in many cities in India as well as in its outskirts. Urban water management can take a central theme in such developments with inform site planning and design considerations. These can reduce the ground water dependency in prime residential areas while catering to the high-water demand. Moreover, effective monitoring of water uses and management incentives for shared spaces can improve efficiency of the project.

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38 RAINCITY STRATEGY FOR GREEN RAINWATER INFRASTRUCTURE MANAGEMENT ON WOODLAND AND 2ND STREET

Vancouver, Canada

Key Details

Scale
Settlement

Implementation Budget (Source)
Rs. 583.68 Crore for city-wide implementation (Green Infrastructure Implementation Branch, City of Vancouver)

Challenges catered
Water stress due to urbanisation

Project Duration
6 years

Implemented by
Green Infrastructure Implementation Branch, City of Vancouver

Project USP
Increased stormwater capture capacity for high-density development

Project Rationale

The City of Vancouver implemented the Green Rainwater Infrastructure (GRI) under its Rain City Strategy. This was done to boost the capacity of the stormwater network in a residential area that will eventually see high-density development. Innovative design and collaboration with the local crew ensured efficient application of sustainable solutions and enhanced community resilience and accessibility to green spaces.

Introduction

Grandview Woodland has a strained sewer and storm system. The Community Plan required increasing the affordable housing units by increasing the density which will in turn add pressure to the stormwater network of the area. Thus, the bioswales were installed in the area to capture rainwater runoff and provide additional capacity for higher-density development. The design was executed using innovative inlet designs and construction material reuse while protecting all existing trees.

Collaboration with the internal city crew allowed the implementation of creative field-fit solutions. Additionally, this project also supported sustainable transportation options by allocating space for bike lanes. It also enhanced the accessible green cover within the area.

On previous page, Raingarden at Woodland & 2nd Avenue Street.

On this page, Weir walls slow down rainwater flow.

Source: City of Vancouver, 2023

Process Involved

The project was initiated at a city-level with the formulation of the Rain City Strategy and implemented at the neighbourhood/street level by the City of Vancouver.

01 Inlets to capture the rainwater runoff and help it slow down to induce sedimentation before the runoff enters the bioswale

02 Weir walls are installed to slow down rainwater runoff. They are made by re-using granite blocks from city curbs. They increase ponding area, and infiltration and reduce the risk of erosion.

03 Bioswales allow for a large volume of water retention and infiltration

04 A diverse range of native plant species in the middle helps in water ponding and helps mitigate flooding. The plants at the edges are planted on drier soil that helps in droughts and provides pollinator habitat.

05 GI Chamber collects water from multiple catch basins and helps distribute it throughout the bioswale

06 Existing trees along the bioswales were protected during construction and included within the design

On this page,
Top, Diagram of the WSUD system used in Vancouver.
Middle and Below, Design elements in bioswales including curbs and inlets.

On the next page, Planing in bioswales.

Source: City of Vancouver, 2022

Impacts

Environmental

- 200 sq. m. bioretention planting area
- 3,000 sq. m. impervious area managed
- 3.8 million litres of urban rainwater runoff filtered and/or diverted from sewer
- Provides pollinator habitat and increased biodiversity

Social

- Greening of street encouraged cycling and walking
- Stamps on large concrete inlet surface provides sense of place

Economic

- New residential and commercial development promote further investment in the area

Scale it Up!

The Green Rainwater Infrastructures (GRI) project can be incorporated in many cities and can effectively address severe water scarcity and urban flooding issues. Initiatives like the Rainwater Infrastructure (RI) project under the Urban Water Management Strategy aim to enhance the stormwater network's capacity, promote sustainable urban development. By identifying high-density areas with strained sewer and storm systems to capture rainwater runoff, such projects can support development.

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39 ØSTERBRO CLIMATE RESILIENT NEIGHBOURHOOD THROUGH BLUE-GREEN CORRIDORS, GREEN ROOFS AND PERMEABLE PATHWAYS

Copenhagen, Denmark

Key Details

Scale
City

Implementation Budget
Rs. 75 Crores

Challenges catered
Flooding, extreme rain events like cloud bursts, stormwater drainage

Project Duration
Ongoing since 2011

Implemented by
Copenhagen Municipality

Project USP
Climate adaptive neighbourhood planning

Project Rationale

Klimakvarter at Østerbro is the first climate adapted neighborhood in Denmark with an aim to cut emissions and boost the area's resilience to heavy rain. Treatment and storage of rainwater, participation of local residents, and creation of green infrastructure in inner city roads and plazas are valuable strategies used to improve neighbourhood-level liveability, boost the area's resilience to flooding and extreme rain events, and reduce the stress on the city's stormwater drainage system.

Introduction

Copenhagen showcases proactive urban resilience amid worsening climate change. Despite its temperate climate, the city faces rising extreme weather events like cloudbursts. The devastating 2011 flood underscored the need for comprehensive climate adaptation. In response, the Østerbro Climate Quarter project pioneers innovative green infrastructure solutions to foster long-term resilience. By embracing sustainable urban design, Copenhagen addresses climate challenges while prioritising citizen well-being and environmental stewardship. This initiative reflects the city's commitment to proactive climate action and sets a precedent for cities worldwide, facing similar climate risks.

On the previous page:
Green infrastructure infiltration areas retrofitted into the neighborhood.

On this page:
Green spaces, biking lanes, and stormwater infiltration trenches.

Source: SLA, Mikkel Eye, 2023

Process Involved

The project was undertaken by the municipality of Copenhagen with the involvement of local communities, from the initial idea phases through workshops and neighbourhood meetings.

01 Green roofs and blue-green corridors capture and filter rainwater, reducing strain on drainage systems and replenishing groundwater.

02 Permeable pavements reduce surface runoff and allow water to seep through for groundwater replenishment. Channelled streets direct rainwater to the harbour, reducing flood risk.

03 Local hills used as natural barriers to guide water to designated retention areas where it can be stored, filtered, or used for groundwater recharge.

04 Public squares with rainwater collection systems for localised use of rainwater for irrigation and other non-potable purposes.

05 Green recreational spaces to integrate green infrastructure and community needs.

On this page:
Top-Permeable pavements.
Source: Mikkel Eye

Middle-ØsterGRO - Denmark's first roof farm.
Source: Karen Sejr

Below-Tåsinge Plads on Østerbro.
Source: Klimatilpasning, 2015

On the next page:
Greening of the neighbourhood plazas.
Source: Charlotte Brøndum, Municipality of Copenhagen, 2019

Impacts

Environmental

- Mitigation of flood risk and efficient water management
- Improved air quality and enhanced liveability
- Mitigation of urban heat island effect
- Groundwater recharge

Social

- Increase in green spaces, improved public health
- Vibrant public spaces and community engagement

Economic

- Reduced flood damage costs
- Reduced cost for development of stormwater drainage infrastructure
- Increased real estate values in associated neighbourhoods

Scale it Up!

Cities can learn from Østerbro's blue-green infrastructure approach for climate change adaptations in neighbourhoods. These approaches not only help in the mitigation of climate related risks but also enhance the liveability of cities and can create more sustainable and vibrant communities. While geographical differences exist, similar strategies can be developed through collaboration and knowledge sharing among communities, local governance bodies, and planning agencies.

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S-5

PLANNING INTERVENTIONS

Embark on a journey through 'Planning Interventions' in Water Sensitive Urban Design (WSUD) that shape sustainable cities. This section illuminates strategic approaches and innovative methodologies for integrating water management into urban planning. Explore how thoughtful planning can enhance urban resilience, mitigate flooding, and promote sustainable development, fostering a harmonious relationship between urban environments and water resources.

40 GREEN DHAKA CAMPAIGN: REVITALISATION OF JUSTICE SHAHABUDDIN AHMED PARK FOR COMMUNITY WELL-BEING

Dhaka, Bangladesh

Key Details

Scale
Settlement

Implementation Budget
Rs. 11 Crore

Challenges catered
Lack of waste management and ecological imbalance

Project Duration
2 years

Implemented by
Dhaka North City Corporation (DNCC)

Project USP
Inclusive urban revitalisation

Project Rationale

The Justice Shahabuddin Ahmed Park revitalisation project in Dhaka addressed the growing need for urban green spaces within the city. The project aimed to create a recreational area connected with nature by preserving biodiversity and ecological balance. By incorporating inclusive design principles, the revitalisation project sought to enhance the community's well-being by providing a safe and accessible space for passive and active leisure pursuits.

Introduction

Rapid urbanisation challenges Dhaka with limited green space and environmental degradation. The Justice Shahabuddin Ahmed Park renovation, part of the "Green Dhaka Campaign," began in 2017 to address these issues. Reviving the park's pond, planting trees, and providing amenities aim to create a safe, inclusive space shaped by public input and naturalist advice.

Biodiversity preservation and diverse plant species prioritise a healthy environment. Dedicated jogging, walking, and cycling paths have made the park popular. This case study highlights how the park's revitalisation aligns with SDGs, integrating environmental and social considerations.

On the previous page:
Justice Shahabuddin Ahmed Park.
Source: Hasan Saifuddin Chandan, Wasik Edaaf, 2023

On this page:
Walking track and amphitheatre.
Source: Vitti Sthapati Brindo Ltd., 2022

Process Involved

The intervention was initiated in 2017 by DNCC and included revitalisation of the existing pond and plantation, and providing amenities for the people living in the neighbourhood where the park is located.

01 Environmental quality and waste management to improve water quality and reduce mosquito breeding grounds. Permeable walkways allow rainwater infiltration, promoting natural drainage and reducing the stress on existing infrastructure.

02 Green space, habitats, and biodiversity revitalisation through extensive planting of native trees and shrubs to create a green oasis, enhance air quality, and restore the urban greens spaces.

03 Improved public health and well-being through, promotion of physical activity and social interaction, focus on mental and physical health for community members of all ages.

04 Inclusive and effective governance through collaborative planning with residents to ensure that the park caters to diverse needs, fostering a sense of ownership.

05 Social justice, cohesion, and equity to create an inclusive space for people from all walks of life.

On this page:
Top-Amphitheatre.
Middle-Walking track around pond.
Below-Walking and cycling track.
Source: Noor A Alam, Business Standard,

On the next page:
Paved connecting paths through the green

Impacts

Environmental

- Local biodiversity restoration
- Improved water and air quality
- Improved natural drainage

Social

- Creation of public green recreational space
- Improved public health
- Inclusion, social cohesion, and community participation

Economic

- Improved real estate values
- Lower healthcare costs for local residents

Scale it Up!

The revitalisation of Justice Shahabuddin Ahmed Park in Dhaka demonstrates the impact of community engagement in enhancing public green spaces in dense urban areas. Cities worldwide can emulate this by facilitating resident involvement through workshops and online platforms. This collaborative model fosters a vibrant public oasis, nurturing community bonds and enhancing urban environments and overall liveability, and can be adapted globally.

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A HOLISTIC APPROACH TO ACHIEVE CITY-WIDE WATER BALANCE: REVIVAL OF TRADITIONAL SYSTEMS AND NATURE-BASED SOLUTIONS

41

Chennai, India

Key Details

Scale
City

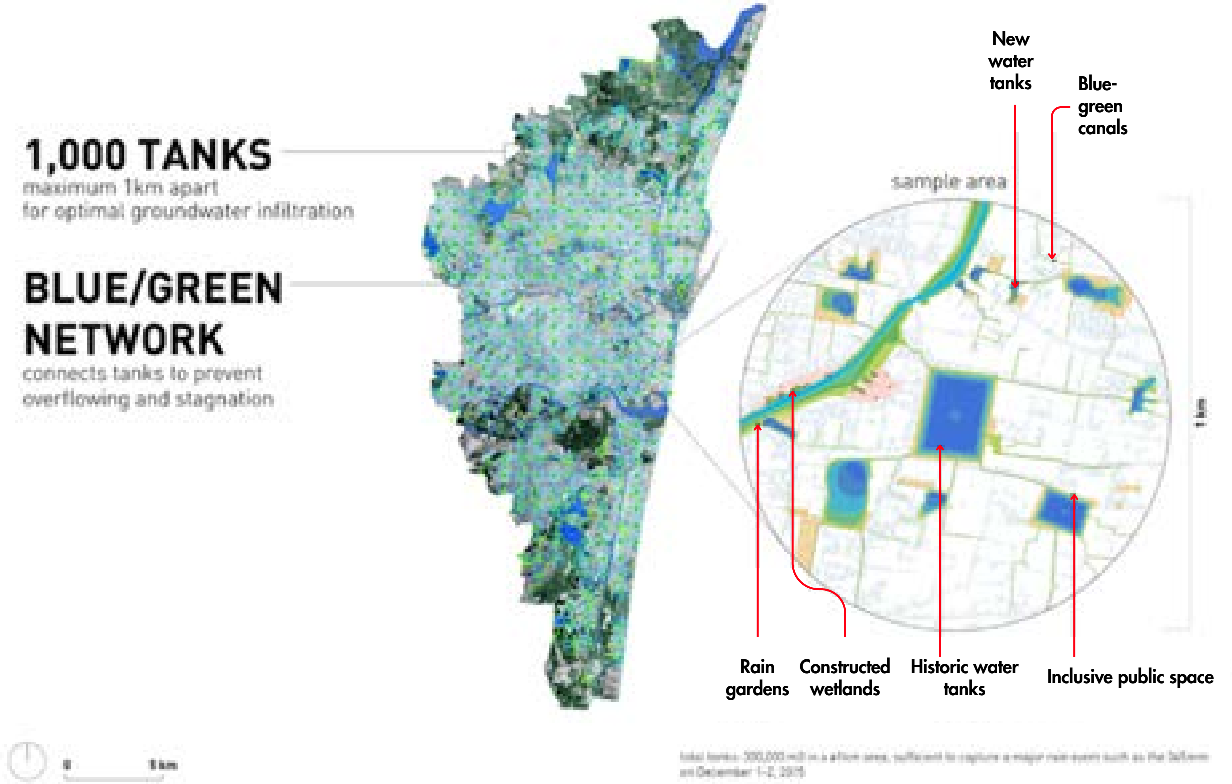
Implementation Budget
NA

Challenges catered
Flooding, water scarcity, water pollution

Project Duration
Ongoing since 2018

Implemented by
Special Envoy for International Water Affairs of the Kingdom of The Netherlands, Government of Netherlands

Project USP
Holistic approach to achieve city-wide water balance



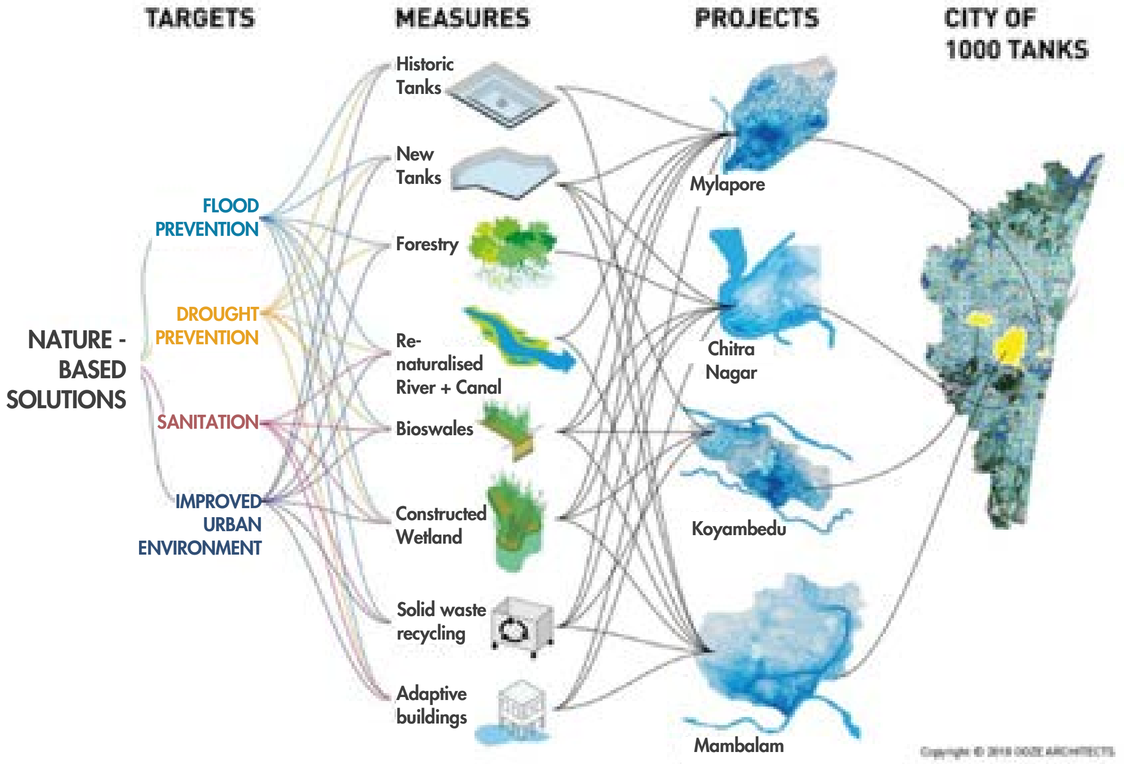
Project Rationale

Chennai has a unique climatic scenario characterised by flooding, scarcity, and saltwater intrusion in groundwater. Considering its current rate of urbanisation, the project focuses on the revival of traditional rainwater harvesting system, introduction of nature-based solutions to rejuvenate the city's water bodies, and leveraging the existing wells to monitor the groundwater level.

Introduction

Chennai has historically relied on monsoon rainfall for the replenishment of its water reserves due to the high levels of pollution in the three rivers that flow through the city. Rapid population growth has led to severe water scarcity and depletion of its aquifers.

To address this, Chennai was re-imagined as the city of 1000 tanks, wherein a blue-green infrastructure system was implemented incorporating temple tanks, new tanks, ponds, bio-swales, and constructed wetlands. This decentralised system treats wastewater, mitigates floods, and ensures year-round water availability. Chennai aims to recharge aquifers during monsoon seasons and store water for drier periods, transforming it into a resilient urban landscape.



On the previous page: City Of 1000 Tanks Vision For Chennai. Source: Ooze Architects, 2019

On this page: Integrating NbS in a systemic approach. Source: Ooze Architects, 2019

Process Involved

The project utilises various nature-based solutions, including:

01 Revival and retrofitting of traditional water systems is being carried out to collect and store rainwater. For example, existing rainwater harvesting structures are repaired and retrofitted for water storage, recycling, and recharge.

02 Decentralisation of wastewater treatment through constructed wetlands, which also prevents pollution of both surface and groundwater sources.

03 Stormwater management, flood protection, enhanced water security through bioswales, renaturalisation of rivers and canals, detention parks, and floating islands.

04 Pilot projects for small-scale implementation in specific site locations to test and refine the design and evaluate social acceptance. Upscaling in larger areas across the city based on learnings from pilot projects

05 City-wide integration with existing infrastructure and urban planning strategies.

On this page:
Top-Canal development in Mambalan neighbourhood,
Middle-Aerial view of the Mambalam Project.
Source: Ooze Architects, 2019

Below-Constructed wetlands, water balance pilot.

On the next page:
View of the constructed wetlands.
Source: Cynthia van Elk, 2023

Impacts

Environmental

- Groundwater replenishment
- Reduced water pollution
- Wastewater treatment enhances water quality
- Reduced reliance on external water sources

Social

- Improved social awareness about NbS
- Improved quality of life for all residents
- Enhanced citizen-led engagement

Economic

- Fosters local economies

Scale it Up!

Cities, especially coastal cities facing water scarcity, intrusion of saltwater into groundwater, and pollution of its surface water reservoirs, can learn from Chennai's "City of 1000 Tanks" model. Local solutions like rainwater harvesting, traditional practices, online knowledge sharing, and community engagement can be replicated to achieve city-wide water security. Further, government support and funding are crucial for wider adoption, paving the way for a more sustainable future.

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42 GREY TO GREEN SCHEME: TRANSFORMATION OF FLOOD-PRONE AREAS USING SUSTAINABLE INFRASTRUCTURE

Sheffield, United Kingdom

Key Details

Scale
Settlement

Implementation Budget (Source)
Rs. 37.89 Crore (Sheffield City Region, European Regional Development Fund)

Challenges catered
Flooding in river catchment areas, river pollution

Project Duration
2 years (Phase 1)

Implemented by
Sheffield City Council with Robert Bray Associates

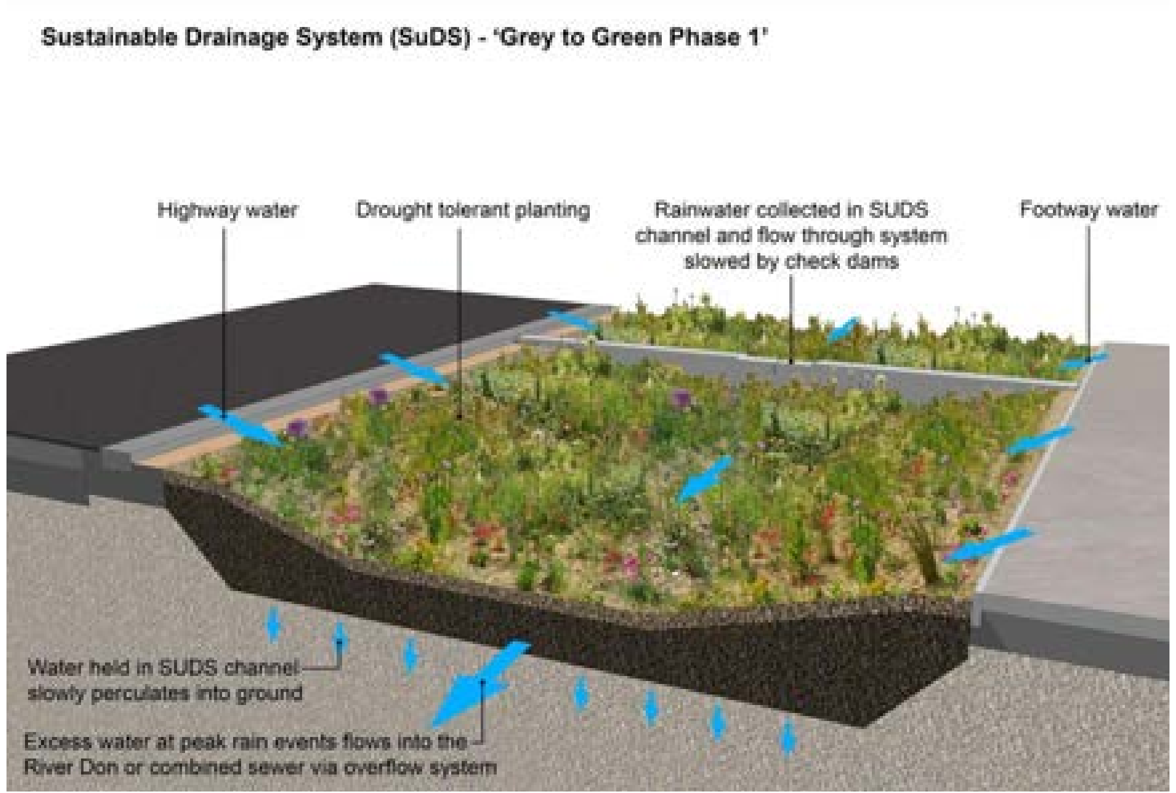
Project USP
UK's largest retrofit WSUD project and UK's largest inner city 'Green Street'

Project Rationale

The Grey to Green Scheme was designed as a 'Green Street' retrofitting in the flood-prone areas of Sheffield, adjacent to the River Don. It aimed to reduce the surface-water runoff reaching the river, by introducing heavy plantations on streets. This was achieved by re-adjusting spaces in slightly less congested streets to make space for rain gardens and bioswales as a response to climate change, citizen wellbeing, and economic investment.

Introduction

Natural river catchments have changed over the years as the city grew, with large parts no longer connected to rivers and streams. During storms, the pipes that carry a mix of stormwater and sewer water overflow into rivers causing pollution. Phase I of the Scheme has been implemented along a 1.6-kilometre-long inner-city dual carriageway that runs adjacent to the River Don and along the edge of Sheffield city centre. The street spaces were re-adjusted from four to two lanes, making space for extensive plantation to capture surface water runoff, slow down the rates of flow, filter it, and promote infiltration into the soil.
Additionally, it aimed to increase urban biodiversity by creating a wildlife corridor, mitigate the urban heat island effect and air pollution through multi-layered planting, and promote overall health and well-being by constructing wider footpaths for pedestrians.



On the previous page: Incorporation of permeable surfaces along streets to capture groundwater.

On this page: SUDS concept design. Source: Nigel Dunnett, 2019

Process Involved

The project was initiated by the Sheffield City Council in collaboration with Robert Bray Associates to strategically reclaim land in the city centre for WSUD elements like rain gardens.

01 Drainage swales and rain gardens are designed, leveraging the slight slope in the streets to guide the rainwater runoff to flow over the kerb edges.

02 Check dams were used to divide the total street length into 25 cells. During a rainstorm, water fills up in a cell and flows over the top of the dam to fill up the next cell.

03 Planted areas are filled with engineered soils, made using recycled compost and glass mixed with crushed sandstone and loam in low proportions. When compared to normal topsoil, this mixture improves the free-draining quality of the system.

04 The substrate is designed using crushed sandstone aggregate (70%) that promotes drainage, composed green waste (20%) that contains a range of plant nutrients, and sandy silt loam (10%) to provide optimal soil structure for plant growth.

On this page:
Top-Check dams.
Middle-Shallow depressions for bioswales.
Below-Use of engineered soil.
Source: Nigel Dunnett, 2019

On the next page:
WSUD along kerb edges.
Source: greytogreen.org.uk.

Impacts

Environmental

- Discharge to the river reduced from 47.31/sec to 91/sec for a 1 in 30 year rainfall event
- 24,000 bathtubs worth of water prevented from entering sewage treatment works each year
- 561% increase in biodiversity value
- Keeps the area cool and mitigates flooding

Social

- Green public space that encourages cycling and walking

Economic

- New residential and commercial development promote further investment in the area

Scale it Up!

Arterial, Urban Extension Roads (UERs) and narrow neighbourhood streets and sidewalks can be re-adjusted to accommodate rain gardens and bioswales that are capable of capturing and filtering stormwater, which can help to enhance the city's resilience to floods during heavy rainfall. They can also help to mitigate air pollution through this case study's multi-layered planting strategy along streets and thus can be universally adapted to local requirements across cities worldwide.

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RAINWATER MANAGEMENT INITIATIVE USING GREEN INFRASTRUCTURE FOR PINE STREET

Vancouver, Canada

Key Details

Scale
Settlement

Implementation Budget (Source)
Rs. 583.68 Crore for city-wide implementation (Green Infrastructure Implementation Branch, City of Vancouver)

Challenges catered
Poor quality of urban rainwater runoff, overland flooding

Project Duration
2 years

Implemented by
Green Infrastructure Implementation Branch, City of Vancouver

Project USP
$30,000 saved by the use of Green Infrastructure

Project Rationale

The Rain City Strategy outlines a series of actions to better manage water accumulation during rainfall, reduce flooding, and improve water quality by capturing and treating 90% of Vancouver's average annual rainfall. By doing so, it aims to increase the resilience to climate change and enhance natural ecosystems in the city.

Introduction

The Rain City Strategy was implemented on Pine Street as a response to the issue of aging storm and sewer mains. The project integrates bioretention systems into traffic calming features on three roadways. It makes use of the Green Rainwater Infrastructure (GRI), a cost-effective technique to manage rainwater that mimics the natural water cycle. The installation of six bioretention corner bulges helps capture and filter runoff rainwater.

The GRI approach eliminated the need to relocate the existing catch basins or install new sewer connections. Moreover, it provides ecological services, lowers the climate change risks, and creates opportunities for the growth of local economy.

On the previous page:
Upgrading Pine Street with Green Rainwater Infrastructure.

On this page:
Use of bioretention soil.
Source: City of Vancouver, 2022

Process Involved

The project was initiated at a city-level with the formulation of the Rain City Strategy and implemented at the neighbourhood/street level by the City of Vancouver.

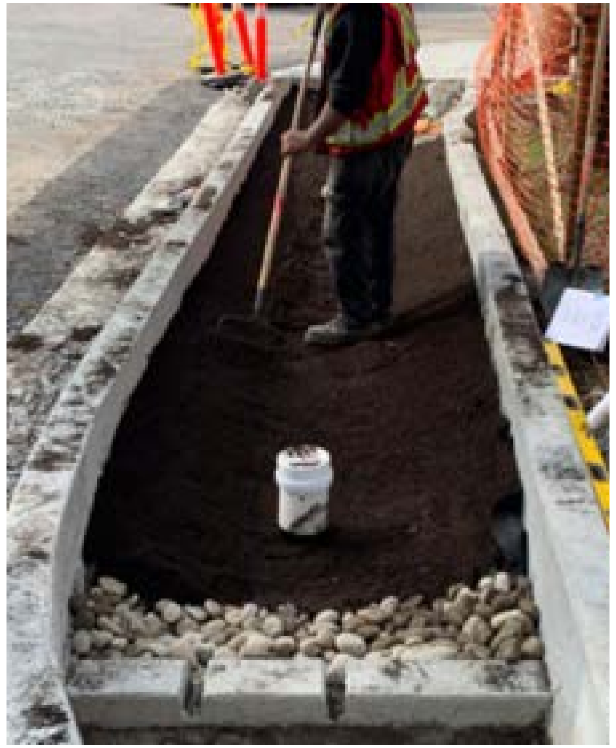
01 Existing catch basins are used to direct and capture any overflow during heavy rainstorms.

02 Green Infrastructure curbs with inlets allow water to enter the bioswale and drain silt. They minimise changes to hydraulic conditions and reduce erosion, in turn preserving the existing boulevard trees.

03 Weir walls and river rocks contribute to lowering erosion and water cuts by distributing the energy of incoming rainfall runoff.

04 Bioretention soil consists of a specialised mix of sand and organic matter. The design allows for infiltration while still providing adequate nutrients to support thriving plant communities. Diverse planting helps to increase local biodiversity.

05 Sub-drains are installed to remove excess rainwater when soil is saturated.



On this page:
Use of bioretention soil, weir walls, and river rocks.
Source: City of Vancouver, 2022

On the next page:
Curbs with inlets that allow water to enter the bioswale.
Source: City of Vancouver, 2022

Impacts

Environmental

- 40 sq. m. of bioretention planting area created
- 2,500 sq. m. of impervious area managed
- 3.1 million litre urban rainwater runoff treated onsite annually
- Provides pollinator habitat leading to increased biodiversity

Social

- Improved public awareness
- Greening encourages walking and cycling

Economic

- Improved commercial and residential potential in the area

Scale it Up!

Green Infrastructure elements like curb inlets can easily be installed in the existing neighbourhood-level streets of cities. This would promote the capture and filtering of rainwater runoff and prevent mixing with the sewer mains. The technique can help in promoting infiltration and recharging groundwater. Moreover, it can also facilitate an increase in local pollination and biodiversity and promote a more active community, encouraging cycling and walking.

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IMPERVIOUSNESS FEE: AN EQUITABLE AND TRANSPARENT ECONOMIC INCENTIVE TO REDUCE RUN-OFF

44

Germany

Key Details

Scale
City

Implementation Budget
NA

Challenges catered
Groundwater depletion

Project Duration
Over multiple years

Implemented by
Municipal authorities

Project USP
Incentivisation to promote adoption of green infrastructure practices

Project Rationale

Worldwide, local governments are looking for mechanisms to respond to the challenges of urban rainwater management. One such mechanism is the equitable and transparent economic incentive used as a WSUD approach in Germany. It is based on the 'polluter-pays' principle and is charged on properties that collect both runoff and wastewater in the same pipe. It aims to incentivize infiltration and reduce runoff through an efficient drainage system.

Introduction

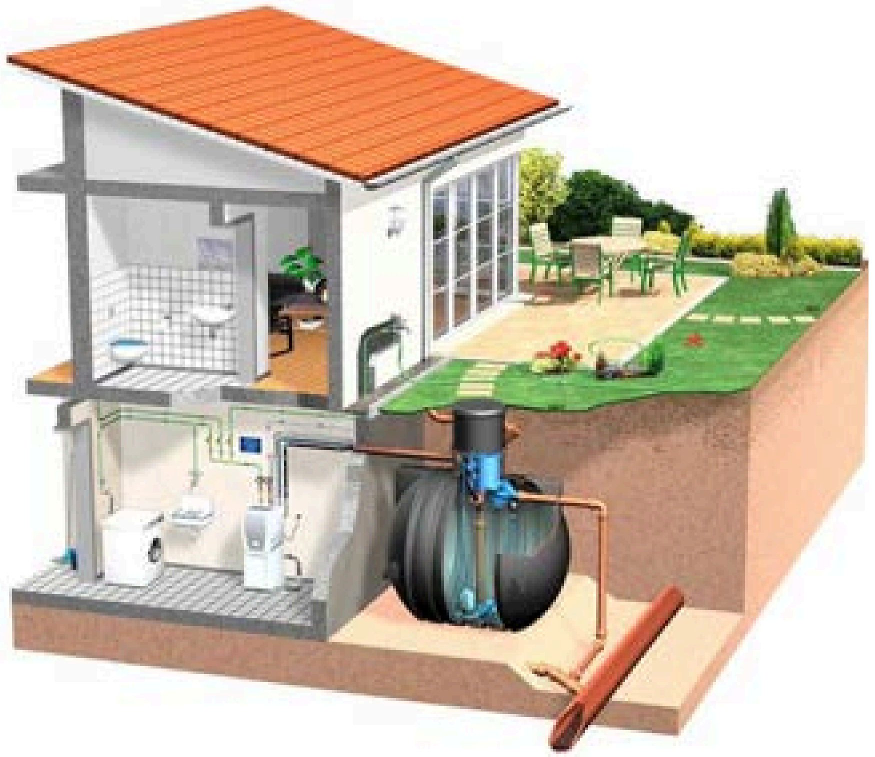
In Germany, 72% of the water supply is from groundwater and spring water. This requires a replenishment of groundwater sources from stormwater infiltration. Thus, most municipalities charge a fee for the collection of rainwater via the rainwater sewer system. It is calculated based on the size of the built-up areas (impervious surface) from which the water drains into the rainwater sewer. Hence, by minimising connection to the discharge system, households can minimise the fee. Consequently, the fee has encouraged the adoption of green infrastructure and efficient stormwater approaches at the property level as public and private landowners seek to pay lower imperviousness fee, achieving flood mitigation and ecological benefits. These approaches include rainwater tanks, green roofs, and pervious pavements adoption at the property-level across the city.

GERMAN INSTITUTE OF STANDARDISATION

Typical decentralised rainwater harvesting unit for a normal household in Germany

Rainwater will be used for:
1. Toilet flush
2. Washing machines
3. Cleaning
4. Gardening

The unit has two main components:
1. Reservoir (here below-ground) with integrated four cleaning steps
2. System control unit with a submersible pump and a supplemental feed system



On the previous page:
Green roofs in Germany for rainwater harvesting and sustainable energy production.
Source: Energy-Greenroof in Germany (Source Gunter Mann, Optigrün AG) via ResearchGate, 2017

On this page:
Decentralised rainwater harvesting unit
Source: German Institute of Standardization via slide player, 2019

Process Involved

Policy of imperviousness fee is nationally enforced and thus adopted and implemented by various municipal authorities at the city-scale in Germany.

01 The mechanism to calculate the fee is set by the responsible municipal government and thus, varies between German cities (average €1.10 for every m2). The two approaches include roughly assuming impervious areas based on the building type and lot area, and actual measurement of impervious surface for each property and its connection to the drainage system using high-resolution aerial imagery supported with data from building permits.

02 Direct infiltration of stormwater is encouraged near the source with no permission requirements for infiltration of mildly polluted stormwater. Stormwater from large areas or roads with high traffic flows requires permission and pre-treatment before discharge.

03 Public information sessions and telephone helplines ensure communication with the community regarding fee incentive and its benefits. Data gathered to calculate the fee is now being used to develop local stormwater management and flood protection measures.

04 The incentive, when combined with subsidies to increase green areas, can be twice as effective. In the case of Berlin, 65,000 m2 of green roofs and 740,000 m2 of green areas on private properties were adopted for Rs 148 crore.

On this page:
Before and after satellite images of Prinzessinnengarten, Berlin, where a parking lot was converted into a mobile urban farm managed by the local community.
Source: Prinzessinnengarten.net,2019

On the next page:
Showcase projects of urban gardening in Berlin created on a brownfield site
Source: Berlin.de, 2020

Impacts

Environmental

- 75 GL of drinking water saved per year
- Paved car parks replaced with pervious pavements
- More than 10,000 ha of roofs slated to be "greened"
- In Munich, 4.5 sq. km. of impervious surfaces have been disconnected from the drainage system avoiding 3000 ML of runoff into the discharge

Social

- Greater awareness in urban communities to manage runoff due to economic incentives involved

Economic

- More than 100 commercial manufacturers of rainwater tanks have been reported in a 10-year period
- 4000 jobs created across Germany
- Germany is now a world leader in the adoption of green roofs

Scale it Up!

In the past, many places and cities have successfully mandated regulations on the use of rainwater tanks in residential areas. The same can be expanded to implement the imperviousness fee that incentivises urban residents to reduce their rainwater runoff and contribute to the urban water management of the city. This requires effective monitoring at the local levels for a successful implementation.

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45

PATHWAYS TO WATER RESILIENT SOUTH AFRICAN CITIES PROJECT

South Africa

Key Details

Scale
City

Implementation Budget
Rs. 8009 Crore

Challenges catered
Water security, flood management

Project Duration
Ongoing since October, 2022

Implemented by
The University of Cape Town's (UCT) Future Water Institute and the University of Copenhagen (UCPH)

Project USP
Water resilience using SUDS and NbS

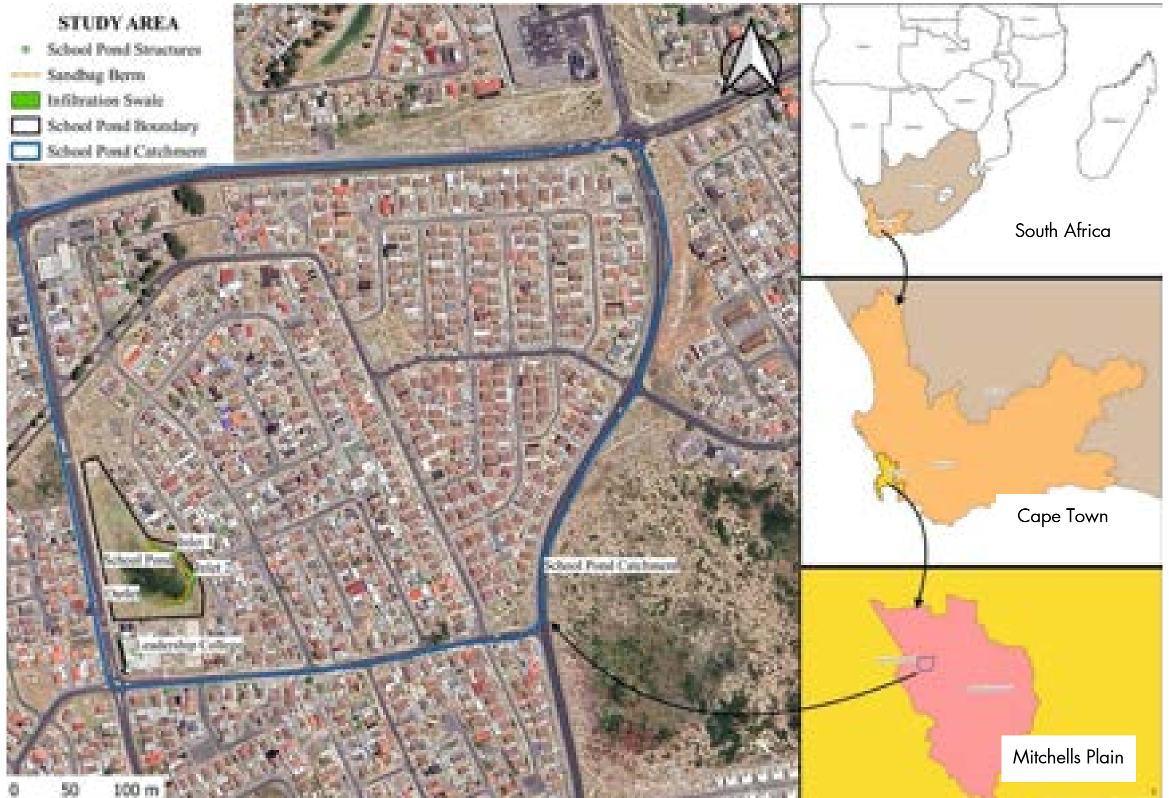
Project Rationale

Cities in South Africa are facing water scarcity and floods. The PaWs project tackles these imbalances by exploring NbS and SUDS like rain gardens to capture and replenish rainwater. It is a decentralised sustainability approach that creates water security and mitigates flood risks. PaWS also focuses on knowledge generation, sharing, and capacity building for long term resilience to climate change.

Introduction

This project has primarily focused on two cities – Cape Town and Johannesburg, to explore the potential of NbS and SUDS and their integration into the existing infrastructure. Interventions undertaken under the initiative include repurposing of existing stormwater ponds to multi-functional blue-green infrastructure, recharge aquifers through stormwater infiltration, creation of usable green spaces for the community, and so on.

This decentralised systems enables better water management and treatment and reduces the risk of floods while also improving the quality of water reaching surface water bodies and the underground water.



On the previous page: Stormwater pond retrofit illustrating the different components.

On this page: Location of site, Fulham Rd, Mitchells Plain, Cape Town.

Source: Pathways to Water Resilient South African Cities, 2023

Process Involved

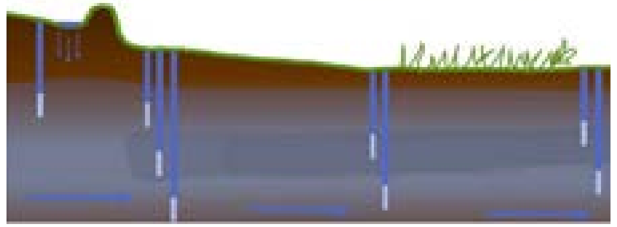
The project involves physical experimentation for site assessment, design, monitoring, and evaluation and the governance part which looks at policy, regulations, and capacity building.

01 Site assessment and design for a comprehensive rainfall, soil, drainage, and other analysis to correctly identify locations for SUDS implementation.

02 Adapting existing policies and regulations to integrate SUDS and NbS into the existing framework and infrastructure.

03 Capacity building among various stakeholders to ensure city-wide adoption of NbS and enable knowledge sharing through workshops.

04 Preparation of policy briefs and technical reports documenting pilot projects, implementation strategies, and details for ease of reference and adoption to enable maximum scalability and community engagement for the creation of transferable knowledge and best practices. This can be scaled up to other cities in South Africa with necessary adaptations to local conditions, fostering strong community engagement throughout the project lifecycle.



On this page:
Top-Aerial image of stormwater pond site (before & after).
Middle-Groundwater monitoring wells.
Source: Pathways to water resilient South African cities – from mono-functional to multi-functional stormwater infrastructure
Below-Locals working on stormwater pond project in Cape Town, 2023.

On the next page:
On-site surveys conducted for design development
Source: Department of Geosciences and Natural Resource Management (University of Copenhagen), 2023

Impacts

Environmental

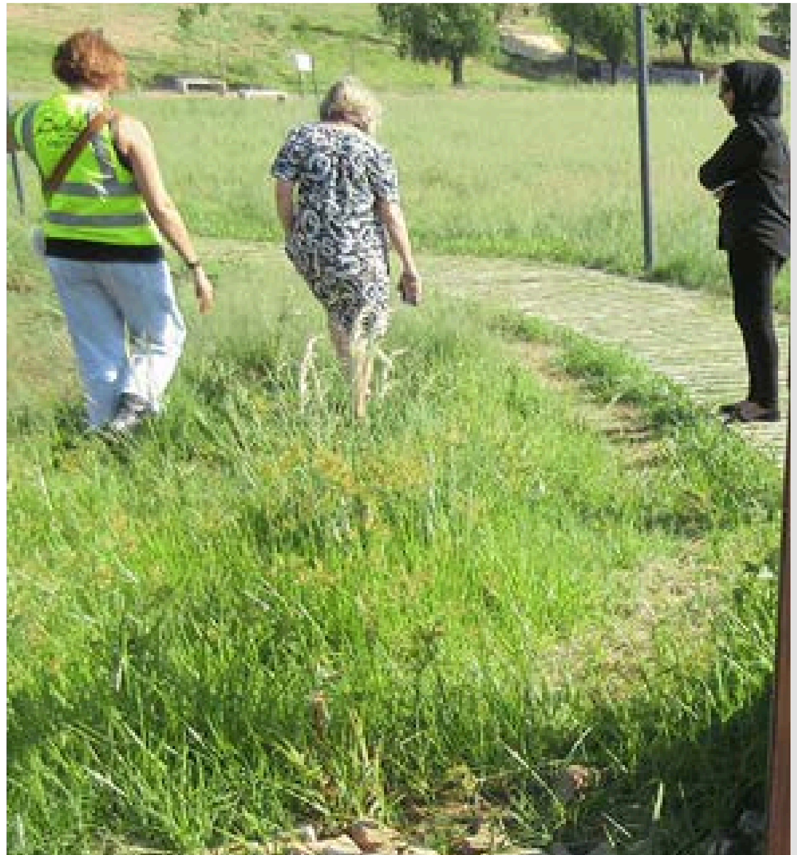
- Increased infiltration (83%) helps replenish groundwater reserves
- Dilution and denitrification processes leading to cleaner stormwater runoff

Social

- Increased green community spaces
- Improved resident engagement with environmental issues and a sense of ownership

Economic

- Cost savings by retrofitting and integration of existing infrastructure
- Creation of attractive green spaces in cities, leading to a real estate value boost



Scale it Up!

The Pathways to Water Resilient South African Cities project aims to create an impact in multiple cities in South Africa by creating a policy level framework, guidelines for adoption and implementation, and enabling their widespread sharing. This model can be adopted globally after doing the necessary local adaptations. Cities can also learn from challenges faced by various implementation bodies across cities and the solutions devised by them for better execution of NbS and SUDS for WSUD.

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SUSTAINABLE URBANISM WITH GREEN ROOFS IN HOHLGRABENÄCKER

Stuttgart, Germany

Key Details

Scale
Neighbourhood

Implementation Budget (Source)
NA

Challenges catered
Urban Floods, Urban Heat Islands

Project Duration
3 years

Implemented by
Planning Authority, City of Stuttgart

Project USP
Cost-effective decentralised stormwater management

Project Rationale

Integrating green roofs into Stuttgart-Zazenhausen's "Hohlgrabenäcker" site promotes sustainable urban development as outlined in the City of Stuttgart's 2010 land development plan. They contribute to minimising environmental encroachment, creating ecological balance and enhancing stormwater management. Green roofs reduce surface runoff, support biodiversity, improve urban microclimate by mitigating the heat island effect, and lower energy consumption for heating and cooling. They also enhance the aesthetic appeal of buildings and offer recreational spaces, contributing to the community’s wellbeing and quality of life.

Introduction

Implemented as part of Stuttgart's 2010 urban development plan, which has been in effect since 2000, it is a project covering an area of 16.7 hectares, comprising 265 individual residences and 9 multi-unit residential buildings. The strategy includes requirements for environmentally friendly features such as green roofs, cisterns, and permeable pavements to reduce the project's ecological footprint. Strategies were established after conducting an Environmental Impact Assessment (EIA) to address issues related to urban runoff and ecological balance. With the incorporation of green roofs and other features, the initiative manages stormwater runoff, conserves biodiversity, and enhances the local urban climate.

On the previous page:
Cistern installation

On this page:
Single-pitch roofs with vegetation layer

Source: Ansel et al., 2012

Process Involved

Before implementation, an Environmental Impact Assessment was conducted to evaluate the effects of construction projects on various aspects of the surroundings. The project adheres to regulations such as the Water Act for Baden-Wurttemberg, which mandates stormwater infiltration or dual piping. The development plan in Stuttgart also includes ecologically sensitive interventions like green roofs and stormwater retention trenches.

01 Green roofs serve as local rainwater storage and detention measures, blending well with the surrounding environment.

02 Underground cisterns, although not visible, collect rainwater for irrigation and domestic purposes, contributing to a sustainable development and saving costs for residents.

03 Pervious pavements, designed to resemble standard paving, help manage stormwater on-site, reducing the need to drain excess water to a separate stormwater pipeline.

04 The implementation included cost analysis, where decentralised stormwater management was shown to be more economical than conventional methods, even with the installation costs of green roofs factored in.

On this page:
Top-Groundwater recharge wells.
Source: Journal of Urban Planning, Landscape & Environmental Design, 2017

Below-Infiltration pavement - buildup.
Source: *Ansel et al.*, 2012

On the Next page
Single-pitch roofs with vegetation layer
Source: *Ansel et al.*, 2012

Impacts

Environmental

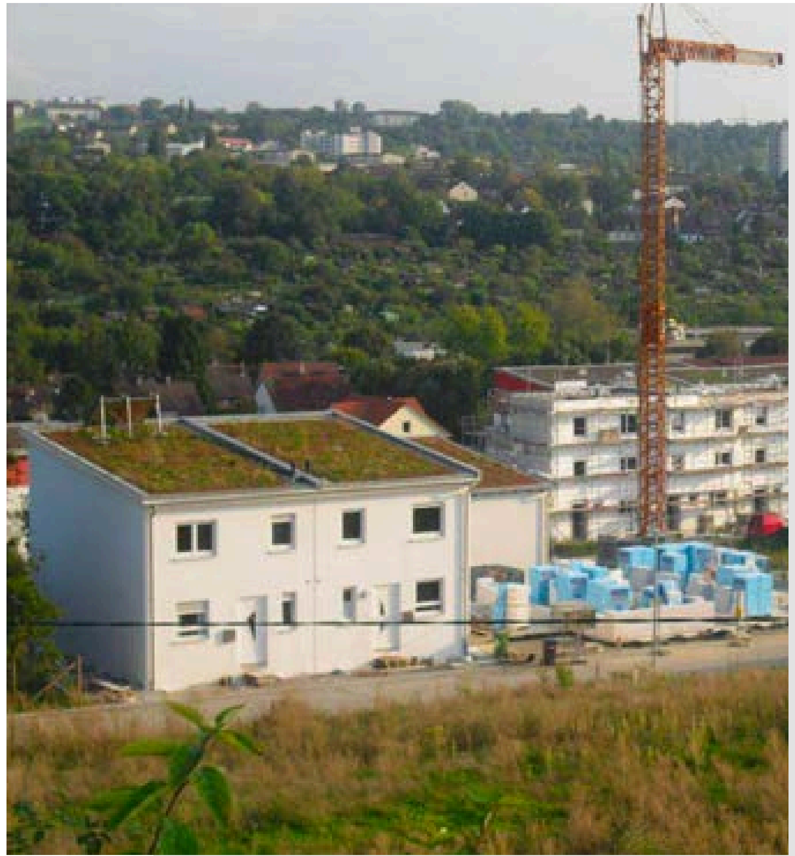
- Improving micro-climate
- Groundwater recharge
- Stormwater storage for demand augmentation

Social

- Water-sensitive mandates help in mainstreaming sustainable urban development
- Enhancing community resilience to environmental challenges and climate change

Economic

- Savings in investment costs compared to conventional stormwater drainage systems



Scale it Up!

Indian cities can adopt strategies from the Water Act for Baden-Württemberg, such as mandating Stormwater infiltration and dual piping in new developments. Integrating green roofs, permeable pavements, and rainwater storage systems into urban planning can minimize runoff. Financial incentives for sustainable practices, pilot projects, and public education can further mainstream blue-green infrastructure.

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SOUTH EAST GLASGOW SURFACE WATER MANAGEMENT PLAN WITH ATTRACTIVE RAIN GARDENS AND COMMUNITY GREENSPACE

Glasgow, Scotland

Key Details

Scale
City

Implementation Budget (Source)
Rs. 50 Crore for Croftpark Avenue (Glasgow City Region City Deal)

Challenges catered
Urban flooding, unregulated surface water runoff, sewer overflow and spills

Project Duration
1 year 6 months

Implemented by
Metropolitan Glasgow Strategic Drainage Partnership (MGSDP)- Glasgow City Council, Scottish Water and SEPA

Project USP
Swale collects runoff water, which flows to a permeable-surfaced multi-use games area, rain gardens

Project Rationale

The South East Glasgow Surface Water Management Plan (SWMP) is a crucial intervention aimed at mitigating flood risks, enhancing biodiversity, and improving urban infrastructure in Glasgow's south-east region. The project stands out for its integrated approach to water management, combining flood prevention, ecological restoration, and urban cooling, thereby promoting a sustainable and resilient urban environment.

Introduction

Glasgow's south-east region faces significant challenges related to heavy rainfall and outdated drainage infrastructure, leading to frequent flooding and environmental degradation. The area, characterised by urban greenspaces and residential zones, required urgent intervention to address these issues. The South East Glasgow Surface Water Management Plan (SWMP), funded by the Glasgow City Region City Deal, was developed to tackle these challenges. The SWMP has delivered a number of retrofit surface water management interventions at Kings Park, Croftfoot Park, Croftpark Avenue, and Croftfoot Primary School. The SWMP focuses on retrofitting existing infrastructure with sustainable urban drainage systems (SUDS), enhancing biodiversity through blue-green infrastructure, and improving community access to greenspaces. The comprehensive plan aims to reduce flood risks, relieve pressure on the combined sewer network, and create a more resilient urban landscape.

On the previous page: Retrofitting of raingardens on Croftpark Avenue.

On this page: King's Park surface water management plan.

Source: Glasgow City Council, 2022

Process Involved

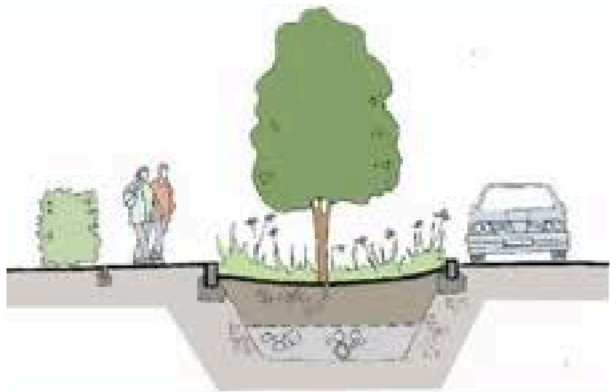
Key processes involved in the stormwater management plans in Glasgow include the following:

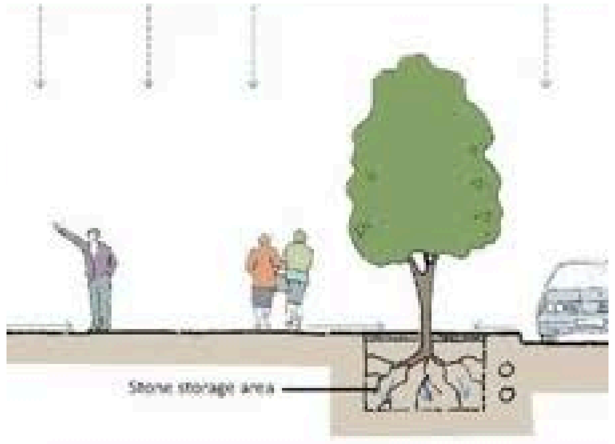
01 Flood attenuation and storage by creation of retrofit swales and SUDS basins in Kings Park and development of SUDS basins in Croftfoot Park.

02 Watercourse restoration with daylighting sections of the Spittal Burn to restore natural watercourses.

03 Blue-green infrastructure development by installation of rain gardens along Croftpark Avenue to manage surface water runoff along with tree planting and creation of a woodland walkway in Croftfoot Park.

04 Creation of educational and recreational spaces including construction of an outdoor amphitheatre and multi-use games area (MUGA) at Croftfoot Primary School, integrating stormwater management features.





On this page:
Top-Typical cross-section of stormwater planter.
Middle-Section through street rain tree.
Below-Green roofs for better stormwater management.

On the next page:
SUDS designed rain trees.

Source: Source: Glasgow City Council, 2022

Impacts

Environmental

- Enhanced flood resilience
- Improved biodiversity
- Increased carbon sequestration

Social

- Better access to green spaces
- Improved recreational facilities
- Enhanced urban cooling and air quality, better liveability

Economic

- Reduced flood damage costs
- Increased property values
- Lowered sewer maintenance expenses

Scale it Up!

Scaling up initiatives like the South East Glasgow Surface Water Management Plan in Indian cities can address rapid urbanization, inadequate drainage, and unsustainable development. These initiatives enhance urban resilience by improving flood management, biodiversity, infrastructure, and watercourse restoration, while integrating blue-green infrastructure for overall sustainability.

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FITZROY GARDENS STORMWATER HARVESTING SYSTEM: A MODEL FOR URBAN SUSTAINABILITY

48

Melbourne, Australia

Key Details

Scale
City

Implementation Budget
Rs. 35 Crore

Challenges catered
Climate change impact on heritage and environmentally significant areas

Project Duration
1 year (2012-13)

Implemented by
The City of Melbourne's Urban Water Department

Project USP
Efficient stormwater and rainwater management using WSUD

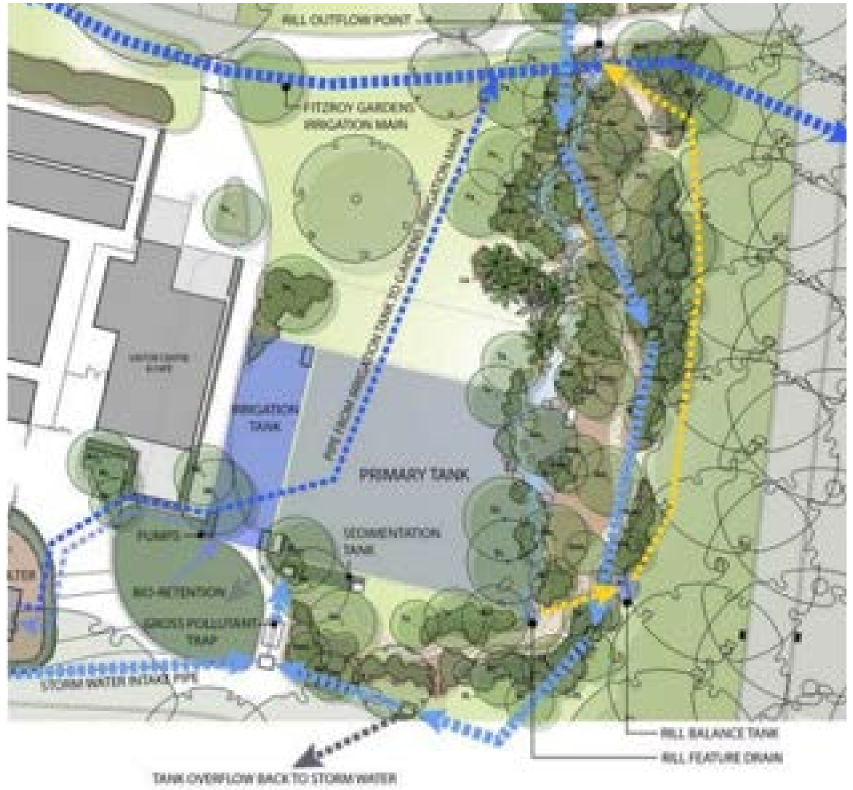
Project Rationale

The Fitzroy Gardens, due to their extensive stretch, have a high water demand for irrigation purposes. It was, therefore, strategically chosen for the development of a water management system, which utilises Melbourne's stormwater runoff and harvests its rainwater. The Gardens also offered a natural collection point for the drainage network, making it the optimal location to maximise the system's impact and efficiently address urban water sustainability in this area.

Introduction

In Melbourne, urban development needed to be harmonised with stormwater management and water supply reliability, especially to sustain drought-prone periods. Fitzroy Gardens, established in the mid-1800s, faces this challenge due to its substantial water needs.

Melbourne introduced a pioneering stormwater harvesting system within the park to tackle this, exemplifying Water Sensitive Urban Design (WSUD). This case study delves into the system's design intricacies, significant impact on water conservation, and broader environmental benefits. It serves as a model for sustainable solutions and water-sensitive design in urban green spaces.



On the previous page:
Stormwater collection in the park

On this page:
Set out plan and plan of the dual underground tank system at Fitzroy Gardens

Source: Urban Water, City of Melbourne, 2018

Process Involved

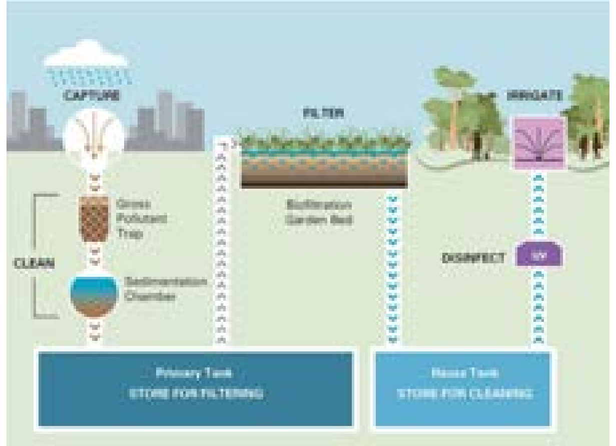
Developed by Melbourne's Urban Water Department, the water management system provides 30 million litres of water every year, helping the city to keep the heritage garden healthy and resilient to climate change.

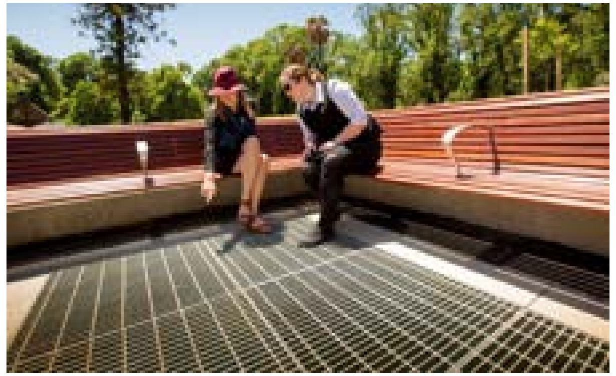
01 Water collection network of drains and pipes captures rainwater runoff from rooftops and paved surfaces within the gardens. This maximises the amount of rainwater collected for potential use.

02 Filtration system is used to remove debris and pollutants from the captured rainwater before storage. This ensures that the water quality is suitable for irrigating the gardens.

03 Biofiltration beds utilise natural processes to remove nutrients from the filtered rainwater. This further enhances water quality for irrigation purposes.

04 Storage tanks in the form of two sizeable underground storage tanks hold the treated rainwater. The size of these tanks considers Melbourne's moderate rainfall patterns, ensuring sufficient water is collected during wet seasons to sustain the irrigation needs throughout the year.





On this page:
Top-Schematic diagram of the garden's water management system.
Middle-Fitzroy Gardens after project completion.
Below-Collection of rainwater using grills.

On the next page:
Creek-bed constructed as per the natural topography of land in the gardens.
Source: Urban Water, City of Melbourne, 2018

Impacts

Environmental

- Reduced reliance on potable water for irrigation purposes
- Water conservation and easing of stress on existing water resources
- Climate change adaptation of heritage greens

Social

- Enhanced user experience in the park
- Increased public awareness about water conservation practices

Economic

- Cost saving due to reduced reliance on potable water
- Water-sensitive design enables efficient functioning of the system throughout the year
- Utilisation of natural drainage mechanism, easing stress on existing drainage infrastructure

Scale it Up!

Efficient utilisation of stormwater runoff in urban areas as well as the harvesting of rainwater is key to achieving water sustainability in cities across the world. This model of stormwater and rainwater collection, storage, and reuse can reduce the climate-related stress on the city's water resources and it can be easily replicated in other cities for innovative water-sensitive solutions.

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GREEN AND CLEAN: WATER SUSTAINABILITY AT INDIAN INSTITUTE OF MANAGEMENT BANGALORE (IIMB) CAMPUS

Bangalore, India

Key Details

Scale
Building

Implementation Budget
NA

Challenges catered
Limited water resources, lack of awareness

Project Duration
NA

Implemented by
IIMB

Project USP
Water conservation and energy saving

Project Rationale

Bangalore's water scarcity drives IIMB's "Green and Clean" initiative. The project aims to reduce reliance on municipal water by implementing water-sensitive urban design (WSUD) elements. This approach promotes water conservation and creates a more sustainable campus environment. The focus is on recycling and reusing water. Leading by example, IIMB hopes to inspire other institutions and communities to adopt similar practices for water sustainability.

Introduction

IIMB faces significant challenges related to water scarcity. Recognising this, the "Green and Clean" initiative implements numerous strategies to promote water sustainability and resource efficiency. Over the past nine years, WSUD efforts in the surrounding area have seen five borewells out of 14 rejuvenated, contributing to water availability. Additionally, initiatives like rainwater harvesting and recycling and reuse of treated sewerage water contribute to meeting approximately 20% of the total water requirement in the area.

Management of water, waste, energy, and holistic green initiatives are used to reduce the overall carbon footprint of the campus.

On the previous page:
Rooftop rainwater harvesting and solar panels.

On this page:
Rainwater harvesting channels on ground.

Source: IIMB, 2019

Process Involved

The project was initiated by the Department of Municipal Administration and Urban Development and implemented by Hyderabad Metropolitan Development Authority (HMDA).

01 Rooftop rainwater harvesting system captures rain water, which is used for various non-potable purposes like irrigation, toilet flushing, and cleaning.

02 Water-efficient landscaping by using native and drought-tolerant plants is used throughout the campus, reducing the water requirement for irrigation.

03 Wastewater treatment plant to enable and reuse of wastewater for irrigation and other non-potable applications.

04 Groundwater recharge wells are strategically designed to infiltrate excess rainwater and treated wastewater back into the ground, replenishing the local aquifer and contributing to long-term water sustainability.

On this page:
Top-Sewage treatment plant for recycling and reusing water.
Middle-Groundwater recharge wells.
Below-Biogas plant.

On the next page:
Extensive plantation on the campus.
Source: IIMB, 2019

Impacts

Environmental

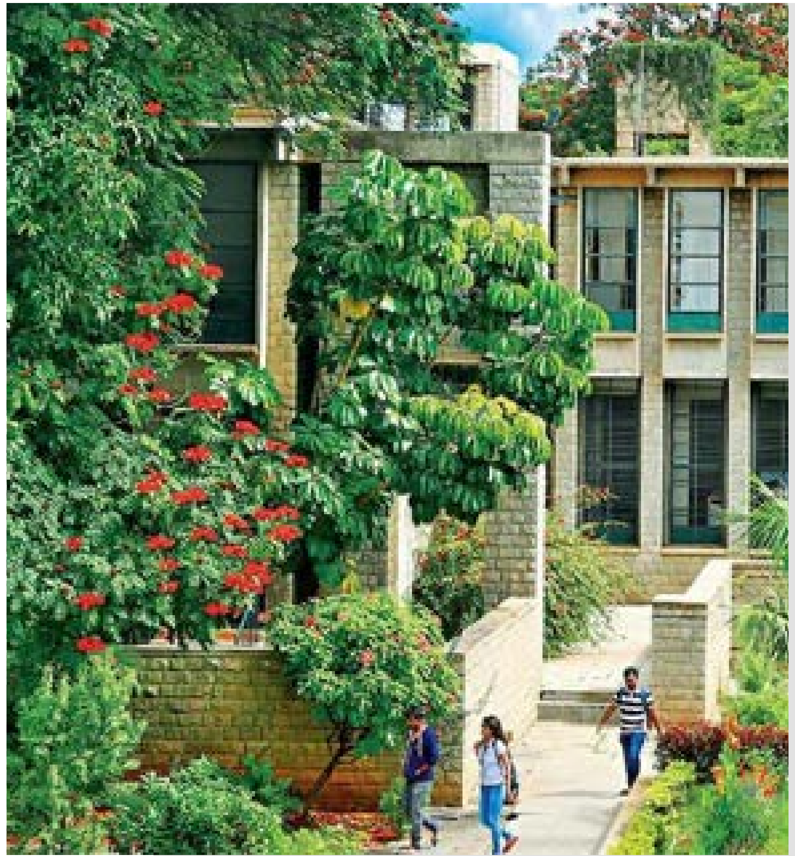
- Reduced water consumption
- Improved groundwater quality and recharge
- Recharge of local aquifers

Social

- Increased awareness about sustainable water and energy practices
- Fosters collective environmental responsibility on the educational campus

Economic

- Cost savings due to reduced water consumption



Scale it Up!

IIMB's WSUD strategies along with other green initiatives for energy and waste management can be adapted and scaled at educational campuses of various scales across the world. Such initiatives enable knowledge sharing through workshops and online platforms and can empower institutions to become water-secure leaders and also impact the local communities in proximity of these educational campuses.

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50 CITY WITHIN A GARDEN EMPHASISING ON GREEN ROOFS TO IMPROVE AIR AND WATER QUALITY

Singapore

Key Details

Scale
Building-scale, city-wide

Implementation Budget
Part of larger urban sustainability initiatives

Challenges catered
Storm water management, wasted surface run-off, flooding, urban heat island effect

Project Duration
Ongoing

Implemented by
National Parks Board (N Parks), Housing Development Board (HDB)

Project USP
Extensive integration of green roofs & vertical greenery for enhanced sustainability and liveability

Project Rationale

Since 1992, Singapore has aimed to become a "city within a garden," emphasising green initiatives. With 148 acres of vegetated roof space, the city prioritises greenery, dedicating 9% of its land to parks and reserves. This effort has expanded the green space from 36% in 1986 to nearly 47% in 2013. Green roofs, which support vegetation atop buildings, provide environmental benefits such as temperature regulation and improved air and water quality.

Introduction

Covering approximately 272 square miles and home to 4.6 million people, Singapore's biggest challenge is space. The city-state faces typical urban issues such as high population density, limited space, and the need for efficient land use. In response, Singapore has adopted a holistic approach to urban planning, integrating nature into its urban fabric through various initiatives, with green roofs playing a crucial role in this transformation. This trend is propelled by government initiatives, incentives, and a growing corporate focus on environmental responsibility, despite challenges like structural considerations and initial costs.

On the previous page:
Creation of green spaces on rooftops.
Source: Bizsu, 2024

On this page:
Vertical green space creation.
Source: Skyrise greenery, 2024

Process Involved

Green roofs maximise greenery in limited urban spaces without compromising the building functionality. Living roofs or eco-roofs are designed to support vegetation and greenery atop buildings using the following processes:

01 Green roofs are composed of several layers, including waterproofing membranes, root barriers, drainage layers, growing medium, and vegetation. The choice of vegetation, ranging from grasses to small trees, depends on the building design and capacity.

02 Regular maintenance is essential to ensure the health of vegetation and the longevity of the system.

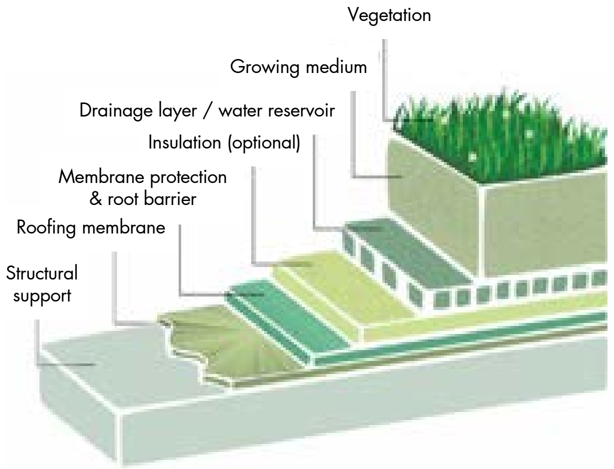
03 The five fundamental components of green roofs include the vegetation layer, substrates or media layer, filter layer, drainage or storage cells layer, and protection membrane or root barrier layer.

04 Plant selection emphasizes species that tolerate dry rooftop conditions, intense sunlight, and low soil moisture. Rainwater stored in the soil media and vegetation layer reduces peak flow and volume compared to conventional roofs.

05 The effectiveness of green roofs in stormwater management hinges on their ability to retain runoff, attenuate peak flow, and provide ecological benefits.

On this page:
Top-Typical cross section of a green roof system.
Source: N Parks, 2024
Middle-Urban agriculture on rooftops.
Source: Prince's landscape pte ltd., 2024
Below-Green roofs for better stormwater management.
Source: Green technology, 2013

On the next page:
Oasia hotel - green facade.
Source: Business Insider, 2023



Typical Cross-section of a Green Roof System

Impacts

Environmental

- Reduction in urban heat island effect
- Improved air quality and reduction in stormwater runoff
- Green roofs neutralise rain acidity & reduce heavy metals in runoff by significant percentages: lead by 99%, zinc by 96%, cadmium by 92%, & copper by 97%
- Habitat creation, food production

Social

- Enhanced visual appeal, adding nature to urban areas
- Accessible green roofs serve as community spaces
- Improved food security and self-sustainability by growing vegetables and fruits

Economic

- Reduce need for air conditioning, saving energy
- Shield roofs, extended lifespan, lower maintenance costs
- Contribute to green building certifications
- Improve Green Mark ratings, incentivization for developers

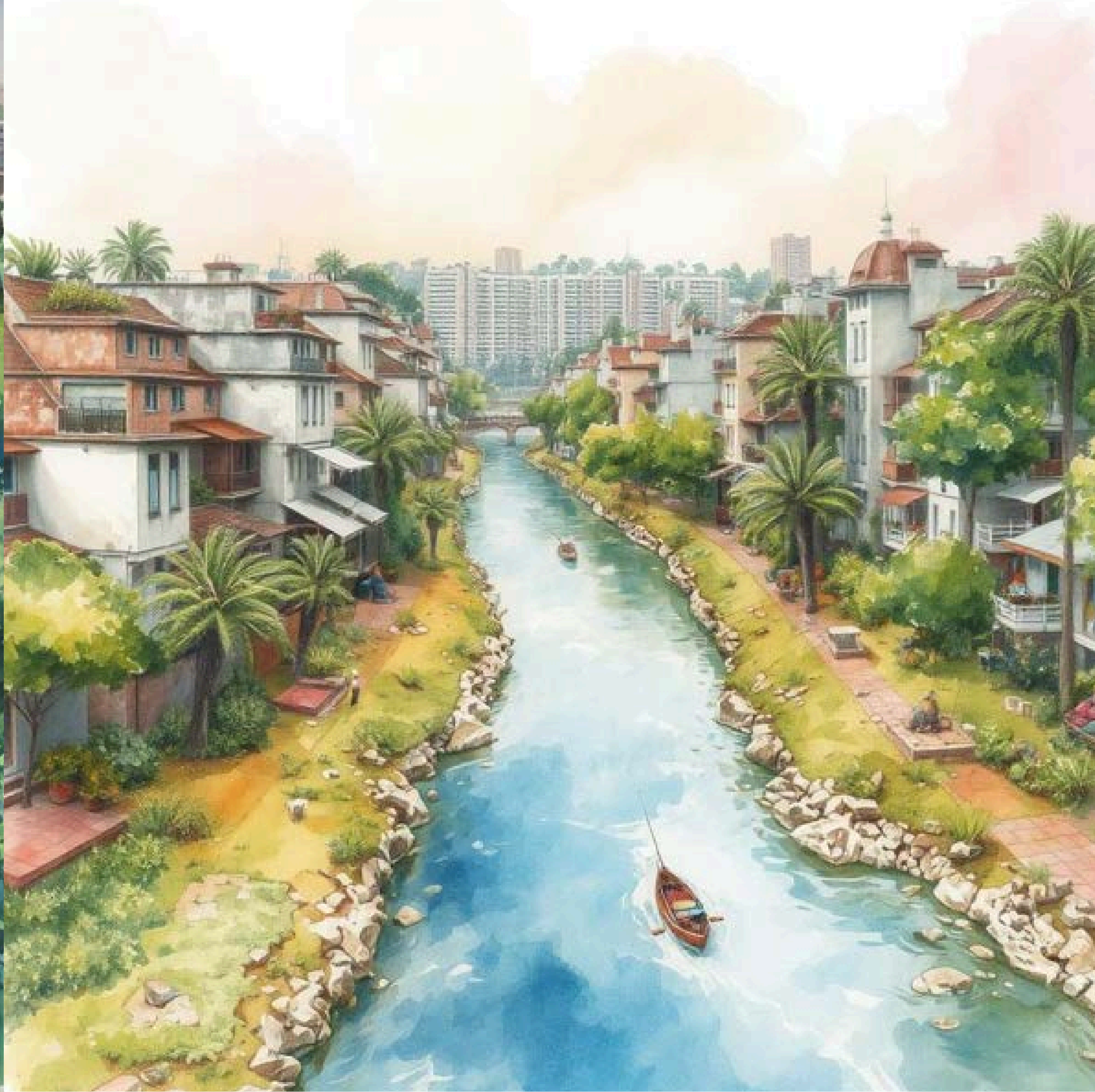
Scale it Up!

Scaling up Singapore's green roof initiative in India can address urban challenges such as heat islands, air pollution, and stormwater management to enhance environmental sustainability, improve air quality, and reduce energy consumption. Incentivizing green roofs through government policies and corporate initiatives can foster ecological balance and community well-being. Native plant species and cost-effective designs can ensure adaptability and economic feasibility for a greener, more resilient urban future in India.

Scan to read more

WAY FORWARD

The Way Forward section of the Water Sensitive Urban Design (WSUD) compendium provides a comprehensive roadmap for the future. This section maps the co-benefits of WSUD initiatives, demonstrating their alignment with sustainable development goals. By examining national and global case studies, it highlights the synergy between local actions and global sustainability objectives. Additionally, it offers strategies for successful implementation in urban settings and emphasizes the importance of policy and framework alignment to ensure long-term success and resilience in urban water management.



POLICIES & MISSIONS IN ALIGNMENT WITH WSUD

NATIONAL WATER POLICY, 2012

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Aim

To propose frameworks for conservation, development, and improved management of water resources as well as for optimum development of inter-state rivers and river valleys in India.

Elements aligning with WSUD

- Equity in water supply
- Conservation of water bodies
- Floodplain management
- Community participation
- River-sensitive master planning
- Reducing non-revenue water
- Groundwater recharge

Implementation

- Setting up of a State Water Regulatory Authority.
- Encouraging the private sector to become a service provider in the public private partnership model to meet agreed terms of service delivery.
- Adequate grants to the States to update technology, design practices, planning practices, etc.

NATIONAL WATER MISSION, 2012

Scan/Click to read more

Aim

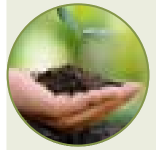
Conservation of water, minimising wastage, and ensuring its more equitable distribution both across and within States through integrated water resources development and management.

Elements aligning with WSUD

- Recycling of waste water
- Adoption of innovative technologies
- Rainwater harvesting
- Community participation
- Groundwater recharge
- Adopting water efficient irrigation systems

Implementation

- Bureau of Water Use Efficiency has been set up for implementation
- Projects are funded by Research & Development Wing of the Department of Water Resources, River Development & Ganga Rejuvenation and their progress is monitored through Indian National Committee on Climate Change.



THE COMPENSATORY AFFORESTATION FUND (CAF) ACT, 2016

Scan/Click to read more

Aim

To establish funds under the public accounts of India and each State to manage monies received from user agencies for compensatory afforestation and forest conservation.

Elements aligning with WSUD

- Treatment of catchment areas
- Forest management
- Biodiversity protection and management
- Managing human-wildlife conflicts
- Engaging local communities
- Soil-water conservation

Implementation

- Compensatory Afforestation Fund Management and Planning Authority (CAMPA) is set up in states for monitoring, technical assistance, and evaluation of compensatory afforestation activities.
- The State and Union territories are required to submit the Annual Plan of Operations , prepared by State CAMPA in accordance with the provisions of CAF Act, 2016.

NATIONAL MISSION FOR CLEAN GANGA (NMCG)

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Aim

Effective abatement of pollution and rejuvenation of the river Ganga and maintaining ecological flow to ensure healthy water quality and environmentally sustainable development.

Elements aligning with WSUD

- Pollution abatement
- Afforestation, wetland conservation for maintaining e-flow
- Groundwater recharge
- People's participation
- Capacity Building

Implementation

- The World Bank has supported NMCG by providing technical assistance and financing of US $ 1 billion (approx. 4600 crore)
- The investments required for projects are shared between Centre and Ganga-State Governments on a 70:30 basis.

POLICIES & MISSIONS IN ALIGNMENT WITH WSUD

SMART CITIES MISSION

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Aim

To promote urban areas that provide essential infrastructure and environmentally sustainable surroundings, and ensure a satisfactory standard of living for residents through the implementation of intelligent solutions.

Elements aligning with WSUD

- Community-centric planning & implementation
- Using resources sustainably
- Multifunctional public spaces
- Smart mobility
- Smart governance

Implementation

- Central Government will give financial support to the extent of Rs.100 crore per city per year.
- Citizens' aspirations were captured in the Smart City Proposals (SCPs) prepared by the selected cities.
- 45% of the projects are funded through Mission grants, 21 % through convergence, 21 % through Public Private Partnerships (PPP), and rest from other sources.

ATAL BHUJAL YOJANA

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Aim

Community-led sustainable ground water management, which can be scaled to improve the groundwater resources in water stressed areas (7 states: Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh).

Elements aligning with WSUD

- Community-centric planning & implementation
- Groundwater recharge
- Improving water-use efficiency
- Decentralised management of water

Implementation

- Atal Jal is relied upon to acquire consistency in the fund flows and expenditure filing systems with the help of Government of India's (GoI's) online Expenditure, Advance, and Transfer (EAT) Module in the Public Financial Management System (PFMS).
- The State Level Steering Committee is responsible for overall functioning.

MISSION LIFESTYLE FOR ENVIRONMENT (LiFE)

Scan/Click to read more

Aim

To initiate changes in extensive industrial and governmental strategies that are able to facilitate sustainable consumption as well as production.

Elements aligning with WSUD

- Promoting indigenous practices
- Reducing non-renewable energy consumption
- Promoting rainwater harvesting
- Adopting sustainable food systems
- Reducing non-revenue water

Implementation

- Coordinated and concerted actions by Ministries/Departments.
- MoEFCC has prepared a comprehensive and non-exhaustive list of 75 LiFE actions for individuals, communities, and institutions.
- Identification of Key Performance Indicators (KPIs) and impact of LiFE actions after the baseline survey.

ATAL MISSION FOR REJUVENATION AND URBAN TRANSFORMATION (AMRUT)

Scan/Click to read more

Aim

Providing basic services to households and strengthen infrastructures in cities, which will improve the quality of life for all, especially the marginalised communities.

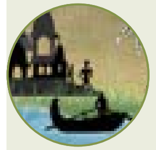
Elements aligning with WSUD

- Stormwater drainage
- Conservation of water bodies
- Groundwater recharge
- Developing green spaces and parks
- Reusing treated used water
- Reducing non-revenue water
- Enhancing urban planning

Implementation

- For cities with less than one lakh population, 50% of the project to be funded by Centre
- For cities with population one lakh to ten lakh, 33% of the project to be funded by Centre
- For Million Plus population cities, 25% of the project funded by Centre

FRAMEWORK AND GUIDELINES IN ALIGNMENT WITH WSUD



URBAN RIVER MANAGEMENT PLAN (URMP) FRAMEWORK

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Aim

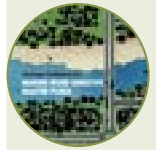
To help the river cities systematically and holistically plan for interventions required to revive and maintain the rivers in a sustainable manner.

Elements aligning with WSUD

- Floodplain management
- Conservation of water bodies
- Increased reuse of treated used water
- Leveraging on the economic potential of the river
- Encouraging citizen-Led activities

Implementation

- Setting up of a URMP Working Group
- City's Baseline Assessment of the 10 objectives of URMP
- Aligning proposed interventions with Central/State Missions for implementation
- Using Compensatory Afforestation Fund Management and Planning Authorities for implementation.



STRATEGIC GUIDELINES FOR MAKING RIVER SENSITIVE MASTERPLANS

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Aim

To look at the river-city interaction closely, and arrive at solutions to enhance this interaction in a more sustainable manner.

Elements aligning with WSUD

- River management in the Planning Landscape
- Planning for urban water bodies & wetlands
- Enhancing river management and governance and citizen-river connect
- Creating riparian zones with native species and maintaining green cover for groundwater recharge

Implementation

- Creating a systematic rehabilitation plan for such encroaching entities, creating green buffers, soft scaping, deconcretizing, etc.
- Adopting revised building bye-laws for incorporating guidelines on household sewer connections
- Using Transferable Development Rights (TDR) to incentivise private property owners to handover critical groundwater recharge areas

URBAN GREENING GUIDELINES, 2014

Scan/Click to read more

Aim

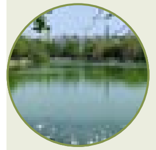
To enhance ecosystem health, minimise disruption to natural habitats, and ensure aesthetically pleasing, resilient landscapes while prioritising biodiversity and environmental conservation.

Elements aligning with WSUD

- Enhancing the landscape
- Enhancing groundwater percolation
- Protection from water logging and floods

Implementation

- The Guidelines suggests steps for protection of trees and enhancing their lives while undertaking concretization of pavements.
- A Central Resource Centre should be set up to aid and advice the State Governments, Municipal Corporations, and other agencies dealing with matters pertaining to Horticulture and Landscaping.



ADVISORY ON URBAN WATERBODY REJUVENATION

Scan/Click to read more

Aim

To provide guidance for developing effective Waterbody Rejuvenation Plans, focusing on holistic assessments, treatment measures, stakeholder engagement, and establishing an institutional framework to ensure sustainable management of waterbodies.

Elements aligning with WSUD

- Holistic water management through addressing the catchment
- Protection from floods
- Enhancing groundwater
- Improving water-quality and biodiversity
- Engaging communities for action

Implementation

- Conducting a situation assessment, engaging stakeholders and selecting appropriate interventions leading to development of a Detailed Project Report (DPR).
- Executing the plan and monitoring progress regularly.
- Establishing an institutional framework for its sustainable management, involving the community, and ensuring adequate capacity building and financing.

KEY CONSIDERATIONS FOR IMPLEMENTATION

01. Kaban Lake Waterfront, Tatarstan, Russia

- The case study brings out design elements like series of floating boardwalks and platforms that can regenerate a waterfront in a short span of time (Project completed in 1 year).
- To treat the urban runoff, terraced wetlands and bioswales have been incorporated as a water remediation buffer along the lake shore.
- While applying such floating structures in and around a lake, non-invasive anchoring techniques must be designed to prevent damage to the lakebed and aquatic habitats.

02. Rain Gardens Underneath Begumpet Flyover, Hyderabad, India

- Rain gardens require a gentle natural slope to typically slow down the run-off and hold water for soaking. They are effective when they are shaped longer instead of wider, thus making them easily replicable in drains and river buffers.
- The design of such green-blue slopes must incorporate native species of trees and plants that are water-friendly and can help with reducing odour and removing sediments and nutrients. Because of the proximity to the drain, the natural slopes within such places must be stabilised to prevent erosion.

03. Interlinking of Lakes in Ahmedabad, India

- This kind of project is ideal for cities where there is an opportunity to connect green-blue networks as a continuum to address issues of water logging. (e.g., The lakes in Ahmedabad were found to be smaller than five hectares, limiting their capacity to store rainwater as an isolated system).
- As in the case study, it is very important to understand water flow patterns, seasonal variations, water balance, and water quality to avoid harm to local ecosystems. A robust engineering design is crucial to ensure efficient water transfer including appropriate channel dimensions, control structures (like gates and weirs), etc.

04. Hatirjheel Area Water Management, Dhaka, Bangladesh

- For wetland restoration in urban areas, it is important to understand water flow dynamics, sources of water inputs (e.g., surface runoff, groundwater), and historical hydrology of the wetland area.
- As in this case, by adding additional drainage infrastructure, cities can manipulate the flow of water to improve water quality within the wetland and incoming water sources.

05. Rajokri Lake Rejuvenation Project, Delhi, India

- Best practices like Rajokri lake are a combination of bioremediation, rainwater harvesting, and stormwater management.
- For replicating the constructed wetland element, it is important to size the wetland for handling the expected volume of wastewater.
- As in Rajokri's case, the design of the wetland must minimise human contact with untreated wastewater, especially in public or recreational areas.

06. Kyalasanahalli Lake Rejuvenation Project, Bangalore, India

- For any city to begin a rejuvenation project on a water body, it is very important to understand the type of waterbody (as per the Wetland Classification System defined in the national Wetland Atlas, March 2011).
- This practice can be replicated in large natural waterbodies with natural buffer areas.
- For growing a Miyawaki forest as in this case study, the plantation density must be 3 to 7 native trees per square metre (Guidelines for Development of Miyawaki Forest, ICLEI).

KEY CONSIDERATIONS FOR IMPLEMENTATION

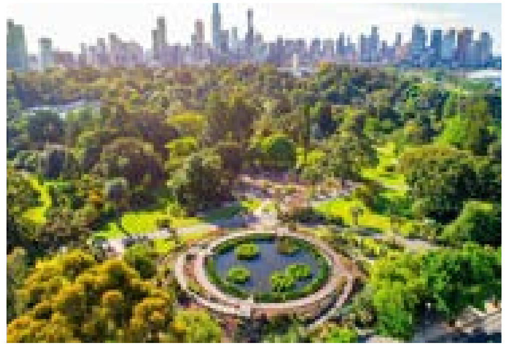
07. Neknampur Lake Wetland Management

- This is one of the cost-effective nature based solutions for a water body with secondary treated wastewater.
- Constructed wetlands work most effectively for secondary wastewater treatment but do not help with strong odour.
- A combination of actions like treatment ponds, aeration, and exclusive immersion ponds as well as citizen awareness are needed for successful implementation.

08. Artificial Lake Creation in Dwarka

- For a newly developed lake that collects treated used water for groundwater recharge, it is essential that the treated water discharged from the STP into the lake follows the norms prescribed by CPCB to avoid the risk of polluting the entire aquifer.
- It is important that such a practice is not carried out in the vicinity of a drinkable water source.
- Regular monitoring and testing of both the treated wastewater and the groundwater are essential in such a case.

09. Royal Botanic Gardens – Working Wetlands



- This case study provides insights into transformation of an existing garden into a functional rain garden, located above a drain using Canna Lily- an ornamental species that can survive in dry conditions and infrequent rainfall.
- The project use elements such as pollution trap upstream of the rain garden to maintain acceptable levels of water quality, and an ornamental garden bed that acts as a bioretention system.
- In such cases, undertaking regular maintenance is crucial for the long term sustainability of the rain garden treatment system.

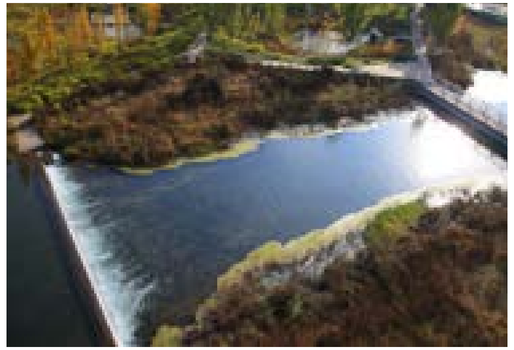
10. Rejuvenation of Parkes Wetlands

- This case study is an example of reusing old treatment ponds by scientifically designing and implementing earthwork to create natural bodies that act as complex habitats for flora and fauna.
- The natural greens in between these ponds have been imagined as the connecting greens that act as the movement channels for both people using the space and the fauna.
- The wetlands have been designed to withstand droughts that are a common occurence in Australia, also using native plants that can survive drought or regenerate when conditions improve.

11. ABC Water Program: Bishan-Ang Mo Kio Park

- This 'parkland' design of intervention is suitable for cities that are looking to re-naturalize the river channel by reclaiming and restoring the floodplains as a multifunctional green area. (In this case, with the ability to carry 40% more water than the previous channel).
- One of the important elements of this design is the soil bioengineering technique that is less expensive to install and maintain compared to traditional concrete drainage channels.
- Soil bioengineering requires a combination of civil engineering design principles with plants and natural materials such as rocks, and relies on plant roots for soil stabilisation ("Kallang River Bishan Park," 2014)

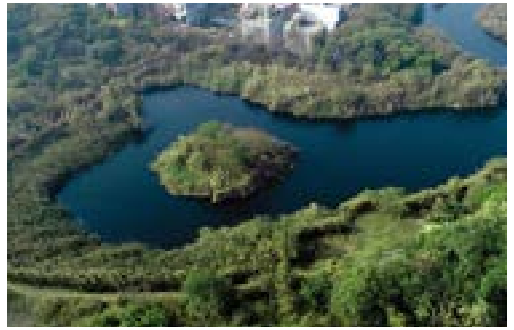
12. Qian'an Sanlihe River Ecological Corridor



- This case study is an example of restoring 100-300 m wide smaller river streams, making use of the differential altitudes that exist naturally.
- The naturally occurring levels can be transformed into multiple water course riparian wetland systems. Thus, when the river's water level drops to its lowest point, pools of water remain in the wetlands, creating a "Green River".
- The Project propagates the idea of 'messy nature' by using low-maintenance native vegetation, lush wetland species, and self-reproductive wild flowers while preserving all the exiting matured trees.

KEY CONSIDERATIONS FOR IMPLEMENTATION

13. Yamuna Biodiversity Park



- Restoring floodplains for large rivers, such as in this case study, is contingent to earmarking of active floodplains by the development authorities with no development.
- Biodiversity parks as this one offer an opportunity to create a mosaic of wetlands together with the grasslands and floodplain forest communities.
- To treat highly alkaline soil with extremely saline underground water, strategies like ecological succession were used. This is done in a phased approach, starting with pioneer species that can be established quickly and that improve soil quality, followed by secondary and climax species to create a stable and diverse ecosystem.

14. Flood Mitigation in Rohingya Refugee Camps

- This case study is one of the practical solutions to better utilise space in crowded settlements while enabling communities to produce vegetables and support their own livelihoods.
- For decentralised plant-based wastewater treatment that has been applied in this case, it is important to choose plants with extensive root systems to maximise the surface area for microbial activity and pollutant absorption.
- Regular maintenance of such systems is very important. It includes routine maintenance of vegetation and periodically removing accumulated sediments to prevent clogging and maintain flow rates.

15. Beijing Yongxing River Greenway

- This example is most suited for drains/ seasonal rivers that have natural buffer or space for restoring natural buffers in dense urban areas. In this case, the land use planning has set aside about 100 meters at the west side of the river as public green space.
- This also demonstrates the in-situ restoration of the drain through 'cut and fill' technique to create a sponge riparian corridor. By using only cut and fill on site, different levels and landforms have been created with a shallow area near the drain shore and higher areas for the walkways.

16. Minghu National Wetland Park

- This case study has been conceived at a macro scale, making it crucial to study the drainage basin of the river.
- All the existing streams, fishponds, and low-lying areas in the basin have been integrated into the ecological purification system along the river, acting as a series of purification wetlands with different capacities.
- The design advocates a low carbon landscape, using materials and native plant species that lower the overall emissions and help in carbon fixation.

17. Canal Rehabilitation in Atlasville

- Nature based Solutions such as geomats used in this case, must be laid to stabilise the canal banks, thus preventing soil erosion due to water flow and reduce sedimentation in the canal.
- While using geomats, it is essential that the porosity of this mat must match the local soil conditions to facilitate water infiltration and reduce runoff.
- It is essential to go for native or adapted plant species that are resilient to local climatic variations and soil conditions.

18. Restoration of the Small Creek concrete

- The case is suitable for cities looking to transform concrete channels to a living waterway.
- One of the major steps in this restoration was removing silt and contaminants deposited in the channel. In this case, removal of 108 tonnes of sediment, 863 kg of nitrogen and 149 kg of phosphorous from the waterways is undertaken annually. 3,600 cubic metres of soil is removed to create deeper pond areas
- Riffles - a deposition of coarse sediment has been created in this to protect fish from predators and provide shelter and food.

KEY CONSIDERATIONS FOR IMPLEMENTATION

25. Stormwater Management at Leidsche Rijn

- This case study presents a classic example of grey-blue-green system, integrating nature based solutions with engineering measures to achieve a sustainable urban drainage infrastructure.
- It has a combination of pumping stations that circulate the required amount of water in order to ensure water quality, main dams and secondary dams, bioswales in living areas that temporarily capture and filter storm water, permeable pavings, and green banks.
- It also demonstrates retention of biodiversity by providing fish passages.

26. Chennai Sponge Parks

- For sponge parks to be successful, it is important to identify such green spaces in low lying areas of a city, particularly in areas with no large water bodies acting as water sinks.
- It is also important to strategically locate the sponge park based on an existing park with surrounding roads to ensure a guaranteed water flow, as well as taking into account the condition of the soil.
- This will not be suitable for areas with a shallow groundwater table.

27. Restoration of Jamburi Park

- This case study shows how an existing water body can be transformed into a green space within high density urban settlements.
- The area has been converted into a public place by simple interventions like planting various fruit, forest, and flower trees on both banks of the lake.

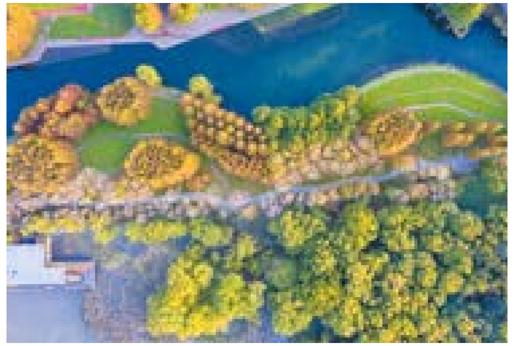
28. Gardens by the Bay, Singapore

- This provides an example for greenfield developments where greens can be seamlessly integrated into contemporary building design and architecture.
- It is an example of the city's vision of a "city in the garden", acting as a space that would both enable communities to bond and interact and attract investors as well as talents from emerging markets.
- The energy and water use in this modern landscape has been optimised by using the horticultural waste for energy and rain water capture.

29. Biophilic Design of ITC Grand Chola

- The biophilic design incorporated in this case study is easily replicable by mimicking the natural environment using elements such as natural light, water, and vegetation.
- Making use of the large footprint of the hotel, the design features a large indoor garden with natural light and a waterfall to create a calming and rejuvenating environment.
- Sustainable water management practices, integrating natural vegetation, and using eco-friendly, non-toxic, and renewable materials has also been adopted.

30. Shanghai Houtan Park



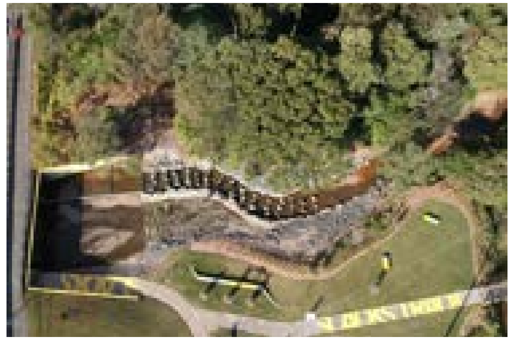
- The case demonstrates how a brownfield industrial site can be transformed into a Green Expo, demonstrating green technologies and transition into a permanent public waterfront park.
- Cascades and terraces have been used to create different filtration and treatment areas to oxygenate the nutrient rich water, remove and retain nutrients, and reduce suspended sediments .
- It also demonstrates how river banks can be naturalized by replacing the existing concrete floodwall with a more habitat friendly riprap that allows native species to grow along the riverbank while protecting the shoreline from erosion.

KEY CONSIDERATIONS FOR IMPLEMENTATION

19. Angus Creek Stormwater and Reuse Scheme

- The case study provides an effective model of harvest and reuse, harvesting rainwater from large building footprints such as car parkings and stadium roofs.
- Harvested stormwater is used for the international sporting facility, thus demonstrating use of harvested water for non-potable use within the large complex itself, that can be adopted by large footprint buildings and complexes in any city.
- This has demonstrated the proven alternative water supply and storage during drought conditions, reducing the reliance on potable water.

20. SLACKS CREEK CATCHMENT RECOVERY PROJECT



- This is a pertinent and relevant case of restoring a watershed / catchment disrupted by urbanisation by restoring the two major creeks.
- One of the major interventions in this is restoring the riparian vegetation along the waterways by removing the weeds and planting 90,000 native species.
- Mimicking the natural flow of water in the area, it has been ensured that the waterways are connected for many aquatic species, including fish. Special attention has been given to the fishways - corridors for fish to move up or down stream.

21. Benjakitti Forest Park

- The case study is a demonstration of how underutilised spaces in a city can be reused and regenerated as green areas.
- It is an example of how a prime land at the heart of the city has been transformed as a low-maintenance regenerative system that intercepts and reduces the destructive force of storm water, filters contaminated water, and provides a much-needed wildlife habitat.
- The park offers a replicable modular approach wherein the existing materials and earthwork have been used to create three constructed wetlands, scattered with hundreds of mini-islands, by simple cut and fill procedures.

22. Nanchang Fish Tail Park

- The case study offers green blue system practices that are adapted to variable water levels for regions with monsoon or variable climates.
- It can also be applied to areas with monsoon-flood-adapted marsh landscape or saturated soil that have a tendency to get inundated during annual monsoon floods.
- As in this case, the plantation strategy for cities with such water extremes (dry and wet) may include various species of emergent, floating, and underwater plants that are adapted to large water-level fluctuations and can also cope with the dry season.

23. Adyar Ecological Restoration Park

- This intervention is an example of restoring unique ecosystems, in this case, an estuarine river ecosystem with coastal ecology.
- It is pertinent for such projects that the city must undertake detailed studies on the ecosystem's water management, flora and fauna habitat mapping, wetland ecology, architecture, and landscaping.
- It is also important in such unique ecosystems to mimic the natural floral and faunal diversity. In this case, 172 species are planted to provide a green cover and typical vegetation of the Coromandel coast.

24. Qingshangang Wetland Sponge Project

- This practice can be implemented in rivers, stream channels, and drains, leveraging their natural elevation. In this case, an 8-meter elevation was used to treat combined sewer overflows with the sewage water discharged through sponge facilities rather than going directly into the water bodies.
- The project also demonstrates that the surrounding built can also start acting as a sponge facility with grass swales, rainwater gardens and infiltration pavements, and rainwater storage modules, laid out in the project area.

KEY CONSIDERATIONS FOR IMPLEMENTATION

31. Community Inclusiveness in Cuttack

- When a city is looking to implement community level interventions to enhance the access to basic services, smaller interventions like revival of dug wells can be taken up that are less cost intensive and time consuming.
- In such cases, it is important to inventorize such water sources with the help of the community and monitor the levels and quality of these water sources.
- In such cases, educating and engaging the community is of prime importance to ensure the long term maintenance and sustenance of such initiatives.

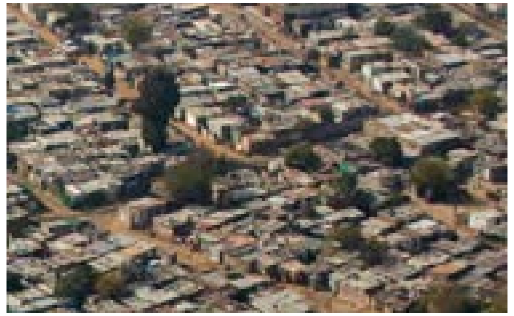
32. Rain Gardens in Renfrew Close

- When designing a rain garden, it is important to account for the extreme rainfall events that may lead to inundation. As in this case, the rain gardens are sized to accommodate a 1 in 10 year rainfall event.
- These rain gardens can be designed to fulfil different functions. In Renfrew, the 'ornamental' rain garden is designed as a 1 in 100 year +30%, with a clearly defined 1 in 2 year central planted basin.
- The 'productive' rain garden is sized for a 1 in 1 year event only and was designed for use as a space for residents to grow their own food.

33. Climate Resilience in Onyika Settlement

- This is an example of building resilience of informal settlements that emerge on the river banks and drain channels, and lack the most basic services.
- In such cases, initiatives like urban food gardens or small scale gardens are developed with the community to resolve water problems as well as create alternatives for food security.

34. SUDS for Flood Resilience in South Africa



- Sustainable urban drainage systems (SUDS) look beyond stormwater drainage for quantity (flow) management to the larger preservation of the environment.
- SUDS can be applied at the source by incorporating elements like green roofs, soakaways, and vegetated strips and at the local level by creating detention ponds, infiltration basins, and constructed wetlands.
- The Operation & Maintenance strategy of such systems must be formulated and implemented at regular intervals.

35. Rehabilitation of Khajrana Talab & Mori Talab

- An integrated water balance and quality model has been used by the city of Indore, that considers water demand, existing water sources and supplies, pollution, population growth scenarios, as well as sewerage, solid waste and sanitation arrangements. This is important for any city to assess the water bodies and prioritise restoration.
- One of the key actions for successful implementation has been ensuring the ownership by the community, concerned officials, elected representatives, and other stakeholders to conserve the lake.

36. Eco-sanitation in Special Needs School, Peru

- Ecological sanitation projects are best applied in poor suburbs and are based on decentralised dry sanitation solutions (dehydrating toilets). They are suitable for areas where water scarcity is a major problem.
- They offer two forms of reuse: dehydrated and hygienised excrements can be used to improve and fertilize the sandy soils around many AHs, and the greywater with urine can be used for irrigation and fertilization (N, P) as well.
- In such cases, it is very important to educate and sensitize the community to make them interested in the reuse of treated effluents.

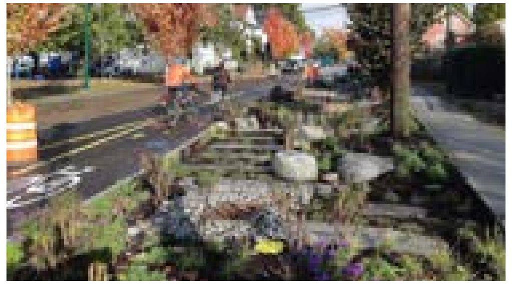
KEY CONSIDERATIONS FOR IMPLEMENTATION

37. Water Management in White Gum Valley

- This case study is an example for cities to involve and push water wise development through private developers with their program "Innovation through Demonstration".
- It is a form of incentivisation, wherein the households are provided with sustainable packages that include simple HH level measures like:

1. The supply and installation of a complete solar PV system.
2. The supply and installation of an above-ground plumbed rainwater tank (minimum 3,000L) with pump and accessories.
3. The supply and planting of a large (100 L pot size) deciduous shade tree.

38. Rain City Strategy Vancouver



- It is a policy level intervention towards rainwater management, which can be contextualised for cities with erratic rainfall.
- It looks at creating Green Rainwater Infrastructure (GRI) in streets and public spaces, buildings and sites, and parks and beaches.
- The city level policy has set measurable targets such as capturing and cleaning rainwater from 40% of Vancouver's impervious areas by 2050.

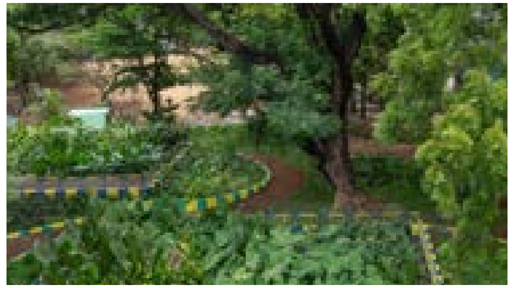
39. Østerbro Climate Resilient Neighbourhood

- This can be adapted in cities looking to future proof the city and the communities against heavier rain and torrential downpours.
- Copenhagen is implementing this by using the wide old streets as opportunities and proposing that 20% of the asphalted areas in the neighbourhood become green spaces that can be used for storm water management.
- It looks at implementation through tangible outcomes such as green corridors, green courtyards, climate resilient blocks, and citizens' own climate projects.

40 Green Dhaka Campaign

- This is an example for cities looking to develop an open area with opportunities to connect with nature as well as have options for recreation for all age groups.
- Another key action towards a successful management of the parks has been partnership with private companies, allowing room for efficiency and innovation in day-to-day maintenance.

41. Water Balance in Chennai



- The Water Balance Program of Chennai is for cities that are looking to use nature based solutions to restore and retrofit the existing water infrastructure at the building complex level.
- The program is fit for areas having potential for aquifer recharge. As in this case, the broken infrastructure has been repaired to collect rainwater, and wastewater is being treated locally in order to replenish the aquifer, thus ensuring local water security and climate resilience.

42. Grey to Green Scheme, Sheffield

- Grey to Green program of Sheffield requires any other city implementing it to evaluate their existing grey mobility and drainage infrastructure for green blue systems.
- The innovative engineering measures include planting beds that capture and hold on to plastics from car tyres and road wear and other pollutants, preventing them from reaching the watercourses.
- To replicate this, the old catchments become the areas of intervention from where the water is redirected to the river, making sure it is done sustainably with clean and slow flows.

KEY CONSIDERATIONS FOR IMPLEMENTATION

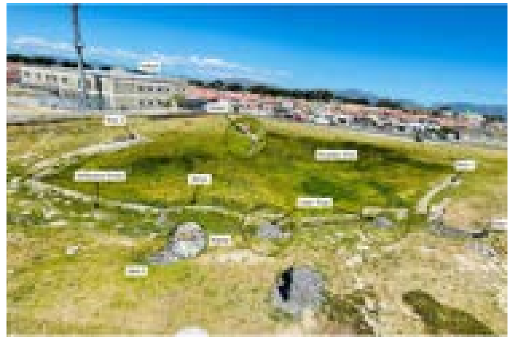
43. Pine Street Rainwater Management Initiative

- This is for the cities that have the opportunity to transform their streets into Green Rainwater Infrastructure - a cost-effective approach to rainwater management that protects, restores, and mimics the natural water cycle.
- Bioretention soil, which is a specialised mix of sand and organic matter, is used. The design allows for infiltration while still providing adequate nutrients to support thriving plant communities.

44. Imperviousness Fee in Germany

- Based on polluter's pay principle, imperviousness fee has been designed by cities in Germany to incentivise infiltration and reduce runoff through an efficient drainage system.
- It is charged on properties that collect both runoff and wastewater in the same pipe.
- This can be rolled out based on the size of the built-up areas (impervious surface) from which the water drains into the rainwater sewer. To minimise the fee, households need to minimise the discharge.

45. Water Resilient South African Cities Project



- The strategy is for cities in regions facing recurrent water scarcity. Here, a combination of both dry detention ponds and wet retention ponds form part of the urban stormwater management system.
- It is largely for cities aiming to convert engineered single-purpose stormwater ponds into multi-functional spaces that can provide a range of water-related biodiversity and amenity functions.
- The pre-implementation study would include design and construction of the pond retrofit, evaluation of aquifer recharge under different scenarios, and evaluation of the water quality and treatment potential.

46. Green Roofs in Hohlgrabenäcker

- In dense areas of Indian cities where there is no space available on ground, green roofs can help fight against progressive concretization.
- The choice of plants for a green roof depends on several factors, such as the climate, season, roof slope, soil depth, water availability, and desired aesthetic and ecological benefits. Some common examples are succulents, grasses, herbs, wildflowers, and sedums.
- A key component of a green roof system is the waterproofing and drainage layer.

47. South East Glasgow Surface Water Management Plan

- This is applicable for areas and cities that are extensively developed and suffer from historical flooding due to their limited drainage capacity.
- The first step in this plan is the identification of areas at greatest risk of river, coastal, and surface water flooding.
- It works on the principles of infiltration and permeable surfaces, collecting and conveying the water following the natural slope, and storing and delaying the water surplus so as to avoid overflow of existing systems.

48. Fitzroy Gardens Stormwater Harvesting

- This is an example of protecting heritage structures/ landscapes that are now susceptible to drought and water stresses.
- The Fitzroy Gardens stormwater harvesting system captures, treats, and stores stormwater to be reused for irrigation in the park, reducing the pressure on freshwater sources for irrigation.
- The large landscape has been used as an opportunity to create different filtration chambers underground and use biofiltration and disinfectant to treat it to be used for irrigation.

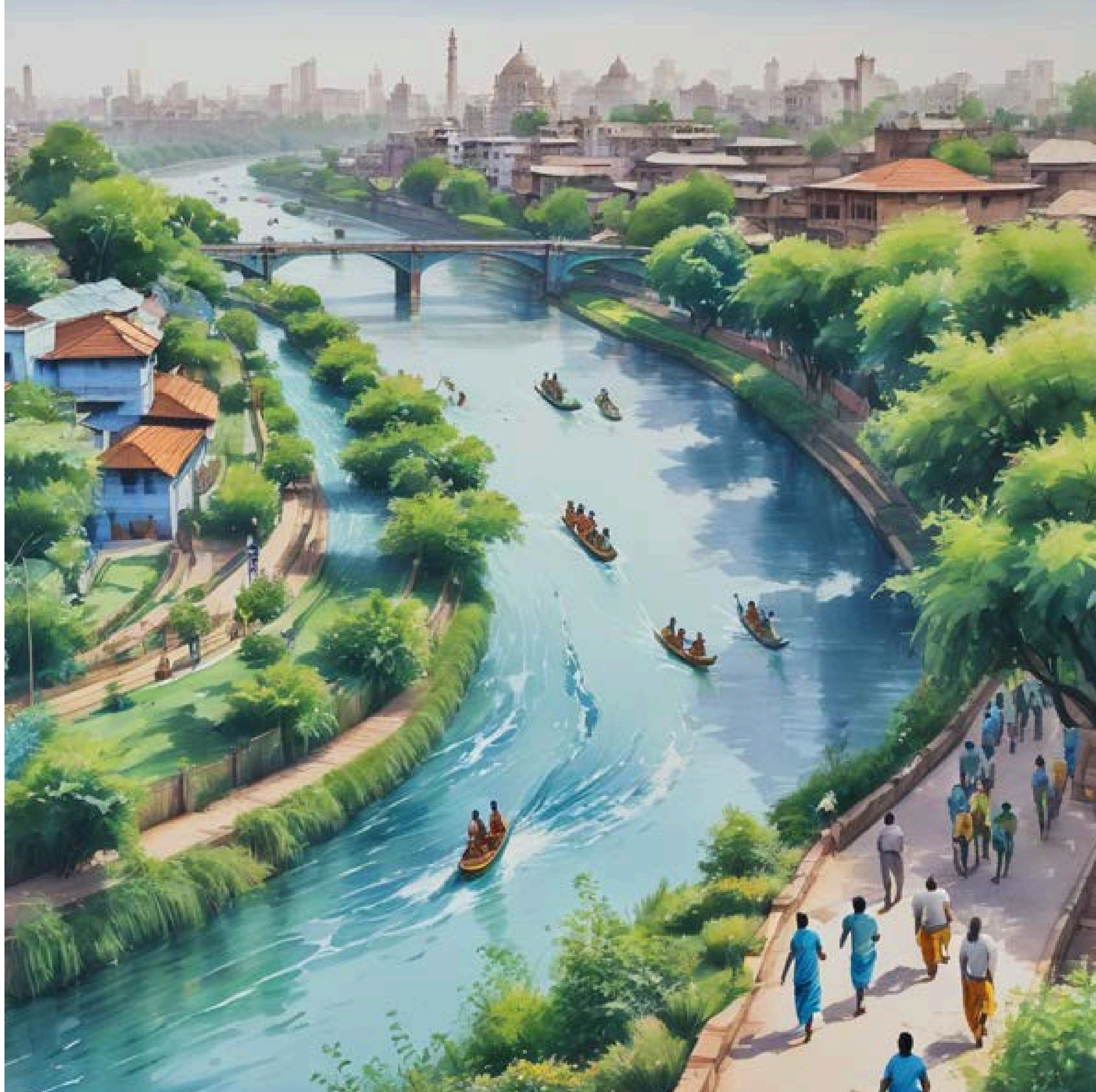
KEY CONSIDERATIONS FOR IMPLEMENTATION

49. Green and Clean: IIMB

- Large institutional and government complexes (such as IIMB) in cities can be made more sustainable by using eco-friendly and locally-sourced materials, implementing rainwater harvesting, recharging aquifers, and having a recycling centre.
- In such cases, the water demand of these complexes are met through inhouse systems. In IIMB, on average, 20% of the total water requirement is met by rejuvenated bore wells and rainwater harvesting measures on campus.

50. City Within a Garden, Singapore

- For any city facing challenges of less space, transboundary water dependence, and high densities, the pointed and actionable vision that Singapore has been successful in implementing must be the guiding template.
- The five pointed objectives are: establishing world-class gardens, optimising urban spaces for greenery and recreation, enriching biodiversity, enhancing competencies of landscape and horticultural industry, and engaging and inspiring communities to co-create. These can be emulated in any city's master plan.



CONCLUSION

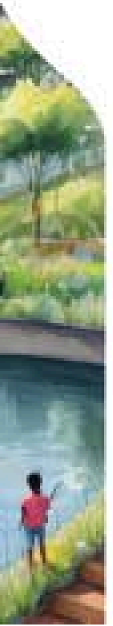
Water Sensitive Urban Design (WSUD) is not just a conceptual framework; it is a practical and essential approach to addressing the pressing challenges of water management in urban areas, especially in the face of recurrent flooding, droughts, and rapid urbanisation. As cities around the world strive to become more resilient and sustainable, WSUD offers a pathway to better manage water resources, reduce environmental impacts, and enhance the quality of life for urban residents.

This compendium, inspired by successful applications of WSUD in Australia and beyond, seeks to bridge the knowledge gap on how to effectively implement WSUD in dense urban contexts. It presents a collection of innovative and diverse solutions—ranging from land-efficient to cost-effective strategies—that have been successfully applied in various global and Indian cities. The case studies and best practices highlighted within this compendium showcase the spectrum of WSUD initiatives, from government-led visions to community-driven actions, and from planning and policy frameworks to on-ground implementations.

One of the core messages of this compendium is the recognition that water management is not the sole responsibility of any single institution. It requires the collaboration of various stakeholders, including government agencies, the private sector, academia, and civil society. This multidisciplinary approach is crucial for integrating WSUD principles into urban planning, ensuring that water is considered not only as an ecological resource but also as a vital element of social, cultural, and community life.

The compendium emphasizes the importance of making water an integral part of both built and green urban development, aligning with the natural urban water cycle as closely as possible. It serves as a guide for city officials to supplement conventional approaches to water resource management with innovative WSUD practices. By understanding and leveraging the interconnections between surface and groundwater sources, cities can create more sustainable and water-secure urban environments.

Lastly, it brings together learnings from the AIWASI - demonstrating that WSUD is crucial to promote sustainable and inclusive urban development and ensuring that cities and urban communities are resilient, water-sensitive, and capable of meeting the challenges posed by climate change. Lastly, it is guiding document for all the water stakeholders of any city towards a future where water is seamlessly integrated into the fabric of urban life.



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