MOVING TOWARDS CLIMATE RESILIENT WATER AND SANITATION SERVICES

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MUMBAI CLIMATE WEEK

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MESSAGE FROM THE MINISTER

Smt. Pankaja Gopinath Munde
Hon'ble Minister,
Environment and Climate Change Department
Government of Maharashtra

India is progressing steadily towards achieving its Nationally Determined Contributions (NDCs) and Maharashtra is committed to leading the nation's response to the climate crisis through progressive policy, governance reforms and strong climate action. As the country's most progressive state, Maharashtra has kept an aspirational target of Net Zero by 2050.

In the past few years, the Government of Maharashtra has continued to promote sustainable development through a range of climate action programs that align the state's vision to the national vision of a sustainable and Vikasit Bharat. Activities under the Jal Jeevan Mission, AMRUT 2.0, Swachh Bharat Mission in Maharashtra and its own Majhi Vasundhara Abhiyan are implementing this vision. The State Action Plan on Climate Change (SAPCC) aligns with the National Action Plan on Climate Change (NAPCC) and many pioneering cities are now operationalizing this vision through their own Climate Action Plans.

I am confident that this guidebook will bridge policy and practice for many other cities, enabling them to contribute meaningfully to India's NDCs and advancing the State's vision of a resilient, sustainable and inclusive future.

MESSAGE FROM THE PRINCIPAL SECRETARY

Smt. Jayshree Bhoj
Principal Secretary,
Environment and Climate Change Department
Government of Maharashtra

In recent years, the impacts of climate change have become increasingly evident, affecting communities and ecosystems across the globe. As extreme weather events, prolonged droughts, flooding, and rising temperatures challenge the availability and quality of resources, the water and sanitation sector has emerged as one of the most vulnerable to these shifts. On the other hand, the contribution of this sector to emissions becomes more relevant with growing urbanization. In this context, we must rethink our approach to water-sanitation services and infrastructure in a way that is climate-responsive, sustainable and resilient.

The State Action Plan on Climate Change (SAPCC) also outlines water resource management, climate proofing infrastructure, disaster readiness, energy efficiency and decarbonization as some of the focus points related to the sector. This guidebook on *Moving towards Climate-Resilient Water and Sanitation Services* is a timely and critical resource for government officials and professionals working in this sector. It offers actionable insights on how to adapt in response to climate change, ensuring that water and sanitation services remain accessible, equitable, and effective, even in the face of environmental uncertainty.

I take this opportunity to acknowledge the efforts of the department and the team at Center for Water and Sanitation (CWAS)-CRDF-CEPT University, in developing this guidebook.

MESSAGE FROM THE DIRECTOR – STATE CLIMATE ACTION CELL

Shri. Abhijit Ghorpade
Director – State Climate Action Cell
Environment and Climate Change Department
Government of Maharashtra

As climate risks intensify, strengthening the resilience and sustainability of water and sanitation systems has been deemed a key priority under Maharashtra's recently published State Action Plan on Climate Change (SAPCC) "Pathways for 2030". The plan strikes a balance between adaptation and mitigation and within this framework, the state is focused on green infrastructure development, efficient water resource management, effective solid waste management and expanding urban green cover.

Further, to translate climate action to the local level, City Climate Action Plans are being developed, alongside the promotion of District and City Climate Action Cells by the State Climate Action Cell. However, changing established practices and encouraging communities to adopt sustainable alternatives requires sustained efforts. Awareness generation, technical expertise and innovative climate finance is needed at the grassroots level to ensure successful and impactful climate initiatives. Additionally, to support complex coordination of local, district, and state level strategies, the State Climate Action Cell conducts regular capacity building activities.

This guidebook is a valuable addition to the state's capacity building efforts for climate action. I trust that it will assist cities in advancing low-carbon, climate-resilient water and sanitation services, contributing meaningfully to Maharashtra's state's climate action goals.

The State Climate Action Cell sincerely appreciates CWAS, for developing this guidebook and for their continued technical support in advancing climate-resilient water and sanitation planning and implementation across Maharashtra.

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MESSAGE FROM THE MISSION DIRECTOR - MAJHI VASUNDHARA ABHIYAN

Shri. Sudhakar Bobade

Mission Director - Majhi Vasundhara Abhiyan
Environment and Climate Change Department
Government of Maharashtra

As the director of Majhi Vasundhara Abhiyan, it is my privilege to present this guidebook on climate-responsive water and sanitation services.

In an era marked by significant climate challenges, the importance of sustainable water and sanitation practices cannot be overstated. Majhi Vasundhara Abhiyan stands among the country's most holistic environmental movements, embedding adaptation and mitigation into local governance structures through citizen participation.

This guidebook is based on experiences from initiatives promoted under the Majhi Vasundhara Abhiyan and serves as a comprehensive resource for the local bodies. It provides practical and contextual insights into integrating climate considerations into water and sanitation services provided by the local governments, ensuring they are resilient, sustainable and involve the local communities.

I encourage you to utilize this guidebook as a tool for action and inspiration. Let us work hand in hand to safeguard our environment and enhance the quality of life for all.

The Majhi Vasundhara Abhiyan sincerely appreciates CWAS for developing this guidebook and for their valuable contribution in strengthening climate-responsive water and sanitation initiatives across Maharashtra.

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MESSAGE FROM CWAS

Dinesh Mehta
and Meera Mehta
Senior Advisors, Center for Water and Sanitation (CWAS), CRDF – CEPT University

Water and sanitation are at the forefront of the climate challenge, impacting not just public health but also the broader ecological balance. However, water and sanitation are often seen as separate from the climate and environmental agenda and the WASH-climate link is not well established.

Disruptions in water supply and sanitation services caused by extreme weather events adversely impact the urban population and improved access to well-designed water and sanitation services can help increase resilience. The contribution of this sector to GHG emissions also needs to be better assessed. Untreated wastewater and solid waste landfills are sources for direct emissions and the water supply and sewage systems account for a significant portion of the total energy consumption of cities. As such, mainstreaming water and sanitation in climate action strategies can yield co-benefits that include both climate mitigation and adaptation.

The Center for Water and Sanitation (CWAS) has been providing advisory and technical support to Government of Maharashtra for over 15 years on improved service delivery for water and sanitation. This guidebook aims to serve local bodies, with implementable approaches to address their needs for climate-responsive water and sanitation services. The methodologies described in the following pages are not just oriented towards services delivery but also on financial sustainability at local level for achieving overall sustainable cities.

We invite local governments to explore this guidebook, adapt it to their unique circumstances, and join us in this essential journey toward a climate-resilient future.

ACKNOWLEDGEMENTS FROM CWAS

Dhruv Bhavsar and Aasim Mansuri
Center Heads, Center for Water and Sanitation (CWAS), CRDF – CEPT University

At CWAS, our core focus is strengthening water and sanitation services, particularly in response to increasing challenges with climate variability. Climate-resilient water and sanitation services are critical for service continuity, public health and protection of vulnerable communities. In this respect, CWAS has been working with cities and villages of Maharashtra along with state departments to strengthen and scale water, sanitation and waste management services through monitoring, technical support and capacity building.

CWAS gratefully acknowledges the Department of Environment and Climate Change and the Urban Development Department of Government of Maharashtra, for their partnerships over the past decade in advancing climate-responsive water and sanitation strategies. We would also like to thank the city officials who have pioneered and institutionalized these activities within the city systems. The leadership and initiatives of these cities have shaped this guidebook into a practical and replicable resource.

We are grateful to Mr. Abhijit Ghorpade, Director – State Climate Action Cell and Mr. Sudhakar Bobade, Mission Director – Majhi Vasundhara Abhiyan, for their constant support and for enabling CWAS to compile and share these experiences in the form of this guidebook.

We are thankful to our advisors, Dr. Dinesh Mehta and Dr. Meera Mehta, whose insight, strategic direction, and sustained mentorship shaped the programs and initiatives that inform this publication. We also extend our appreciation to the CWAS team members who conceptualised and compiled the content of this guidebook and the team who worked closely with Urban Local Bodies, State departments and communities to facilitate the practical lessons and evidence that underpin this work.

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Moving Towards Climate Resilient Water and Sanitation Services

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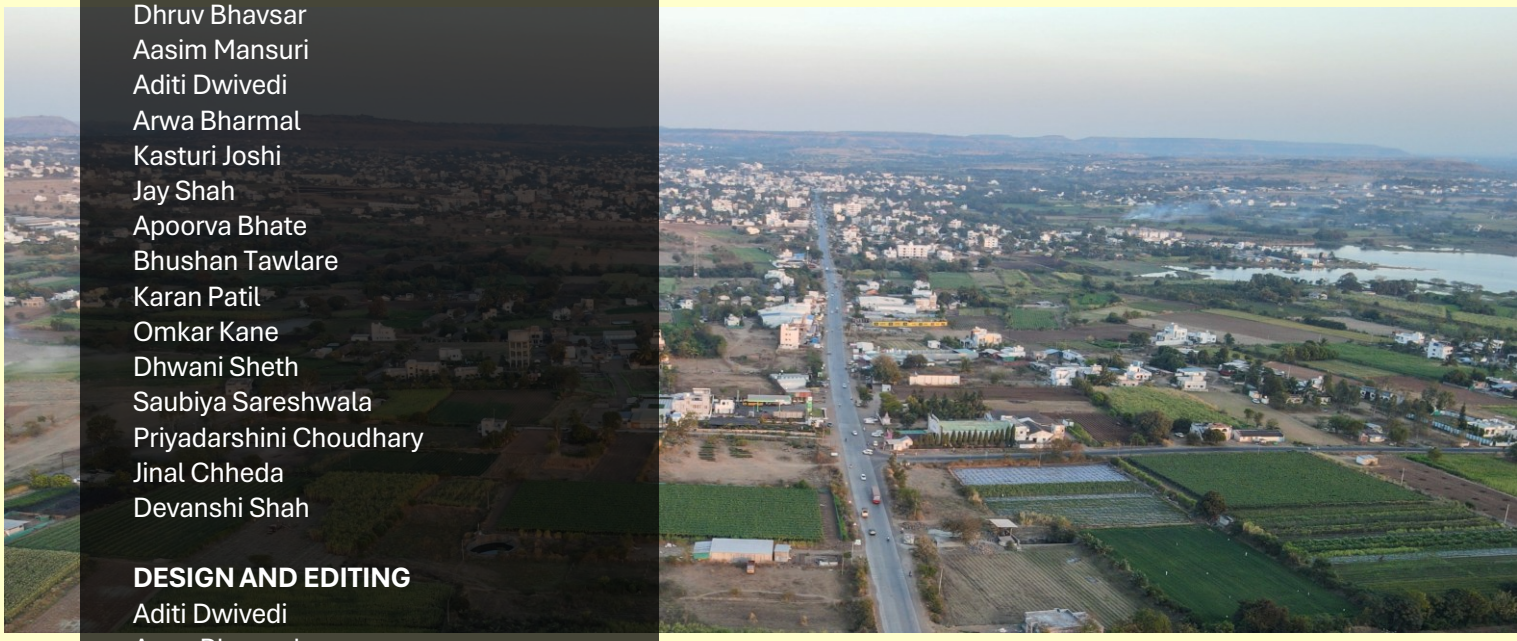

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CONTENTS

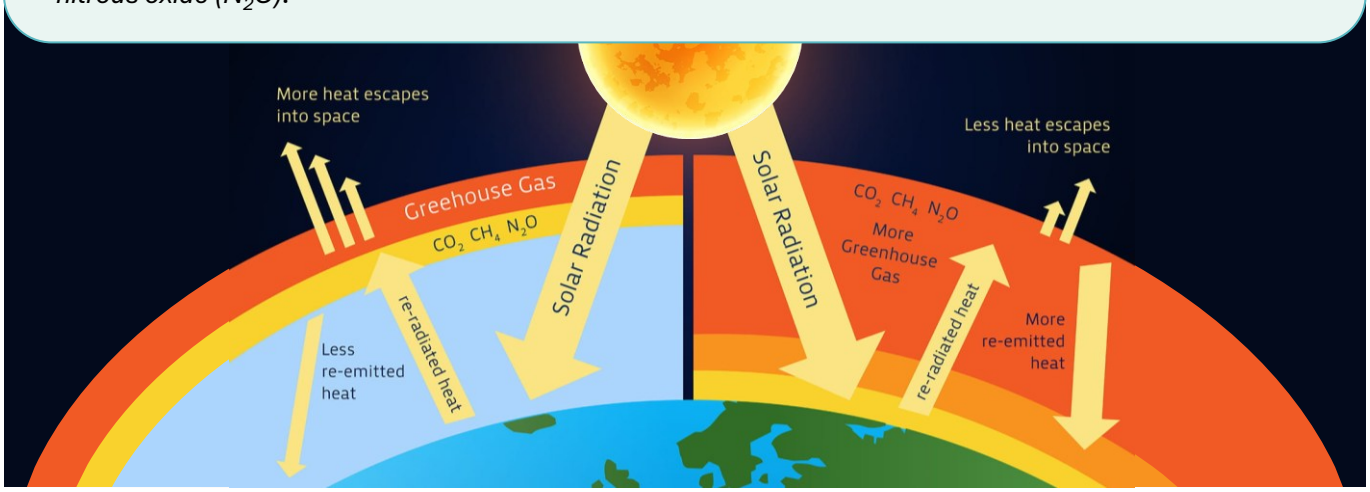
1

Climate Change and Linkages to Water and Sanitation Services

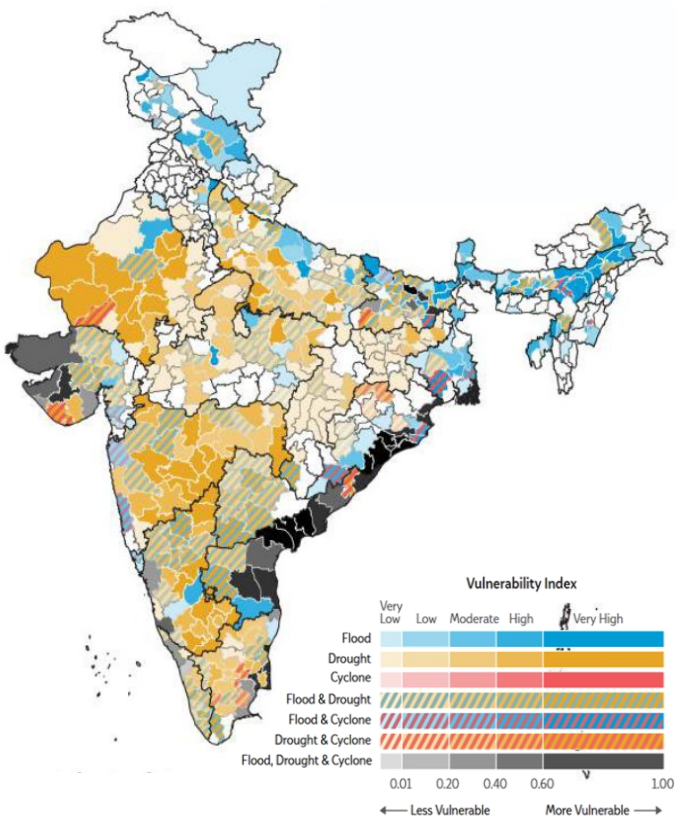
Climate Change *refers to the long-term shifts in temperature and weather patterns.*

Global Warming: *While climate fluctuations have occurred naturally for millions of years, there is evidence the earth is warming up at an unprecedented rate. While such changes have happened naturally in Earth's history, in recent decades, human (*anthropogenic) *activities have been the main driver of accelerated changes in the Earth's climate.*

Greenhouse Effect: *Burning of fossil fuels(like coal, oil, and gas), deforestation, and industrial processes produce gases which trap heat in earth's atmosphere in the same way that glass does in greenhouses. The main greenhouse gases (GHGs) causing climate change include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).*



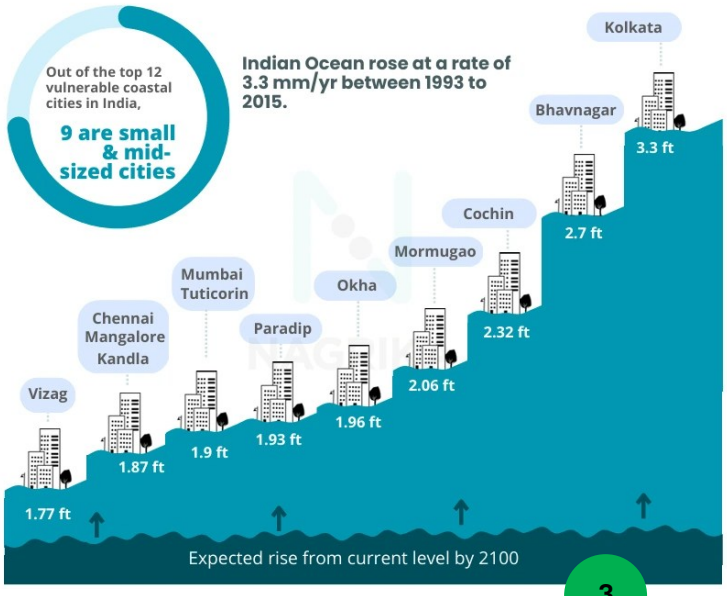
Immediate vulnerability to extreme events



Long term global warming, melting ice caps and sea level rise

Mean sea-level-rise trends along the Indian coasts are about 1.30 mm/yr

Future projections indicate about 0.48 m by 2100 even if global emissions follow a moderate path, roughly consistent with existing commitments by countries.



Carbon: *We often talk about 'carbon' as a shorthand term for* ***carbon dioxide (CO2)****, which is the primary greenhouse gas responsible for climate change. However, it is also used to describe the entire range of greenhouse gases when discussing carbon emissions.*

Green House Gases in context of water and sanitation services

Carbon Dioxide
Produced when fossil fuels or other organic matter is burned

Methane
Produced when decomposition of organic matter in absence of oxygen

Nitrous Oxide
Produced in biological nitrogen conversion processes (sludge digestion, composting) especially in low oxygen

Black Carbon
Although not a gas, it is fine particulate matter ($PM_{2.5}$),released from incomplete burning

Coal based electricity

Landfill conditions

Sewage and sludge digestion

Open burning of waste

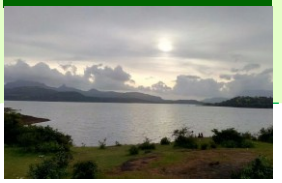
CARBON SOURCES are elements or processes that release GHG gases while functioning and they release more GHG gases than they absorb

CARBON SINKS absorb more GHG gases than they release into the atmosphere while carrying out operations or lifecycles.

Forests

Plants absorb carbon dioxide and convert it into organic matter through photosynthesis

Oceans and lakes



Carbon dioxide dissolves in water and is taken up by aquatic organisms

Soil and wetlands

Soil locks carbon as organic material from decayed plants and animals. In wetlands, slower decomposition further traps carbon

CCuS – Carbon Capture Utilization and Storage Technologies

Emerging technologies in the industrial sector are using chemical and physical processes to trap carbon from being released in the air. These are further utilized in value added products

Types of emissions

Scope 1 (Direct emissions)	Scope 2 (Indirect emissions)	Scope 3 (Linkage emissions)
Emissions generated during operational process directly related to the sector. Example : • Methane emitted during used water treatment process • CO_2 emitted from use of fuel in solid waste trucks during collection	Emissions generated from the production of energy purchased and used. Example : • CO_2 emitted at coal-based power plants for production of electricity used for pumping water and sewage or running treatment plants	Emissions from supply chains, material production and downstream activities. Example: • Emissions during production of pipes used in water network • Emissions during production of cement used in construction of STP

Mitigating carbon

Zero Carbon: *A product or activity, which emits no CO_2 emissions during its use phase, for example, electricity from wind turbines could be called 'zero carbon electricity'.*

Carbon Neutrality: *A carbon neutral footprint is one where the sum of GHG emissions produced is offset by natural carbon sinks and/or carbon credits. The rules around carbon neutrality are less strict than for Net Zero Carbon as they allow to claim neutrality in ways such as buying offsets for avoided emissions, rather than eliminating their own emissions.*

Net-Zero: *Net zero emissions are achieved when emissions of greenhouse gases (GHGs) from human activities to the atmosphere are balanced by anthropogenic removals, meaning withdrawal of GHGs from the atmosphere as a result of deliberate human activities over a specified period.*

Adaptation measures are crucial especially for the water and sanitation sector

Adaptation is the process of adjustment to actual or expected climate and its effects. Climate change intensifies extreme weather events resulting in hotter summers, more frequent heatwaves, unpredictable rains and flash flooding, disrupting human life. Water shortages, groundwater depletion, water contamination and disruption in power, water and sewer networks affect the efficiency of infrastructure. Adaptation is even more important to the vulnerable such as those living in slums who are affected disproportionately. These hazards increase health risks and larger system failures, highlighting the need for disaster risk reduction (DRR) measures for resilient and climate-proof water-sanitation infrastructure.



Water Security - Droughts and pressure on water infrastructure



Human Health – Floods, water contamination and diseases



Operational disruptions – Damage to water sanitation infrastructure

Mitigation measures are equally important for long term sustainability

Climate change mitigation is the process of human intervention to reduce emissions or remove greenhouse gases form the atmosphere. Mitigation measures are technologies, processes or practices that contribute to mitigation. These may include renewable energy technologies, waste minimization processes and improvements for reduction in fossil fuels .

Coal based electricity vs solar for operating treatment plants

Fossil fuel usage vs Electric Vehicles for daily waste collection

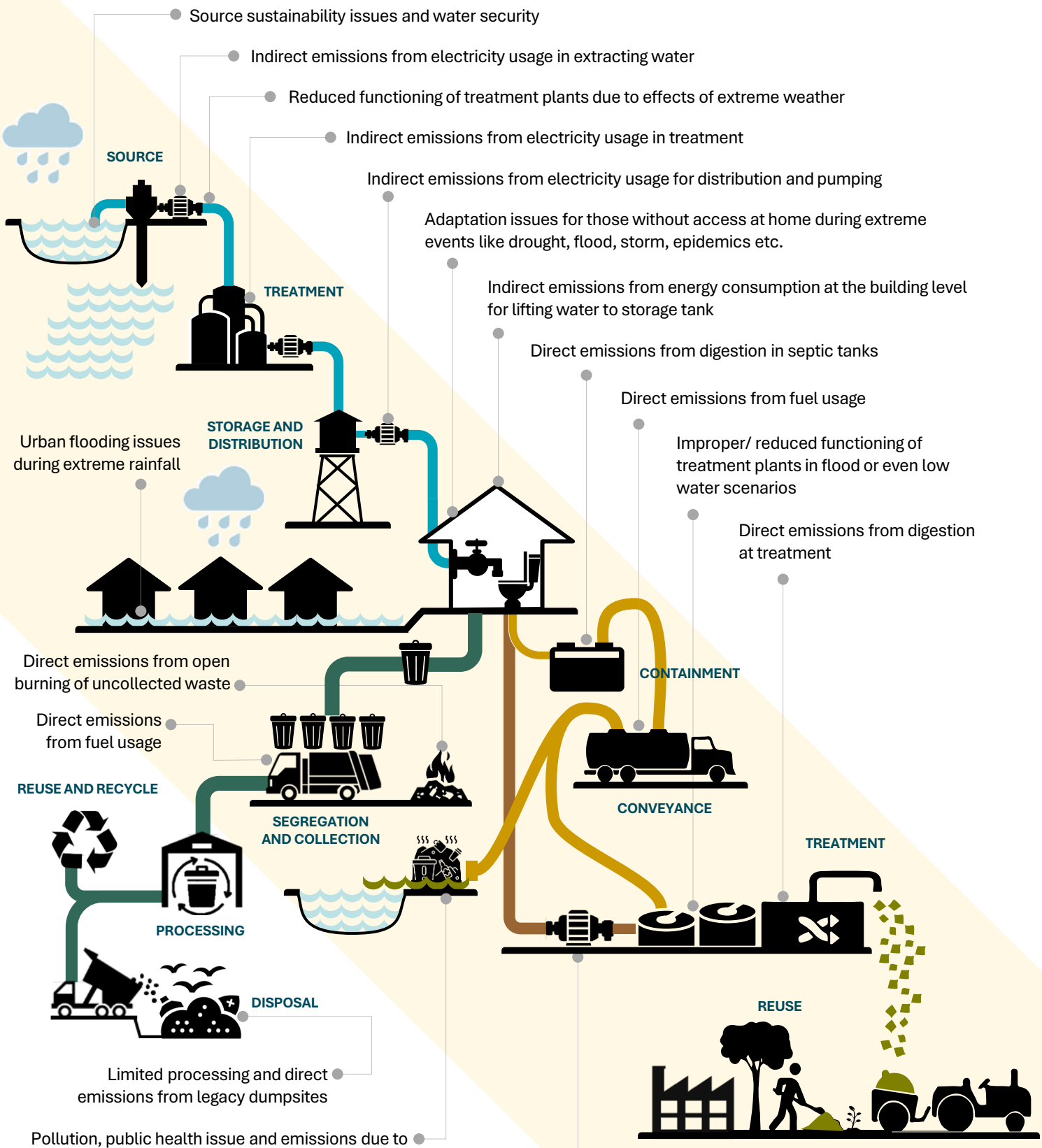
Methane emissions and resource recovery at STP for “Waste to energy”

Landfill emissions and legacy waste management

Water reuse and urban forests as “Carbon Sinks”

Segregation at source to enable recycling and diversion form landfill

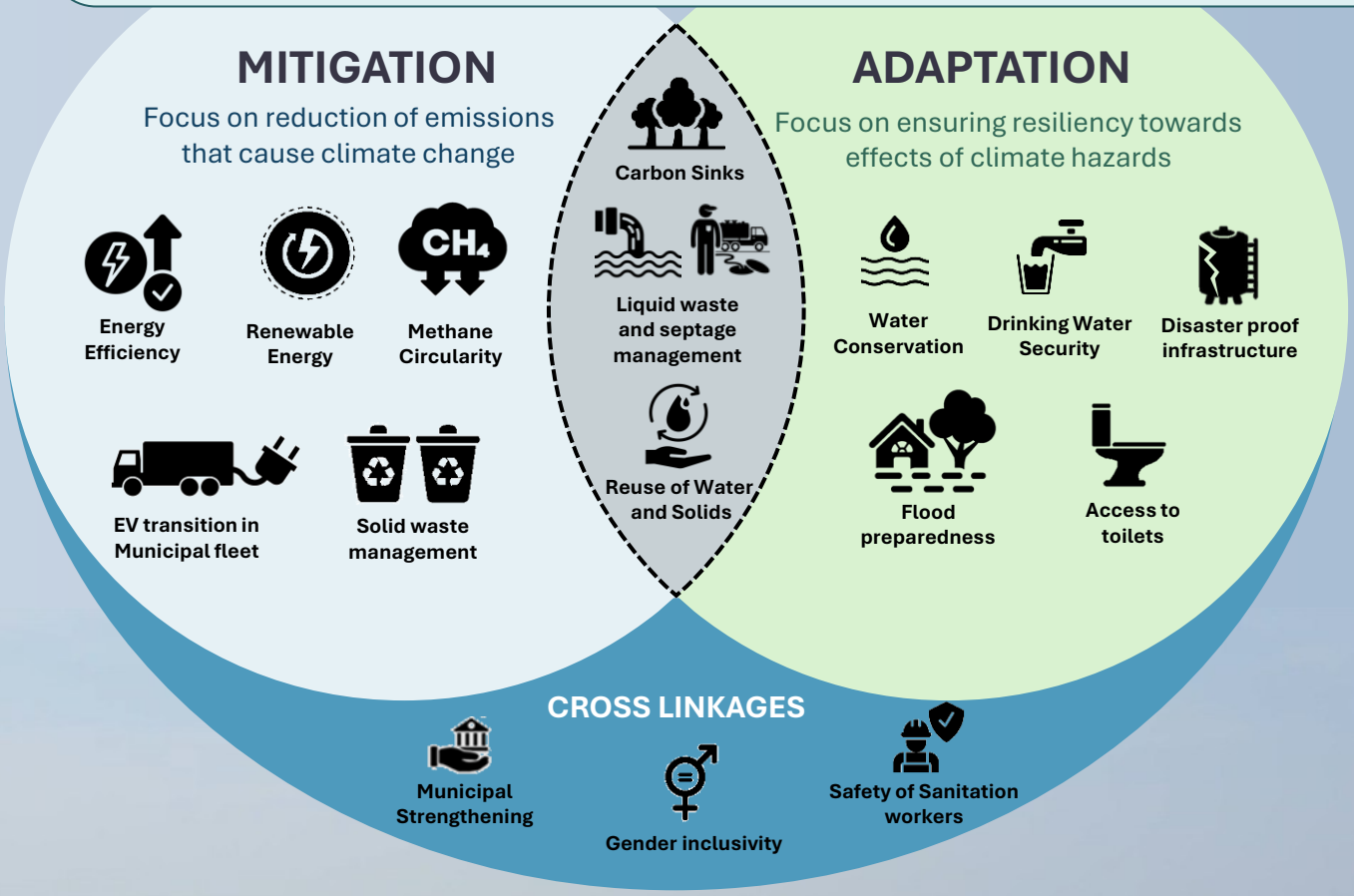
Water and Sanitation Services – Climate Vulnerability, Risks and Impacts



Need for Climate Resilient Water and Sanitation Services

Climate resilient development is a process of implementing greenhouse gas mitigation and adaptation options to support sustainable development for all.

Climate resilient water and sanitation is the capacity of communities and infrastructure systems to anticipate, absorb, and recover from the effects of a potentially hazardous climate event such that essential basic structures and functions are preserved and restored. e.g. Drinking water that is sustained through seasons and extreme events sustaining good water quality.



Climate Change Action – Policy and Programs

Global policy

PARIS CLIMATE AGREEMENT : *A legally binding international treaty was adopted by 196 parties (including India) at COP 21 in Paris, on 12 December 2015. Its goal is to limit global warming to well below 2 degrees Celsius, preferably to 1.5 degrees Celsius; enhance adaptation to its effects, and foster climate finance. Countries submit Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat under the Paris Agreement. These NDCs are updated every five years at the Conference of the Parties (COP).*

SUSTAINABLE DEVELOPMENT GOALS : *The SDGs, Adopted by all UN ,ember nations, address a broader range of social, economic, and environmental challenges. They are designed to be mutually reinforcing, with climate action being crucial for achieving many of the SDGs. The Paris Agreement is directly linked to SDG 13, which focuses on climate action.*

India's Nationally Determined Contributions (2021 – 2030)

1. Promote 'LIFE' movement (Lifestyle for Environment)
2. India will create carbon sink of 2.5-3 billion tons through forest cover by 2030
3. India will bring emission intensity of its GDP down to 45% by 2030
4. India will fulfil 50% of its energy needs through renewables by 2030, leveraging technology transfer & GCF
5. Mobilize domestic & additional funds from developed nations, build capacities to adopt climate friendly path

National Programs launched by Govt. of India to achieve climate resilience

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National Action Plan on Climate Change

8 missions to address climate change concerns & promote sustainable development

- National Solar Mission
- National Mission on Sustainable Habitat
- National Mission for Sustaining the Himalayan Ecosystem
- National Mission for Enhanced Energy Efficiency
- National Water Mission
- National Mission on Strategic Knowledge for Climate Change
- National Mission for a Green India
- National Mission for Sustainable Agriculture

G20 भारत 2023 INDIA

ENERGY IS LIFE BEE CONSERVE IT

उज्ज्वला

PMAY PRADHAN MANTRI AWAAS YOJANA

GRIHA

महात्मा गांधी राष्ट्रीय ग्रामीण रोजगार गारंटी अधिनियम Mahatma Gandhi National Rural Employment Guarantee Act
महात्मा गांधी नरेगा Mahatma Gandhi NREGA
ग्रामीण विकास मंत्रालय, भारत सरकार Ministry of Rural Development, Govt. of India

Wetland Conservation Act (WCA)

SOLAR WATER PUMP

अमृत Atal Mission for Rejuvenation and Urban Transformation

ATAL BHUJAL YOJANA

Smart City MISSION TRANSFORM-NATION

Har Ghar Jal Jeevan Mission

प्रकृति: स्थिति रक्षिता Nature Protects if She is Protected

INTERNATIONAL FOOD SECURITY MISSION

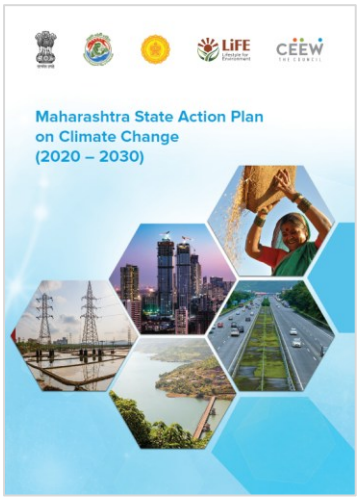
स्वच्छ भारत एक कदम स्वच्छता की ओर

SATAT Sustainable Alternative Towards Affordable Transportation

gobardhan कचरे से कंचन

State Policy - Maharashtra State Action Plan on Climate Change

Maharashtra's State Action Plan on Climate Change (MH SAPCC) is a comprehensive roadmap focusing on resilience, mitigation, and adaptation, targeting multiple sectors and involving district-level plans and initiatives to tackle vulnerabilities like extreme heat and drought. The plan integrates with national goals and promotes green tech, EV adoption, and climate-resilient practices across industries and communities.



Agriculture & Allied Sectors

Water

Rural Development

Tribal Development

Industries

Energy

Disaster Management

Urban Development

Health

Tourism

Transport

Forestry

State Climate Action Cell (SCAC): *To implement the State Action Plan on Climate Change (SAPCC) and other Climate Actions in Maharashtra, a cell is developed at state level. For further strategy and monitoring of activities, climate action cells at district and city levels are being developed.*

Net Zero Emissions pledged by 43 AMRUT Cities by 2050 as part of cities 'Race to Zero' campaign.

City Climate Action Plans developed by Mumbai, Solapur, Nashik and Chhatrapati Sambhaji Nagar.

Net Zero Carbon Roadmap developed for pilots in Amravati, Chandrapur, Nashik, Navi Mumbai, Panvel and Thane

EV policy aims to promote the use of sustainable and clean mobility solutions in and aspires to make Maharashtra top state in the country in adoption of electric vehicles.

Maharashtra Plastic Action Policy Roadmap to promote circularity and waste management.

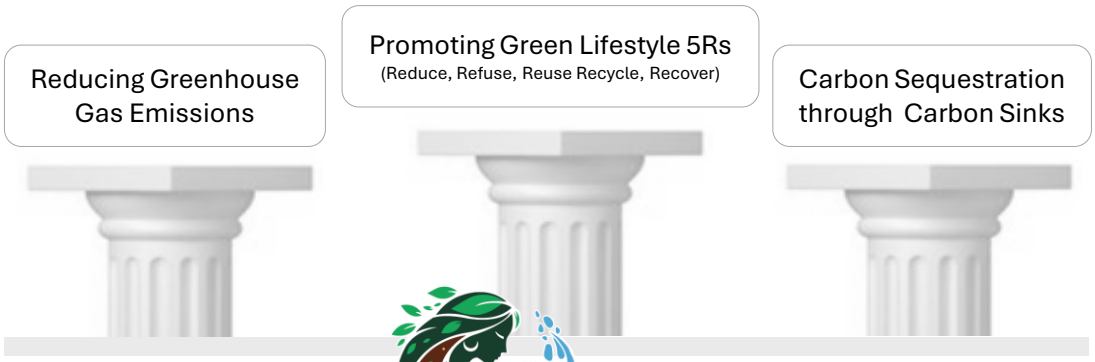
Development of **Climate Finance Access and Mobilization Strategy** for Maharashtra.

Formation of **Bamboo Task Force** to encourage farmers in the state to undertake sustainable bamboo cultivation.

Harit/Green Maharashtra Program has been launched to enhance state's green cover through effective implementation of MGNREGA.

Maharashtra's Majhi Vasundhara Abhiyan (MVA) – My Earth Mission

An initiative by Department of Environment and Climate Change of Government of Maharashtra aiming to make citizens aware of the impacts of climate change and environmental issues, encouraging them to make a conscious effort towards improvement of the environment. .



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Thematic Areas

Green Cover and Biodiversity

1. Promoting plantation of indigenous and climate resilient species.
2. Preservation of heritage trees
3. Development of green areas like "Devrai", "Panchavati", "Miyawaki"

Air Quality

1. Air Quality Monitoring
2. Improving Air Quality
3. Implementation of EV Policy
4. Preparedness for Disaster Management

Transitioning towards Energy Efficiency

1. Promoting Renewable Energy
2. Green Building Initiatives
3. Cool Roofing Solutions
4. Energy Audit of public buildings

Solid Waste Management-

1. Solid Waste Management Rules 2016
2. Plastic Waste Management Rules 2021
3. Biomedical Waste Management Rules 2016
4. E Waste Management Rules 2022

Water Management

1. Conservation of water resources
2. Rain-Water Harvesting
3. Groundwater Recharge
4. Wastewater Reuse
5. Water Efficient Farming
6. Sustainable festivals

Awareness to combat Climate Change

1. Promotion of activities by leveraging social media platforms
2. Participation of Youth, Self Help Groups
3. Educational courses to combat Climate Change

Outcomes of the Abhiyan - 2025

Plantation and Survival of Trees – **293 Lakhs**
Green Areas developed and maintained – **52,497**

3,18,250 2 wheelers
33,192 3 wheelers
22,198 4 wheelers
3,869 E Buses

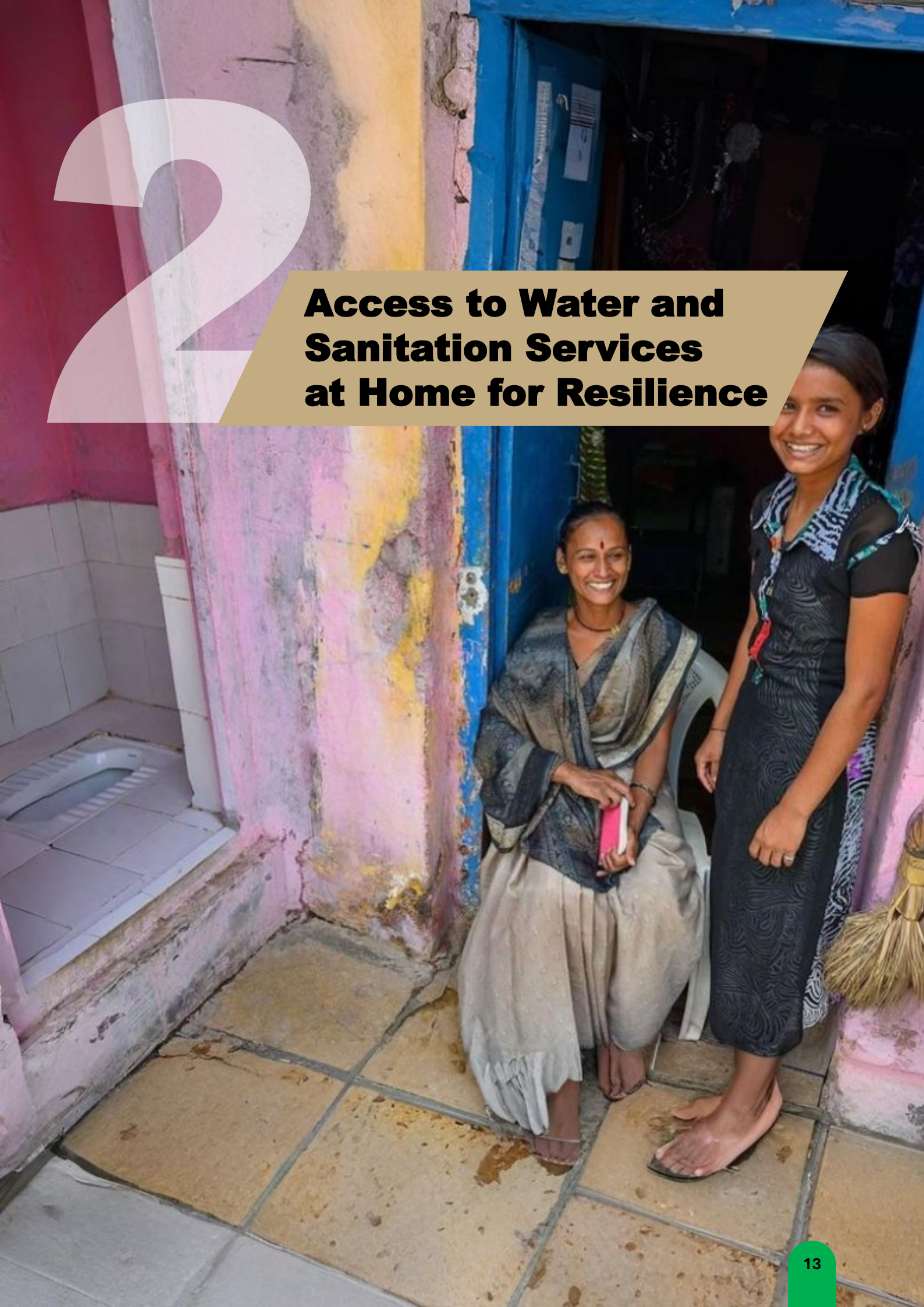
Water conservation potential generated - **228 Cr.m3**
Water percolation pits developed – **28,035**

Green buildings built – **533**
Installed solar capacity – **2,651 MW**

Carbon sequestration through activities under Majhi Vasundhara Abhiyan - **56,50,309 tonnes**

2

Access to Water and Sanitation Services at Home for Resilience



Drinking water from tap at home is adaptation towards climate change!

Access to safe drinking water at home through household tap connections is a critical adaptation measure towards climate change. It reduces the daily burden of fetching water from distant sources, which becomes even more difficult during heatwaves, floods, and extreme weather events. Reliable tap water also lowers dependence on unsafe and contaminated sources that households often turn to during shortages. It eliminates the need to queue for tanker water - an uncertain, time-consuming, and inequitable coping mechanism during climate stress. As climate change increases the frequency of floods, heat stress, and need for water rationing, secure in-house water supply enhances resilience by protecting health, saving time and energy, and enabling households to cope with climate shocks with dignity.

Har Ghar Nal Se Jal: *The AMRUT mission envisages providing water tap connections in all statutory towns through new household tap connections. While significant progress has been made in expanding water infrastructure, more focus is needed towards achieving the goal of universal coverage of water connections. Establishing "Last mile Connectivity" , particularly in slum areas, is key for achieving this.*

Ensuring universal access to water from taps at home

1 Improve city-level network and infrastructure

- Extend existing network to new areas
- Identify and regularize unauthorized connections – this clarifies a realistic picture of coverage
- Include internal supply network for slums in Detailed Project Report (DPR) by mitigating legal barriers
- Consider decentralized mini-piped water supply schemes in "unsupplied" areas, connected to a localized source like borewell

2 Simplify procedure for getting formal connections

- Reduce the number of documents required for new connections and implement single-window system
- Provide both online and offline platform for water connection applications
- Delink land tenure from provision of water supply connections

3 Make connection charges and water tariff affordable

- Spread out connection charge in smaller installments with water tax/bills over time
- Reduce charges for slum households and urban poor
- Exclude additional costs of road cutting and plumbing from the connection fee

Advisory on Last Mile Connectivity for Water Supply - Ministry of Housing and Urban Affairs, Government of India

Pioneering examples

Reduced connection charges for urban poor - Sangli-Miraj-Kupwad charges a nominal fee of Rs100/connection under the "Valmiki Niwas" slum rehabilitation programmes by MHADA. Additional fund was used from 14th finance commission grant, or Ward Development Fund.

Infrastructure augmentation- Parbhani Municipal Corporation, with source augmentation and network expansion under AMRUT, was able to add 25,000 connections and move to daily supply as compared to supply every 15-18 days. All households in slum areas got individual connections.

Toilet access at home is adaptation towards climate change!

Access to a toilet within the home is a critical yet often overlooked adaptation to climate change. As climate impacts intensify, populations dependent on community toilets become more vulnerable, having to travel to these locations through floods and rains in unsafe and undignified conditions. Climate change also acts as a risk multiplier, amplifying frequency and scale of infectious disease outbreaks and creating epidemic or pandemic like situations wherein shared sanitation facilities become sites of crowding and heightened disease transmission. Household toilets ensure continuity of sanitation services during climate shocks and public health emergencies, while also responding to the specific needs of women, children, the elderly and persons with disabilities, for whom distance, queues, safety, privacy and accessibility are major constraints.

Ensuring universal coverage of individual household toilets

1 Ensure supporting infrastructure and and sewerage services

- Extend existing network to new areas
- Identify and regularize unauthorized connections – this clarifies a realistic picture of coverage
- Ensure well-designed septic tanks in places where sewerage is inaccessible.
- In cases of space constraints, enable construction of shared septic tanks

2 Remove legal barriers for enabling toilet construction

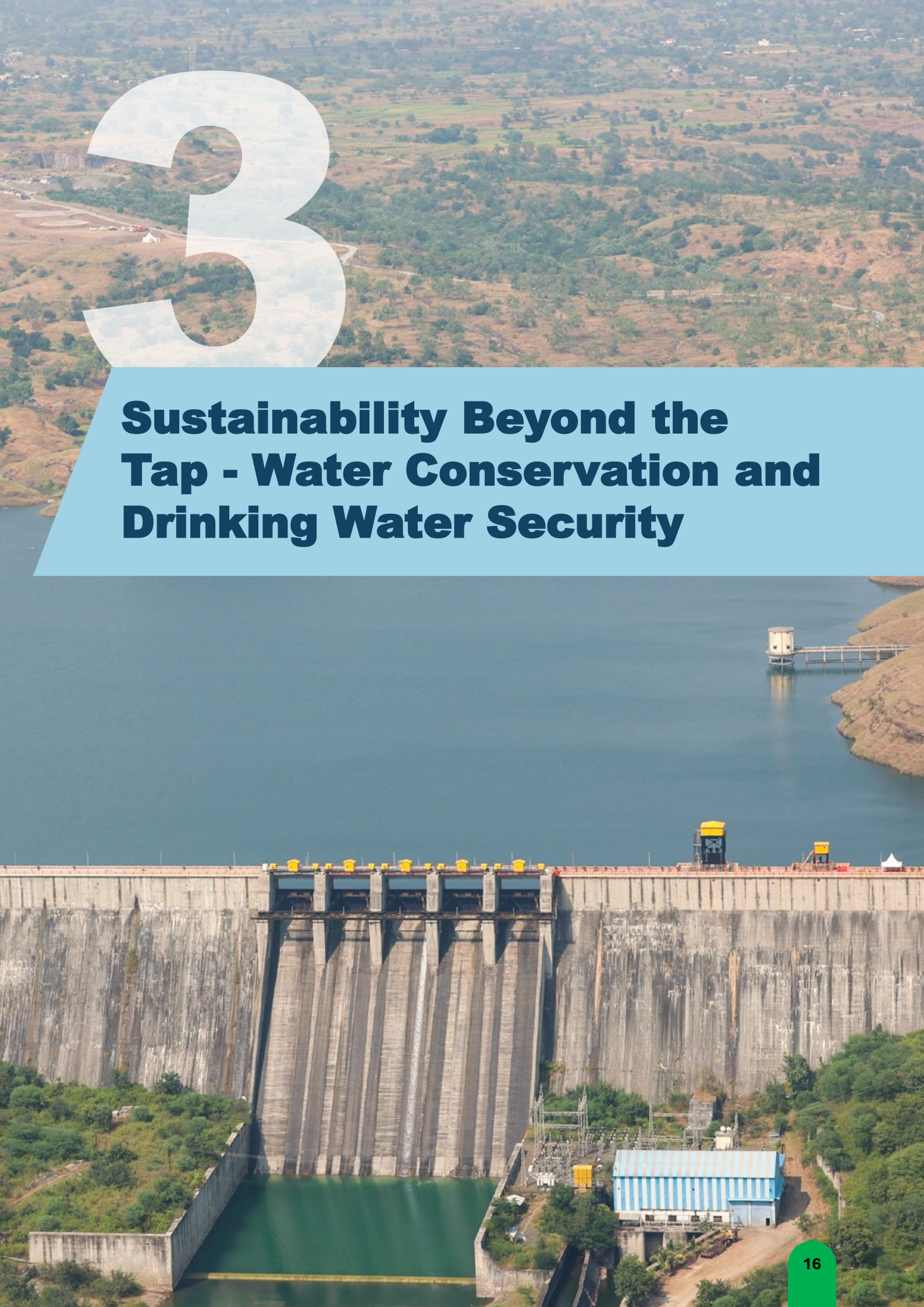
- De-link building permissions from land tenure status of applicants
- Recognize shared toilets – built between a small group of households.
- Fast track approval process by involving community-based groups

3 Overcoming space constraints for construction in dense areas

- Encourage cases of adaptive use of space in dense areas with small dwellings
- Recognize and encourage shared or group toilets – built between a small group of households
- Wherever possible, convert existing community toilets to shared toilets through lock and key model

3

Sustainability Beyond the Tap - Water Conservation and Drinking Water Security



Ensuring source sustainability is critical for achieving long-term water security. With growing demand, depleting groundwater reserves, and climate-induced variability in rainfall, cities must focus on augmenting local water sources, both surface and groundwater, we well as look to scaling alternatives such as rainwater harvesting.

Safeguarding Surface Water Sources

It is imperative to fortify existing surface water sources. Challenges such as diminished rainfall in the distant catchment area, significant evaporation losses, and reduced storage capacity due to silting in reservoirs necessitate prompt and effective management strategies.

Reservoir protection

- Carry out regular desilting to maintain storage capacity and ensure long-term water security and reduce future siltation through upstream check dams and desilting of inflow channels
- Implement technological solutions to control evaporation losses
  - Use of covers or sheets for smaller tanks
  - Floating solar panels to reduce direct radiation and also produce energy
  - Construction of embankments, fences, or vegetative windbreaks to reduce wind speed across the surface
  - Tree belts and aquatic edge vegetation reduce wind velocity and surface heating.
- Regularly monitor physical, chemical, and biological parameters to detect contamination early
- Operate gates and spillways in timely manner to safely manage floods and prevent contamination during extreme rainfall events

Revival of traditional water bodies

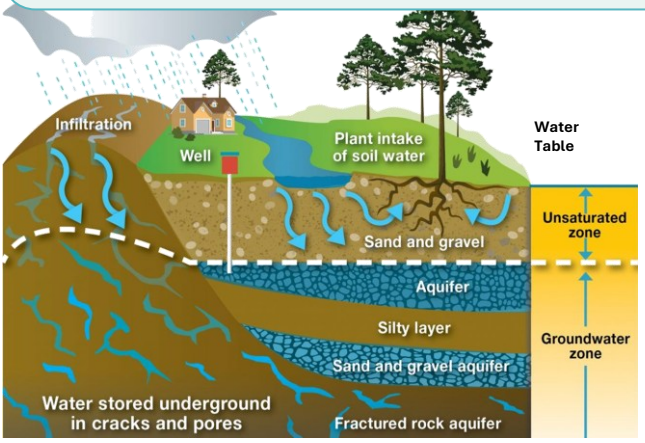
- Identify and map existing and lost water bodies using revenue records, old maps, satellite imagery, and community knowledge.
- Demarcate boundaries, remove encroachments and legally notify the area in local plans
- Repair feeder channels, stormwater inlets and natural streams in catchment area to ensure proper inflow
- Remove accumulated silt and debris to restore original storage capacity, ensuring safe disposal or productive reuse of silt.
- Prevent sewage and solid waste inflow

Pioneering example

Desilting to increase the storage capacity - The desilting of the Khadakwasla Dam represents a collaborative effort led by civil society organisations, with support from volunteers, CSR partners, and military engineering units. Khadakwasla is one of the main sources of water for Pune. However, silt buildup at the bottom of the dam has reduced its holding capacity. Mechanical desilting was done systematically during low-water periods using excavators and tippers, alongside environmentally responsible reuse of excavated silt. The intervention has helped restore live storage capacity, improve water availability during lean seasons, and enhance the dam's ability to buffer extreme rainfall.

Safeguarding Groundwater and Aquifers

Groundwater management *is essential to secure water resources in the face of rapid urbanisation and climate change. As groundwater levels decline, planned management helps through recharge measures and regulated abstraction. In coastal regions, it is vital to reduce saltwater intrusion in groundwater, which threatens freshwater aquifers as sea levels rise and pumping intensifies.*



Aquifer *is a body of porous rock or sediment saturated with groundwater. It acts as a natural buffer during rainfall events by absorbing and storing excess water, reducing urban flooding as well as storing water for the lean season, thus functioning as a key climate change adaptation measure.*

Understanding the geohydrology and aquifer characteristics of city is fundamental to developing sustainable strategies, particularly in water-stressed regions where groundwater serves as a critical resource for municipal supply.

Aquifer Mapping

Surface hydrology

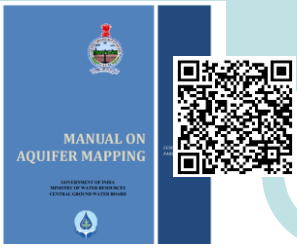
- Landuse analysis - built-up, pervious and impervious areas, water bodies
- Catchment analysis - Contour hydrology to analyze water movement, drainage patterns and storage

Sub-surface hydrology

- Literature study on regional geology
- Litholog analysis to understand stratification - depth, extent, water-bearing potential
- Lineament mapping to understand structural controls influencing water movement - fractures, faults, joints
- Electrical Resistivity tests, if required, to measure subsurface materials, moisture content, porosity, and groundwater salinity

Groundwater

- Well water level monitoring to understand water table
- Pre and post monsoon analysis to observe seasonal fluctuations and recharge response to rainfall events
- Identification of extraction zones
- Quality testing for critical parameters - salinity, fluoride, nitrate, iron, arsenic - to determine drinking suitability, contamination risks and treatment measures



Manual on Aquifer Mapping - Central Ground Water Board

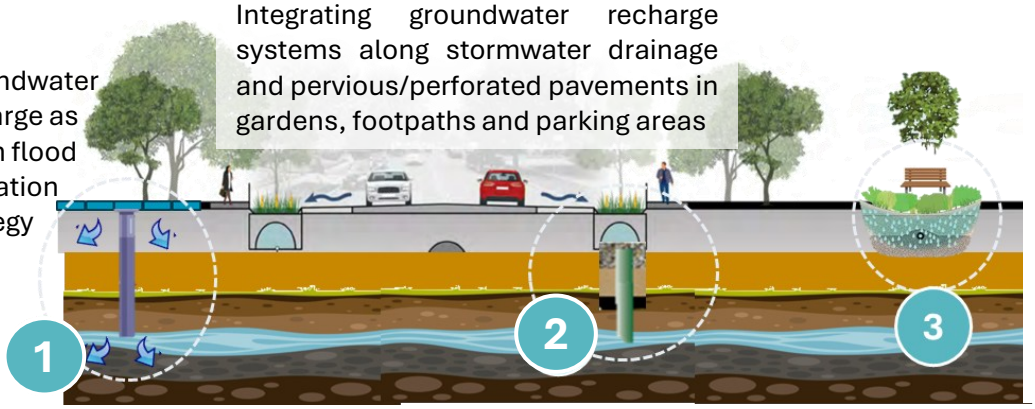
Recommend practices

- Identify recharging and storing water bodies
- Determine sustainable abstraction limits
- Allocate potential recharge zones and suitable techniques

Blue-Green infrastructure for urban groundwater recharge

Groundwater recharge as urban flood mitigation strategy

Integrating groundwater recharge systems along stormwater drainage and pervious/perforated pavements in gardens, footpaths and parking areas



Nature-based solutions such as rain gardens, recharge pits and bio-swales

Artificial recharge solutions such as recharge borewells

Pioneering examples

Pune Municipal Corporation – Established a groundwater cell. Aquifer mapping, monitoring and identification of recharge zones with 1200 locations for recharge structures. Further implemented initiatives at local parks and ponds.

Nagpur Municipal Corporation - Aquifer mapping, identification of 10 locations for shallow aquifer recharge. Cleaning of 460 wells across the city and development of 144 recharge shaft structures along city roads.

Financial Assistance

Funds available under for groundwater recharge and aquifer management

- State grants
- Central level project based grants under Jal Shakti Abhiyan
- City level budgetary allocation

Rainwater Harvesting

Capturing rainwater allows communities to tap one of the purest sources of freshwater, especially valuable in areas where groundwater quality is declining. By storing or recharging rainwater, households and cities can significantly reduce their dependence on energy and cost intensive groundwater pumping - making it both an economically and environmentally sustainable solution. Despite nearly 45% of India's population living under water stress, only about 8% of annual rainfall is currently harvested, resulting in massive runoff losses.

Supporting regulatory environment

Unified Development control and promotion regulations for Maharashtra mandate RWH structures for buildings above 500 sq.m.

RWH structures are one of the priority areas under the Maharashtra State Water Policy - aiming towards ensuring clean water access, building resilience to water scarcity and increasing the quantity of usable water

"Catch the Rain", where it falls, when it falls - National level mission supporting RWH

What can cities do?

Regulation and Mandates

- Developing city level policy for rainwater harvesting structures and enforcement of building bylaws

Implementation

- Setting up RWH cell at city level
- Providing incentive in property tax for uptake of RWH structure
- Linking RWH structures with building permissions and occupancy certificate

Community engagement

- Appointing "Jal Sathi" or water champions and involving NGOs
- Awareness programs and gatherings like Jal mela, Pani Panchayat, competitions and events at schools

Pioneering examples

Greater Mumbai Municipal Corporation – Enforcing RWH mandate for plots > 1000 sq.m. Setting up RWH & water conservation cell, under the Hydraulic Engg. department. Providing incentives for taking up rainwater harvesting initiatives at society level in terms of TDR and tax benefits. Implementation of RWH at all public buildings.

Pune Municipal Corporation - Green Tax initiative providing 10% rebate on property tax.

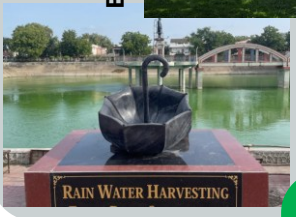
Nagpur Municipal Corporation - RWH committee mandated RWH structure in all public buildings. 5% tax rebate to encourage the RWH uptake.

Amaravati Municipal Corporation - Awareness campaigns around RWH. Streamlining process of obtaining permits for rooftop systems.

RWH Theme parks

Hyderabad

Bangalore



Gandhidham

Water Audit - A scientific method to assess and reduce water losses

Water audit is a systematic process of objectively obtaining a water balance by measuring flow of water from the site of water withdrawal or treatment, through the distribution system and into areas where it is used and finally discharged. Conducting a water audit involves calculating water balance, water use and identifying ways for saving water.

Conducting a Water Audit in your city

Mapping and understanding the water sources and distribution pattern from source to disposal in an entity/city

Assessing the volume and frequency of water supply throughout the service chain to estimate losses

Analysis of monitoring systems, service level benchmarks, billing systems and citizen feedback

In absence of meters, conducting on site bucket surveys at pilot locations and water flow measurements at distribution and junction points

Implementing actions to improve the gaps, water losses and monitoring of efficient water use

Non-Revenue Water (NRW) is the portion of supplied water that does not generate revenue for the city

System Input Volume	Authorized Consumption	Billed Authorized Consumption	Billed Metered Consumption	**Revenue Water**
			Billed Unmetered Consumption	
		Unbilled Authorized Consumption	Unbilled Metered Consumption	**Non-Revenue Water**
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorized Consumption (theft / illegal connections)	
			Metering inaccuracies and data handling errors	
		Real Losses	Leakage on transmission and/or distribution mains	
			Leakage and overflows at utility storage tanks	
			Leakage on service connections up to point of customer metering	

Low efficiency despite adequate supply!

- Inequity in water supply hours leading to over-consumption of water in some zones and inability to achieve standard per capita supply in others
- Poor water pressure in areas with significant topographical differences
- Unaccounted water supply from booster pumps and water theft
- Mismatch in storage capacity and demand
- Distribution systems that cannot adapt to changing supply in summer months

Reduction strategies for NRW

Leakage repairs, maintenance of valves

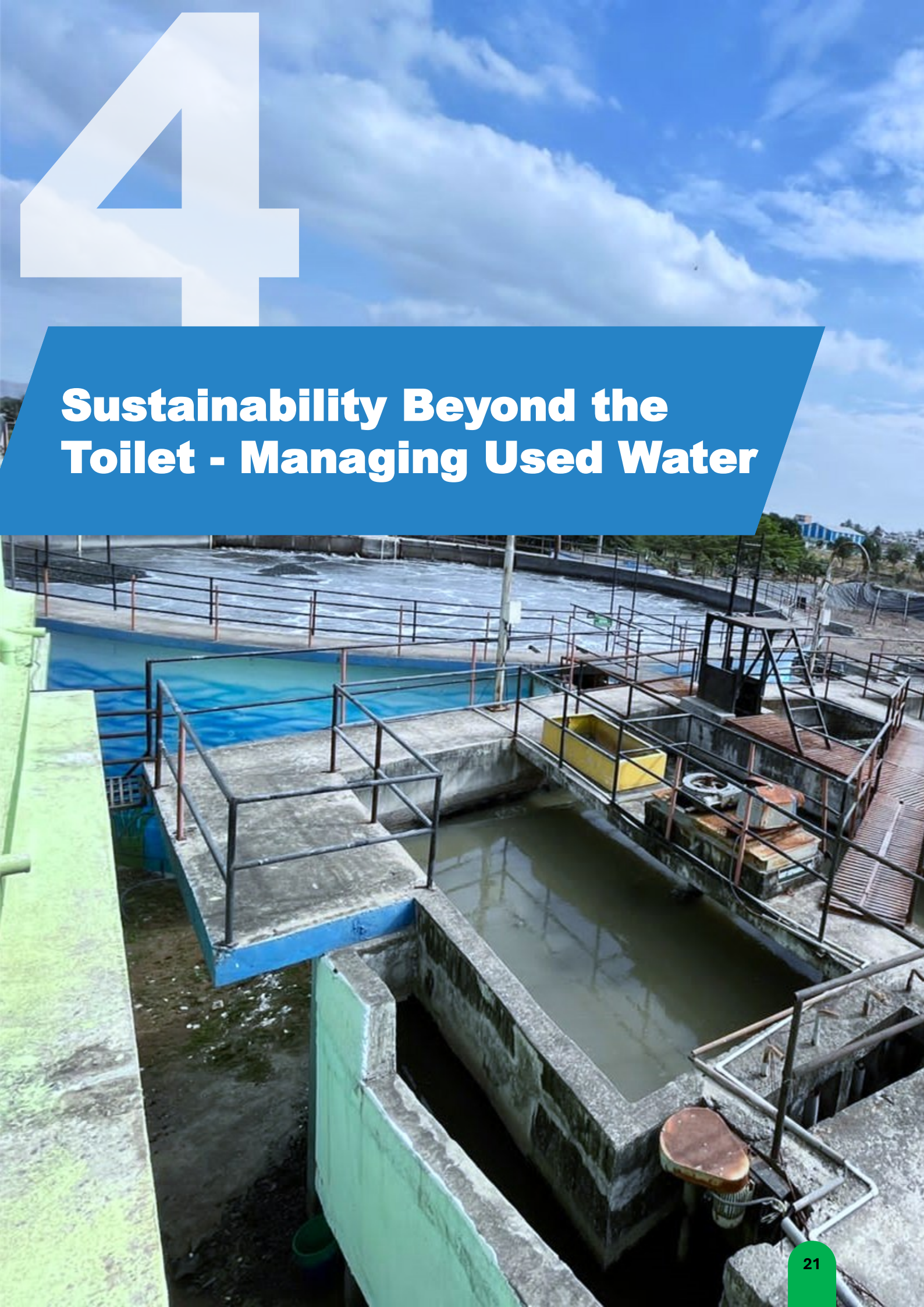
Performance based contract linked with reduction of water losses for maintenance of distribution network

Regularisation of unauthorised connections

Capacity building of waterworks department for utilization of SCADA data and awareness campaigns for consumers regarding water conservation

4

Sustainability Beyond the Toilet - Managing Used Water



Liquid Waste Management

Liquid waste management means safe collection, treatment, and reuse/disposal of used water and sludge. Climate-resilient liquid waste management reduces GHG emissions, conserves water, and protects communities from floods, droughts, and disease outbreaks.

***Sullage/Grey Water**: Used water generated in the kitchen, bathroom, house washing and laundry falls under the category of Grey water. Grey water usually contains pathogens.*
***Storm water:** Heavy rains leading to accumulation of runoff water falls under this category. Safe drainage is essential to prevent water stagnation which leads to waterborne diseases.*
***Black water:** Used water generated or drained out from the toilet is known as "Black water". Black water contains harmful pathogens and needs to be treated before disposal.*

Impacts of improper liquid waste management

Higher GHG emissions


Water body pollution


Public health issues – spread of disease


Groundwater contamination


Impact on aquatic life and crops

Liquid Waste Management Strategies for Sewered Cities

1. **Expand and Optimize Sewers:** Ensure total coverage, plug leakages, extend and maintain networks to unserved areas.
2. **Upgrade Treatment Infrastructure:** Revamp Sewage Treatment Plants with climate friendly, energy efficient technology. Foster "co-treatment" with faecal sludge for greater efficiency.
3. **Mandate Water Reuse:** Promote decentralized treatment with city-wide targets for recycling treated water in non-potable uses like gardening, industry, and construction.
4. **Routine Operation and Maintenance:** Regular checks for leakages and blockages, daily monitoring of pumping operations, ensure safety and backups.
5. **Monitoring and Reporting:** Monthly reporting to pollution control board authority and maintaining digital dashboards for effective supervision.

Liquid Waste Management Strategies for Non-Sewered Cities

1. **Decentralized Solutions:** Promote DEWATS such as Faecal Sludge Treatment Plants, with mapping of containment units and scheduled desludging.
2. **Safe Faecal Sludge and Black Water Collection:** Prevent mixing of stormwater with grey and black water and adhere to all safety procedures and protocols.
3. **Community Engagement:** Engage Self Help Groups and private agencies for collection and maintenance, while running public awareness campaigns on periodic cleaning and safe practices.
4. **Routine Operations:** Maintenance of data log quantity and disposal location for accountability
5. **Climate Smart Delivery:** Ensure affordable, cost-recovered services by leveraging government incentives and promoting local reuse of treated water.

Setting up a treatment plant

Selecting Appropriate System: Assess system based on the probability of sewage network and connectivity for all properties.

- **Centralized system** – Best suited for larger towns with sewer networks enabling centralized sewage collection and treatment.
- **Decentralized system** – Suitable for small towns with near-source treatment integrated into existing onsite systems.

Land Availability: Identify potential land for treatment facilities in the development plans or at the downstream part of the city. Incase land not available, feasibility of co-treatment at nearby cities.

Treatment Technology : This is based on conveyance system in the city, available land area, discharge quality requirements, process time, energy demand, GHG emissions, resource recovery and sewage load characteristics.

- **Nature-based treatment facility:** Uses natural processes such as wetlands, soil, and vegetation to treat used water sustainably.
- **Tech-based treatment facility:** Relies on engineered systems and advanced technologies to treat used water efficiently.

Financial and Operational Model: Based on resource availability ensuring long-term sustainability through viable cost recovery, efficient operations, and inclusive stakeholder participation. PPP based O&M involving SHGs can be preferred.

Forward and Backward Linkages : Safely treated liquid waste reused for agriculture, industry, or groundwater recharge. Efficient collection, conveyance, and treatment systems ensuring minimal leakage and pollution.

Routine Maintenance Checklists

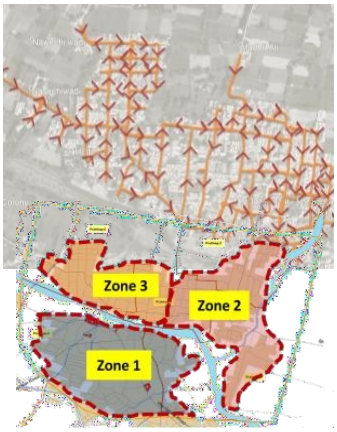
Daily Check	Sewered Cities	Non-Sewered Cities
Network Blockages	Inspect for choke/overflow	Inspect septic tanks/pits
Manholes	Secure, only authorized opening	
Pump Stations	Monitor levels, test pumps/alarms	
Black Water Handling	Direct to STP, no mixing	Safely collect, direct to FSTP
Data Recording	Digital dashboard/log	GPS log of collections
Public Awareness	Notices, campaigns	Outreach, engagement

Managing faecal waste with Scheduled Desludging of septic tanks

Typically, septic tanks are emptied only when they are completely full and begin to overflow. Long gaps between desludging reduce the efficiency of septic and result in deteriorating effluent quality, increasing environmental and public health risks especially during monsoons, including a higher likelihood of manual scavenging. CPHEEO suggests emptying at least once in two - three years.

Scheduled desludging *addresses these challenges by shifting from a complaint-based, demand-driven system to a regular, service-oriented approach. Under this, all septic tanks in the city are covered through a planned three-year schedule ensuring universal coverage, operational efficiency and improved regulation.*

Implementing a scheduled desludging service in your city



Creating Schedule

- Divide city into zones to be covered each year
- Create route map for each zone, going street by street
- Use property tax data or a citywide household survey to create a database on toilets and septic tanks – ensure each property is covered

Calculate resource requirements

- Calculate requirement of trucks and daily trips based on number to septic tanks and average yield from each emptying
- If required, implement a tendering process to onboard a service provider
- Set regulations, penalties and payment terms in place

Prepare property owners to receive service

- Inform households in advance before their service turn
- Provide masons, if required, to support citizens in keeping their access covers open in advance
- Conduct awareness campaigns to ensure active participation of citizens

Ensure efficient services

- Prepare with long pipes, additional pumps to reach inner city areas
- Monitor truck movement and ensure that daily desludging targets are met and that sludge is safely disposed

Climate benefits

- Safeguard against environmental contamination and disease outbreak during heavy rains and floods
- Reduced methane emissions reported in academic studies from regularly desludged septic tanks
- "Access to all" model safeguards the vulnerable in crisis conditions. Safety of san-workers from unsafe manual labour risks that often worsen during emergencies

Pioneering example

Wai and Sinnar Municipal Councils are the first cities in India to implement scheduled desludging of septic tanks. Innovations demonstrated by these cities such as sanitation tax, performance-based contracts and financial model , escrow mechanisms for payments and digital monitoring of service have led to success of the initiative which has achieved a 90%+ acceptance rate from HHs. Sanitation workers now wear safety gear regularly, households pay sanitation tax instead of high user charges for desludging and in Wai one full cycle was completed with the city covering all properties.

Resource Recovery Opportunities for Used Water

By-products can be reused across multiple sectors, categorized as on-site or off-site based on parametric assessment. Large-quantity by-products can be strategically utilized to enhance resource efficiency, climate resilience, and disaster preparedness.

Typical reuse practices in Maharashtra

Sale of dried sludge for farming

Treated water for developing urban forest

Other potential uses

Liquid component (Treated wastewater)

- Reduce freshwater demand; water security in droughts: Reuse of water
- Renewable energy back up: produce electricity using steam production
- Resilient agriculture: Nutrient recovery like nitrogen and phosphorus from used water residue
- Green hydrogen through electrolysis of treated used water

Solid component (Treated sludge)

- Healthy soil; climate smart farming: Fertilizer through processed sludge
- Improved land fertility: Biochar by sludge pyrolysis for land application
- Resource security: Phosphorus, nitrogen, other nutrient and volatile fatty acids recovery for usage
- Circular economy: Sludge-based pellets, eco-construction and bioplastics

Planning for reuse of by-products in your city

✓ Prepare reuse action plans, prioritizing non-potable uses (e.g. construction, fire extinguisher, etc) to reduce freshwater demand and strengthen climate resilience.

- Understand quantity and quality of by-products generated for applicability
- Conduct lab testing of Samples and ensure within quality permissible limits as per MPCB

✓ Prepare financial model – capital costs, revenue model, O&M costs – Successful projects in Maharashtra highlight the potential to scale reuse across cities with financially viable models for end-users.

✓ Consider user perspectives - Human contact and acceptance rate, Demand for products

✓ Reuse planning should align with sanitation infrastructure

- Land and infrastructure availability
- Conveyance options and distance to end-users

✓ Effective reuse depends on stakeholder participation, inter-departmental coordination, and a supportive legal framework to unlock resource recovery potential

✓ Continuous quality monitoring and capacity-building programs are essential for safe reuse and enhanced disaster preparedness.

Market potential of treated used water

By-products can be reused across multiple sectors, categorized as on-site or off-site based on parametric assessment. Large-quantity by-products can be strategically utilized to enhance resource efficiency, climate resilience, and disaster preparedness.

Industrial Reuse

- Cooling Towers
- Data centers
- Chemical manufacturing
- Textile industries
- Automobile industry

Agricultural Reuse

- Irrigation
- Fertilizer substitute
- Horticulture
- Fisheries

Ecological Reuse

- Gardening and landscaping
- Groundwater recharge
- Water bodies recharge
- Green space development

Civic Reuse

- Railways
- Construction
- CT and PT cleaning
- Fire Dept.
- Others

Maharashtra's Safe Reuse & Management of Treated Wastewater Policy, 2025

1. Mandatory reuse of treated wastewater: Processing and reuse of treated used water for non-potable purposes - industrial cooling, urban services (e.g., gardening, vehicle washing, firefighting) and agricultural irrigation.
2. Priority order for reuse applications: Treated water is to be allocated first to thermal power plants, then to industries and industrial estates, followed by urban uses and agricultural irrigation.

Awareness and Market Creation for reuse products: To encourage **climate-resilient practices by** reuse of by-products, free samples can be provided to farmers for testing, while awareness campaigns via social media and videos. ULBs should maintain usage records and collaborate with the agriculture department for research-backed benefits promoting climate smart agriculture. Engagement with industrial and builder associations can expand safe water reuse across sectors, use of resilient materials enhancing **disaster preparedness** and **resource security.**

Pioneering examples

Nagpur Municipal Corporation – 90% reuse with tertiary-treated sewage supplied to nearby thermal power plants through tie-ups with Maharashtra State Power Generation Company (MAHAGENCO) and private operators.

Resue of treated water from FSTP for developing urban forests at Vita, Wai, Sinnar, Satara, Karad, Ichalkaranji - Urban forests located near FSTP, nurtured with treated water from FSTP.

5

Carbon Circularity and Carbon Sinks

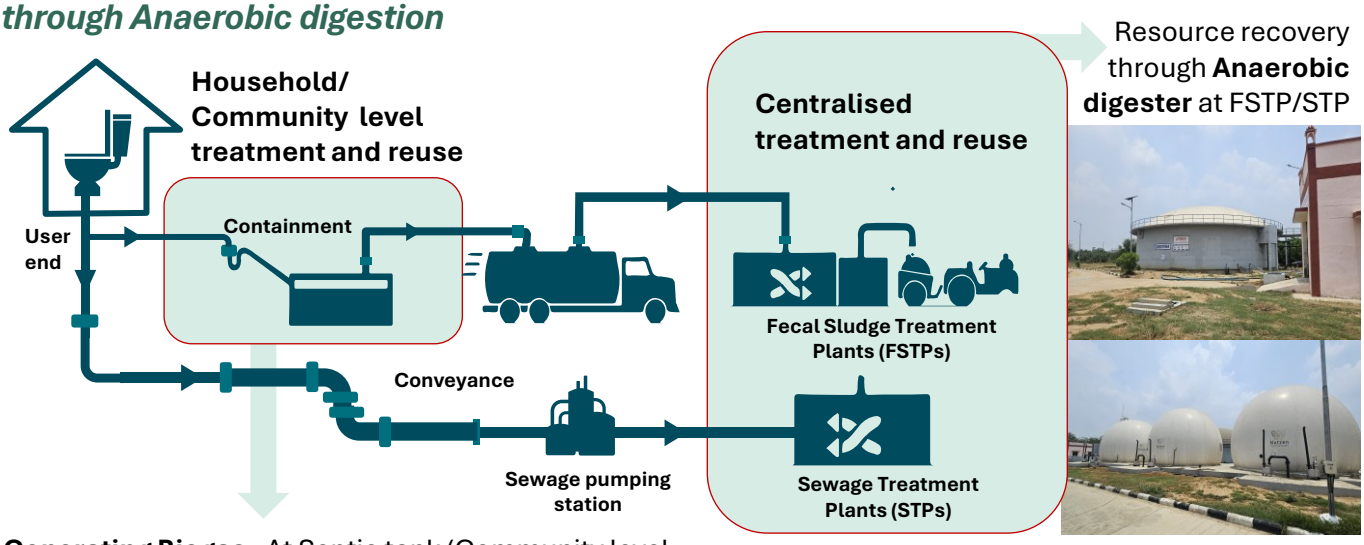
Methane as a Resource

Methane, a by-product of sewage and sludge treatment, presents a valuable opportunity in building climate-resilient water and sanitation systems. Harnessing this gas not only reduces greenhouse gas emissions but also enables energy recovery, contributing to circular carbon economy goals.

Sewage, released into the environment with little or no treatment emits methane. Domestic used water is the largest waste-sector GHG emission source (49.3%), followed by industrial wastewater (41.5%) and municipal solid waste (9.2%). Additionally, Methane(CH4) accounts for 83.8% of waste-sector GHG emissions, with remaining from nitrous oxide (N2O)

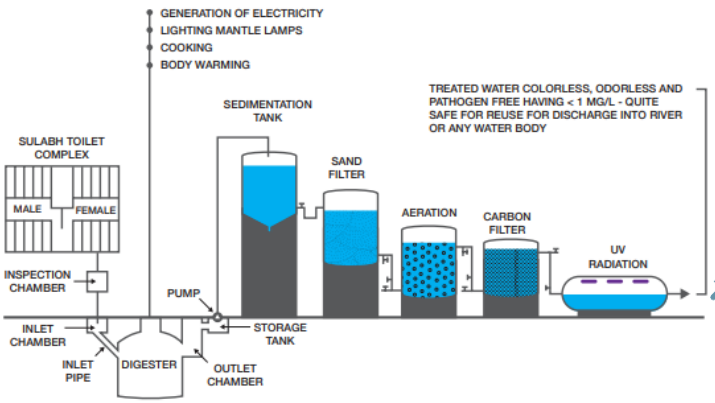
Methane from sewage and sludge is both a potent greenhouse gas and a reliable local energy resource. Capturing and using it (biogas / renewable natural gas) reduces emissions, offsets energy costs of treatment, and supports circular-carbon sanitation systems.

Potential to capture methane across sanitation service chain- Biogas generation through Anaerobic digestion



Generating Biogas– At Septic tank (Community level and Household)-Sulabh model

- ✓ Capturing the household/community level methane gas generated from pit and using it as cooking fuel
- ✓ By product can be reused at farmland or dumped in the open as it will not emit more methane



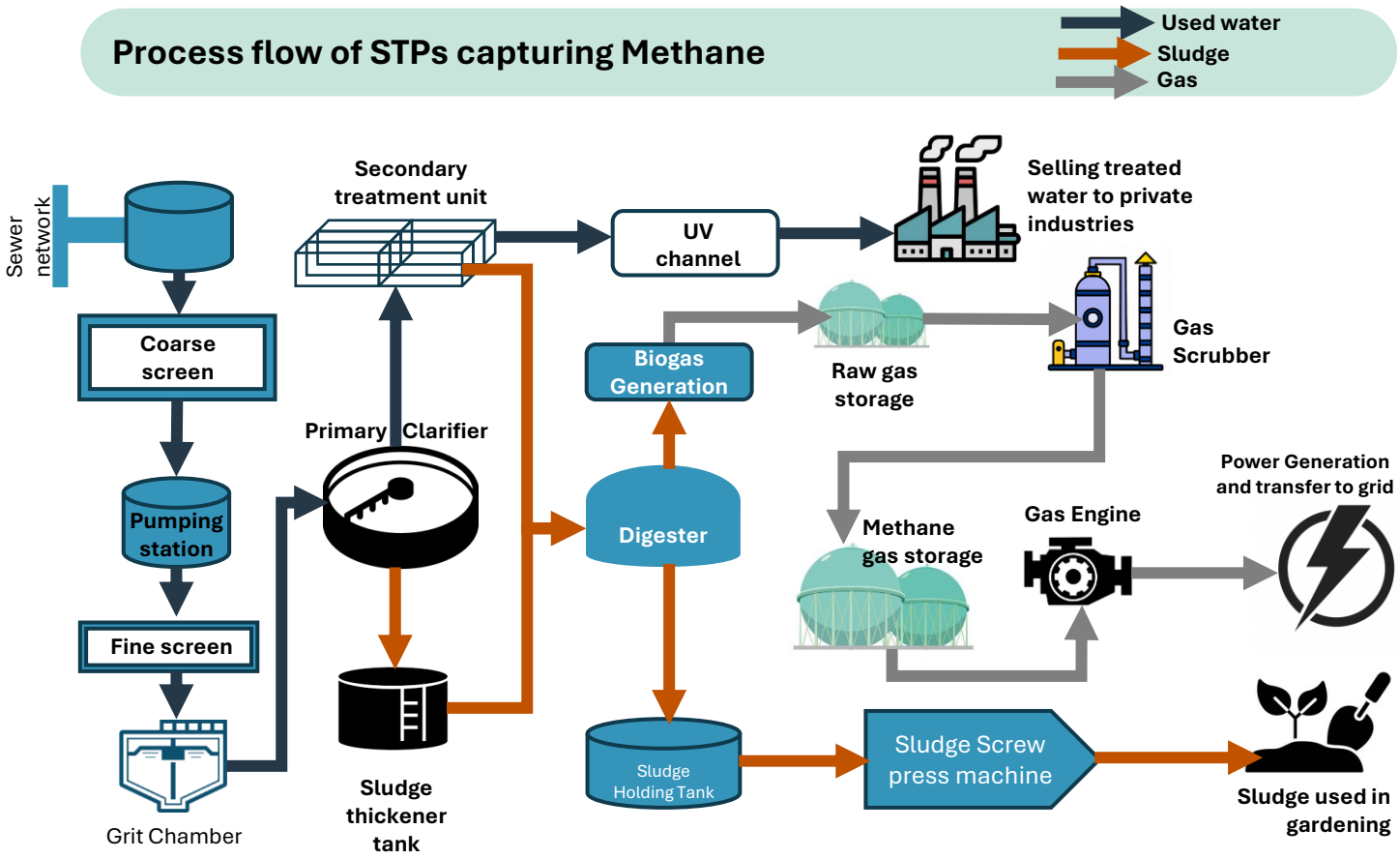
- ✓ Enhancing the sludge management process and incorporating the digestor unit for capturing the methane at STP/FSTP
- ✓ Convert methane into energy through Anaerobic digestion and reuse as per the market potential
- ✓ Adding different feedstock / shredded organic solid waste to enhance the gas generation

Generated electricity can be reused at STP – reduce dependency on power from grid

Selling of generated gas to private player for energy generation- CNG, PNG is more viable than electricity generation at STP

In financial models, payback period of STP with Anaerobic digester is less than STP with solar panels used for electricity generation

Process flow of STPs capturing Methane



Sludge from primary treatment unit and secondary treatment unit should be taken to digesters

Involving private operator for operation - Risk assessment and Penalty clauses

Input water quality - COD and TSS value- should be suitable to generated envisaged gas

Pioneering examples

The Delawas Sewage Treatment Plant (STP) in Jaipur is a notable example of energy recovery from used water through methane capture. The 215 MLD, SBR-based treatment plant harnesses biogas generated during the anaerobic treatment of sewage sludge, capturing methane that would otherwise be released into the atmosphere as a potent greenhouse gas. This raw gas is partially used to generate electricity for in-plant operations recovering~43% O&M cost and reducing dependence on grid power. The rest is sold to a private CNG company generating more revenue.

The Tapovan Sewage Treatment Plant (STP) in Nashik is another example of climate-smart used water management through methane capture and energy recovery. The 78+52 MLD plant based on UASB technology capture biogas produced during sludge digestion and uses the methane to generate electricity, meeting a part of its internal energy demand. This reduces reliance on external power, lowers operational costs, and prevents the release of methane into the atmosphere.

Urban Forests as Carbon Sinks

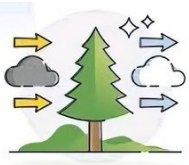
Urban forests are green infrastructure in an urban landscape. They function as vital carbon sinks by absorbing carbon dioxide from the atmosphere and storing it in trees, soils and biomass, helping cities mitigate climate change. Through photosynthesis, urban trees sequester carbon while also reducing ambient temperatures, lowering energy demand for cooling, improving air quality and providing aesthetic value. Beyond carbon storage, urban forests enhance climate resilience by managing stormwater runoff, reducing urban heat island effects, and improving biodiversity. When planned and maintained at scale, urban forests become a low-cost, nature-based solution that delivers long-term climate, environmental, and public health benefits for cities.

Swachh Bharat Mission 2.0 and Maharashtra reuse policy suggest reuse of treated used water for non-potable purposes such as watering gardens and for urban forests

Cools the air

Mitigates climate change

Increases biodiversity



Filters for Urban pollutants

Regulates water flow and improves water quality

Steps for developing an urban forest in your city

1

Selection of Land for plantation

- ✓ Land adjacent to Grey water /Fecal sludge/Sewer treatment plant or erstwhile solid waste dumping grounds should be preferred.
- ✓ Easy access to treated used water/other sources of water.
- ✓ Accessible for development and maintenance.

2

Identifying the source of finance

- ✓ ULB to finalise the sources of financing: Own revenues, CSR funds, FC funds, MVA price money etc.

3

Getting necessary approvals

- ✓ Approvals from respective departments of the ULB for using the selected land for development of urban forest
- ✓ Approval from GB /Chief officer through a resolution

4

Selection of type of Urban forest to be developed

- ✓ ULB, in consultation with garden department, to decide the type of urban forest to be developed: Ghanvan/Devrai/Miyawaki forest etc.

5

Selection of agency for implementation and O&M

- ✓ Agency for implementation : ULB's own staff or private contractor.
- ✓ Develop and float tender in case private consultant is to be engaged.
- ✓ Preference to be given to women's SHG for O&M of urban forest

Selection of species for Urban forest

- ✓ Prioritize native species or those that are climate-resilient to support local biodiversity
- ✓ Non-fruit-bearing and non-edible trees should be prioritized for the urban forests being developed using treated used water.

Southern Tropical Semi – Evergreen Trees	Southern Tropical Moist Deciduous Trees	Southern Tropical Thorn Trees
1. *Terminalia paniculata* (Kinjal)	1. *Tectona grandis* (Teak)	1. *Acacia arabica* (Babul)
2. *Memocylon umbellatum* (Anjani)	2. *Terminalia tomentosa* (Ain)	2. *Acacia leucophleca* (Hiwar)
3. *Terminalia chebula* (Hirda)	3. *Delbergia latifolia* (Shisham)	3. *Butea monosperna* (Palas)
4. *Actinodaphne hookeri* (Pisa) etc.	4. *Adina cardifolia* (Haldu) etc.	4. *Belanites rexburghii* (Hinganbet)

Note: This list is not exhaustive, more names are available at https://mahaforest.gov.in/writereaddata/act_rule_file/14087811382A%2002%20MFR%202014.pdf

As a part of **National Bamboo Mission**, ULBs are encouraged to plant Bamboo trees in large scale.

Local bodies can also plant species recommended by National Bamboo Mission: https://nbm.da.gov.in/Bamboo-Species

1. *Bambusa tulda*
2. *Dendrocalamus brandisii*
3. *Bambusa balcoa*
4. *Dendrocalamus stocksii*
5. *Dendrocalamus strictus* etc.

Pioneering example

Urban forests at FSTPs of Wai and Sinnar

Wai and Sinnar, two medium-sized towns in Maharashtra, have been treating the fecal sludge collected from septic tanks at their dedicated Fecal Sludge Treatment Plants (FSTPs) for the past eight years. To efficiently reuse the treated usedwater and septage, the Wai and Sinnar Municipal Council have developed gardens and urban forests near the FSTPs, spread over 4,000 m^2 and 8,000 m^2 respectively.

So far, over 20 million litres of treated wastewater in Sinnar and more than 26 million litres in Wai have been reused to maintain these green spaces. The urban forest in Wai has been developed using the Miyawaki method. Around 1400 trees have been planted across the gardens and urban forests in both cities. The tree varieties include Black Ficus, Neem, Bamboo, Bakul, as well as fruit-bearing species such as Coconut, Guava, Jamun etc.

Together, the urban forests have sequestered around 123 tons of CO_2 and contributed to enhancing local biodiversity. What was once barren land has now transformed into lush green areas with trees as tall as five meters. Both cities have engaged local women's Self-Help Groups (SHGs) to maintain the gardens and forests, providing them with opportunities for sustainable and dignified livelihoods




Disaster Risk Reduction – Flood Preparedness and Climate Proofing Infrastructure

6

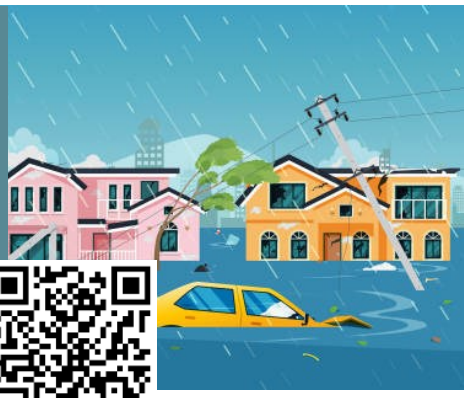
Urban Flooding and Preparedness

Urban flooding is an increasing challenge for cities and towns in Maharashtra due to intense rainfall events, inadequate drainage capacity, encroachments on natural drains and climate change impacts. Floods disrupt water supply, sanitation services and significantly increase public health risks. Urban Local Bodies play a critical role in preparedness, response and recovery, especially from a water and sanitation perspective.

India's Disaster Management Act (DM Act, 2005) mandates a structured disaster risk management system with National, State and District authorities. NDMA lays down disaster management policies & guidelines, and SDMAs adapt them to state context. ULBs must align local disaster preparedness with state & national plans.

*The **National Disaster Management Plan 2016** guides recovery and rehabilitation, addressing asset vulnerability and ensuring minimum service standards during outbreaks and climate disasters.*

https://sdma.maharashtra.gov.in/en/national-disaster-management-plan-ndmp-2019



Disaster Risk Reduction

Step 1
Understanding disaster risk
(Vulnerability, hazard characteristics)

Step 2
Strengthening disaster risk governance
(at all levels national, state, city fostering collaborations)

Step 3
Investing for resilience
(public and private investments to enhance the economic, social, health and cultural resilience of community

Step 4
Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction

Actions for flood proofing communities

Pre-Monsoon Preparedness

Sewer, Access Hole & Nalla Cleaning

Before monsoon (typically April–May), ULBs must schedule and complete Ward-wise pre-monsoon cleaning calendar:

- Cleaning and desilting of sewers, culverts, drains and nalla networks
- Inspection and repair of access holes
- Removal of debris and encroachments blocking urban drains
- Protect urban wetlands and green spaces to enhance infiltration
- Keep storm water paths free of solid waste

These measures reduce flooding, stagnant water and waterlogging. National flood guidance emphasizes structural and non-structural actions to minimize flood losses.

Urban Planning Integration

Integrate flood risk reduction and water-sanitation considerations into city development plans and annual ULB budgets — a practice reinforced in national disaster management plans.

Airtight Septic Tanks

Promote airtight covers for septic tanks to prevent ingress of floodwater and contamination of drains.

Emergency response

Flood Early Warning & Monitoring

- Maintain regular contact with District Disaster Management Cell, IMD/State Meteorological Dept - India uses advanced flood forecasting & early warning systems such as C-Flood (real-time forecasts providing 1–2 days advance alerts) and Multi-hazard Early Warning Systems (integrating IMD rainfall forecasts, river gauge data and hydrological models for urban areas).
- Subscribe to national alert platforms like the NDMA 'Sachet' app for CAP alerts.
- Display river/urban drain gauge thresholds in ward offices.
- Use WhatsApp groups, public display boards & loudspeakers to disseminate warnings early.

Early warning gives precious time to:

- Evacuate vulnerable settlements
- Secure infrastructure
- Mobilize sanitation staff & health responders

Evacuation Planning

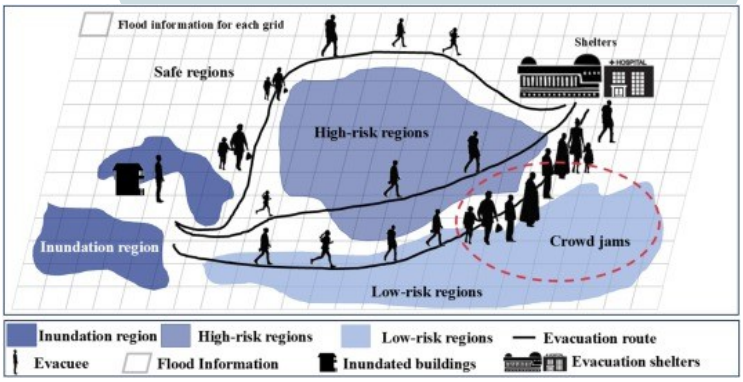
- Each ULB must prepare a flood evacuation plan that identifies Vulnerable zones, Evacuation routes, Safe shelters such as community halls, and schools.
- The plan should be reviewed annually and practiced through pre-monsoon drills.

Water-Sanitation Services at Shelters

Shelter planning must integrate:

- Safe drinking water supply & storage Functional toilets segregated by gender
- Handwashing stations with soap
- Medical first-aid and waste disposal

Community volunteers and ward staff should be trained on water and sanitation protocols at shelters.



Disease Preparedness

Floods dramatically increase the risk of water-borne (cholera, typhoid, dysentery) and vector-borne (dengue, malaria) diseases.

Water Safety

- Chlorinate public water sources
- Advise boiling drinking water
- Protect overhead tanks & wells from contamination

Sanitation & Hygiene

- Disinfect community toilets and waste collection points
- Deploy temporary toilets where infrastructure is damaged
- Promote handwashing with soap

Vector Control

- Remove standing water
- Coordinate with health department for fogging / larvicidal activities

Actions for Climate Proofing Infrastructure Assets

Adaptive Sustainable Design

- ✓ **Elevation:** Build tube wells, pump houses, storage tanks, STPs on raised plinths or flood safe sites to protect them from inundation.
- ✓ **Robust Construction:** Use climate -resistant materials to withstand water pressure and damage. To avoid overflows city should have separate stormwater and sewage network.
- ✓ **Integration with Green Infrastructure:** Incorporate nature-based solutions such as wetlands, buffer zones, and recharge systems to manage stormwater.
- ✓ **Decentralized Wastewater Systems:** Shift from centralized plants to decentralized, ones. If one unit fails, the entire city's sanitation isn't compromised.

Technological Measures

- ✓ **Real-time Monitoring:** Employ sensors and early warning systems for extreme events for digital monitoring and informed decision making.
- ✓ **Treatment Technology:** Enable flexible treatment processes that can handle variable flows during extreme rainfall or droughts.
- ✓ **Simulation models and calibrations:** Helps identify key issues in sedimentation and rising hydraulic capacity.

Operational Efficiency

- ✓ **Adoption of Renewables:** Increase dependency on renewable power sources for uninterrupted service during grid failures.
- ✓ **SoPs for Disaster Risk Reduction:** Develop clear protocols for municipal staff on chlorination, pump operation during power outages, and emergency water trucking.
- ✓ **Performance Monitoring and Capacity Building**: Regularly review performance and strengthen staff capacity for crisis management.

Pioneering example

Ichalkaranji raising its new Sewage Treatment Plant on Plinth

The 18 MLD plant at Takwade Ves, Ichalkaranji, lies on the bank of the Kala Odha nala, about 3 km from the Panchganga River. As the site faces frequent flooding with water levels rising 4–5 feet, the facility has been elevated 8 feet on stilts. This design minimizes flood risk, protects infrastructure, and ensures uninterrupted operations during extreme weather.

7 Reducing Emissions with Solid Waste Management

Solid waste is a significant but under-addressed contributor to climate change. With 40–60% of municipal waste in Indian cities being biodegradable, inadequate segregation and continued reliance on landfills lead to avoidable GHG emissions, alongside local air, soil, and water pollution. Every tonne of solid waste disposed, results in 227 kg CO2eq generation (2005-2015) in the form of methane from landfills where organic waste decomposes anaerobically. Open burning of waste, still prevalent in many cities, releases short-lived climate pollutants such as black carbon, which accelerates warming and worsens air quality.

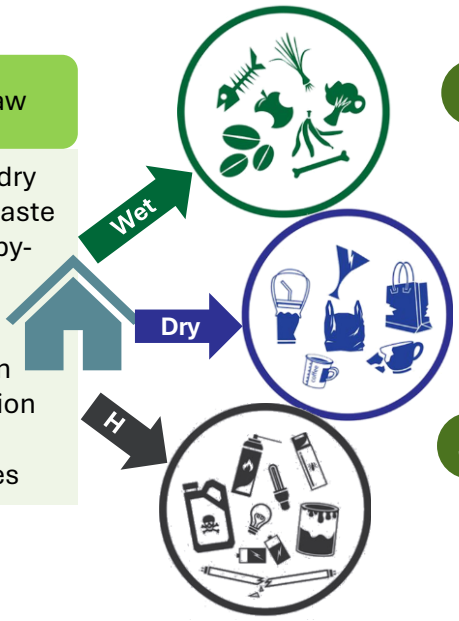
Source segregation, backed by effective collection, is the critical entry point for climate-responsive waste systems. It enables organic waste to be channelled into composting and bio-methanation, while dry recyclables can be recovered. Plastics, metals and paper re-enter manufacturing supply chains, avoiding tertiary emissions from virgin material extraction and processing.

Ensuring segregation at source

1 Mandate through local law

Notify segregation for wet, dry and domestic hazardous waste and embed it in municipal by-laws and user charges.

Standardise and provide colour-coded bins and align them with separate collection schedules or compartmentalized vehicles



2 Enforce in collection contracts

Link contractor payments to segregation outcomes - introduce penalties for mixing and incentives for high performance . Train sanitation workers, supervisors and drivers on rejection protocols

3 Engage bulk waste generators

Mandate on-site segregation and processing for apartments, institutions, hotels and markets

4 Enable decentralised processing

Set up ward- or cluster-level composting and dry waste sorting facilities. When residents see waste being processed locally, compliance improves.

5 Intensive behaviour change communication (BCC)

Use door-to-door engagement, women SHGs, RWAs, schools, and market associations. Reinforce messaging around “no mixing after segregation” to build public trust.

Inter-personal communication

Print media

Radio jingles

Social media

Use of Mascot

Building a Segregation Culture: Panchgani Model for Achieving 100% Source Segregation

Panchgani’s success was driven by a consistent on-ground campaign of interpersonal communication. The city deployed a dedicated team of “Swachhagrahis” - cleanliness supervisors, health inspectors and local women volunteers - who conducted door-to-door visits. These teams provided live demonstrations to households, explaining the "why" and "how" of segregating waste. This hands-on education built trust and clarity with citizens, transforming their behavior and increasing participation. The continuous supervision and feedback by these teams ensured that segregation practices were correctly followed and sustained.

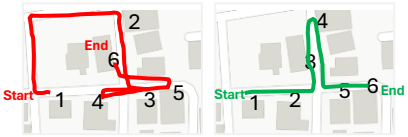
Ensuring 100% Door to Door Waste Collection

1 Identify and include unserved areas

Prepare property inventory covering slums, informal settlements, high-rise buildings, commercial areas, and institutions. Formally include slums, gaothans and peri-urban pockets in collection plans

2 Deploy adequate collection vehicles

Use a mix of pushcarts, tricycles, auto-tippers, and compactors matched to local conditions, street width, density and waste quantity.



3 Desing rationalized routes with timebound collection

Design routes with

- Minimal backtracking and dead runs
- Loop or one-way flows
- Near-to-far collection, ending closer to transfer or processing points
- Balanced waste volume and stop points, not just distance in each route
- Fixed uniform collection windows for each locality which are publicized - Predictability drives participation

4 Performance-linked contracts

Tie contractor or staff payments to coverage (% households served), punctuality and no-miss days, not just volume collected

5 Robust Grievance Redressal

Display collection timings, helpline numbers and ward contacts. Enable quick complaint resolution to prevent open dumping

6 Strictly penalise open dumping and littering

City level actions for reducing climate impacts

1. Regularly clean drains and install trash traps / bar screens to prevent waste from clogging drains

2. Remove and transform Garbage Vulnerable Points (GVP)

3. Take actions to stop waste burning

4. Promote RRR behavior and set up RRR center

Wet Waste Processing

Household and Community Level
- Khamba composting and Bin Composting

- Segregate bio-degradable waste such as leftover of food, peels of fruits, vegetables etc. and put it into Matka or Bins.
- Sprinkle water on the waste and turn the waste thoroughly.
- Compost will be ready to harvest in around 6-8 weeks.
- It can be used for gardening and plantation.

City Level Initiative - *Bio-methanation Plant*

- Bio-degradable waste can be processed here
- End product of the plant is biogas which can be used for cooking or fuel for vehicles
- Reusing end products for other purposes promotes circular economy and reduces GHG emissions.

Using one cubic meter of biogas for energy can offset about 0.5–0.6 kg of CO_2 that would otherwise generate from burning fossil fuels, while also avoiding methane emissions from decomposing organic waste. A biogas plant handling 50,000 tons of organic waste per year can prevent an estimated 8,000 – 10,000 tons of CO2eq emissions. This is comparable to taking more than 2,000 cars off the road.

Dry Waste Processing – Material Recovery Facility (MRF)

- ✓ Bring all dry waste to MRF center for segregation and processing of waste.
- ✓ End product from the MRF such as recyclables can be sent to recyclers and non-recyclables can be used as Refused Derived Fuel (RDF) for industries or road construction.
- ✓ Reusing recycled waste helps in reducing GHG emissions.

Process for using reuse and processed byproducts

Sample test in nearby Government Fertilizer Control Laboratory
- *Submit the required kg sample*
- *Make payment, collect receipt*
- *Fill testing form, attach the receipt and submit the form with a sample for testing*

Quality Testing Report received by ULB post and email

Report to be within prescribed limits

Report to be attached via email to SBM office requesting for Harit brand certification

GHG Emission

By processing wet and dry waste, Maharashtra is currently reducing around 1.47 Million Tonnes of CO2eq emissions per year, these prevent waste from being disposed to dumpsites. Achieving 100% waste processing can reduce 0.58 Million Tonnes of CO2eq emissions per year.

Legacy Waste Management

Legacy waste refers to accumulated, unscientific dumps of municipal solid waste deposited over years at open dumpsites or poorly engineered landfills. These sites pose severe environmental, public health, and climate risks, including huge amounts of methane emissions, leachate contamination of soil and groundwater, frequent fires and loss of valuable urban land.

1 Site assessment

Conduct topographic and waste characterisation studies to estimate volume, age, composition and contamination risks

2 Biomining and bioremediation - processing and disposal

Biomining / bioremediation involves excavation, sieving and segregation of legacy waste into-

- Soil-like material: used for site remediation, landscaping
- Recyclables: channelled to authorised recyclers
- Combustible fraction (RDF): co-processed in cement kilns or waste-to-energy plants
- Inerts and rejects: disposed in engineered landfills

3 Environmental Safeguards

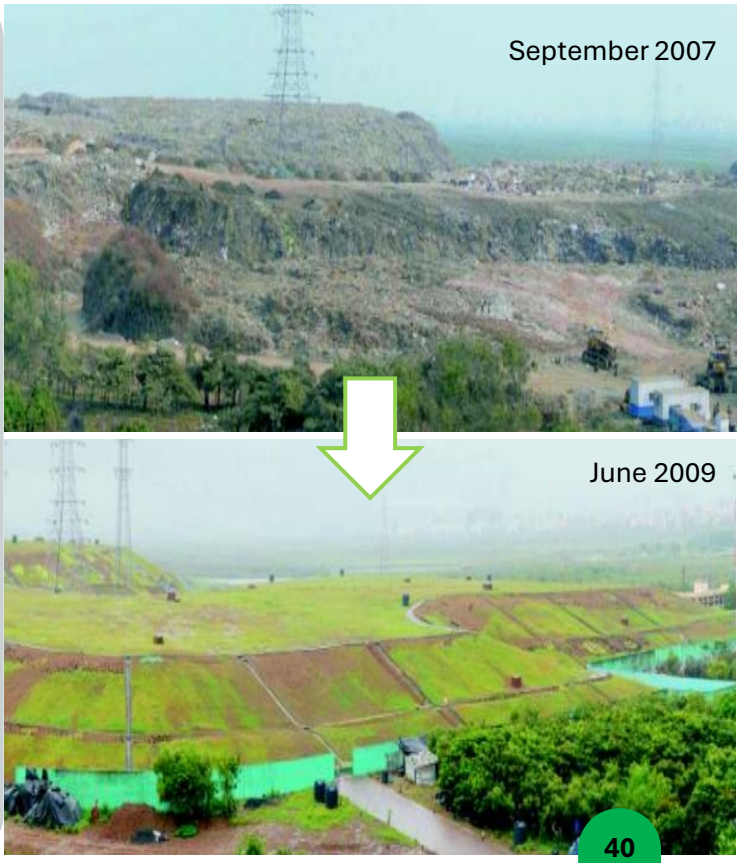
Implement dust suppression, odour control, fire prevention, and leachate management

Continuous monitoring of air quality, groundwater, settlement, and residual gas emissions is essential

4 Land reclamation and reuse

Reclaimed land can be repurposed for green buffers, solar parks, material recovery facilities, or public infra.

The Gorai Dumpsite Transformation in Mumbai - The closure and scientific capping of the Gorai dumpsite in Mumbai stands as a landmark achievement in urban environmental management. The site was receiving 2200 MT of waste daily and had collected an estimated 2.34 million tonnes of waste averaging height of 26 meters in December 2007. It was scientifically closed in July 2009, with key engineering interventions including installation of impermeable liners, topsoil and vegetation cover, leachate collection and treatment systems, boundary wall and stormwater drains, internal roads and landscaping. A landfill methane gas collection network of wells was also constructed. Under the Clean Development Mechanism registration, estimated amount of annual GHG emission reduction was approximately 1.2 million tonnes of CO_2 eq. over a 10-year crediting period. In addition, 19.6 hectares of land was transformed into green landscape.



Energy Efficiency and Renewables in Water and Sanitation Services

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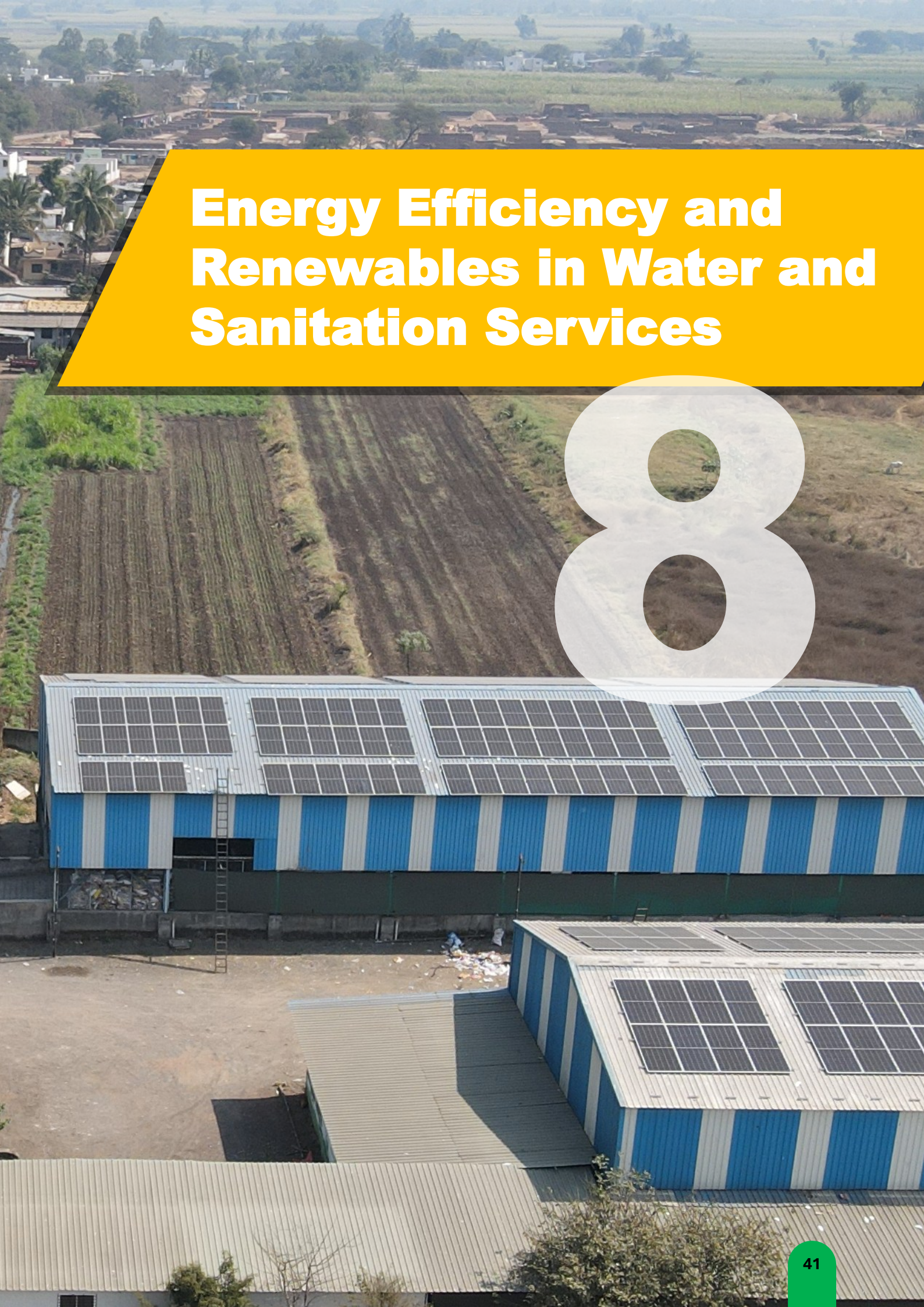
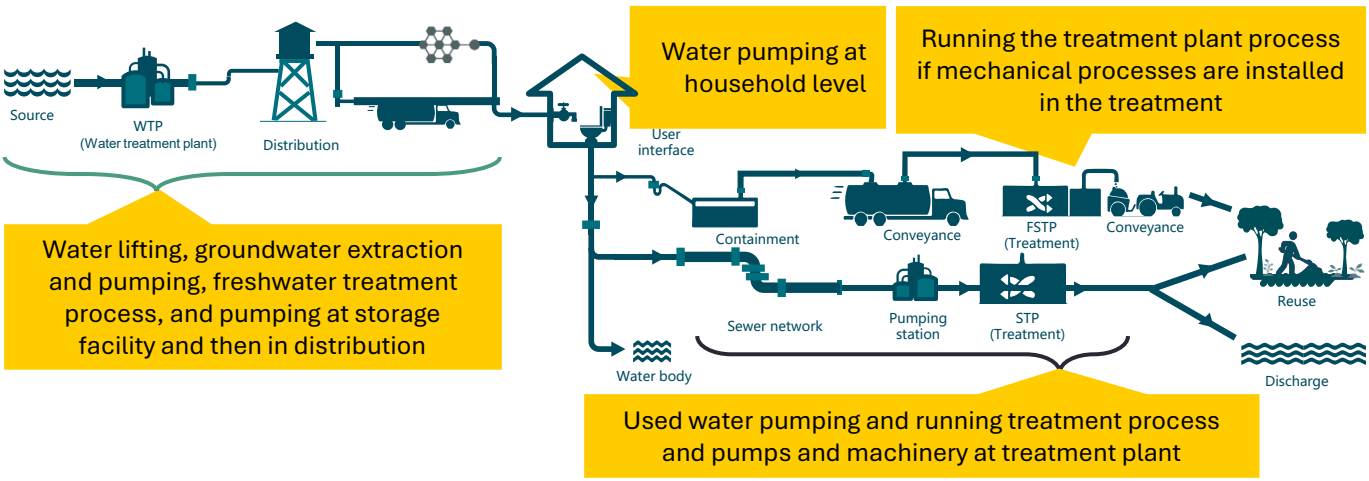


Energy Audit for Improving Efficiency in Water and Sanitation Utilities

Water and sanitation services consume 40–90% of municipal energy, making them a key area for reducing emissions and building climate resilience. Energy savings are directly linked to de-carbonization, be it electricity or any carbon-emitting fuels. Enhancing efficiency is not only important to reduce carbon footprint but also to ensure service continuity during disasters and power disruptions. Thus implementing energy audit measures make water and sanitation systems more climate-resilient and environmentally sustainable. Enhanced operational performance, positive returns on investment, and increased awareness ensure reliable service delivery even during disasters, reducing risks of system failure

Conducting a Preliminary Energy Audit



1

Develop a database for the overall Water supply and sanitation value chain
Map the entire water and sanitation service delivery chain and track key data points, such as water production, distribution, consumption, energy usage and waste management. Collect historical data on energy usage, bills, equipment specifications, operation schedules.

2

Verify and analyse data and calculate pump efficiency
Verifying and analyzing data ensures accuracy in flow rates, pump head,and energy use. This data is then used to calculate pump efficiency, helping identify areas for energy optimization.

3

Develop recommendations and action plans for climate resilient services
focusing on efficiency upgrades, operational optimizations and renewable options. Action plans set steps, timelines and resources to keep water and sanitation services reliable during climate shocks and disasters.

4

Next steps and follow up
Establish monitoring and reporting systems to track savings in the future

Calculation of key performance metrics

Energy saving in Rs./year
Estimate cost savings from reduced energy consumption after efficiency improvements.

Pump efficiency
Measure the current efficiency and ways to optimize pump performance.

Payback period
Time to recover the investment through energy savings.

Pump capacity
Ensure pump size matches operational needs for optimal efficiency.

Pump replacement cost
Total cost of replacing inefficient pumps, including equipment and installation.

Funding availability

As per the 13th Jan 2011 GR, MEDA offers up to ₹20 lakhs to ULBs for installing energy-saving devices like auto sensors, timers, voltage dimmer switches, SCADA, and web-based monitoring for street lighting and water supply schemes. Specifically, for SCADA and web-based monitoring in water supply schemes, MEDA provides up to ₹5 lakhs.

Post energy audit measures for improving energy efficiency

Improve pumping efficiency
Replace old, inefficient pumps with star-rated, energy-efficient pumps and correct power capacity to match actual head and discharge requirements.

Install APFC panels
Automatic Power Factor Correction panels monitor and correct the power factor leading to lower bills, avoidance of utility penalties, reduced losses and voltage stability improving equipment life

Reduce Non-Revenue Water
Leak detection, pipe rehabilitation and pressure management reduce excess pumping and energy wastage.

Optimise operating schedules
Shift pumping to off-peak electricity tariff hours and synchronise pumping with storage and demand patterns

Enhance monitoring and automation
Install SCADA, smart meters and energy monitoring systems to track pump performance, energy consumption and losses

Consider alternative energy sources
Use renewable energy, recover energy from used water to offset grid electricity consumption

Adopting Renewable Energy: Solar Energy

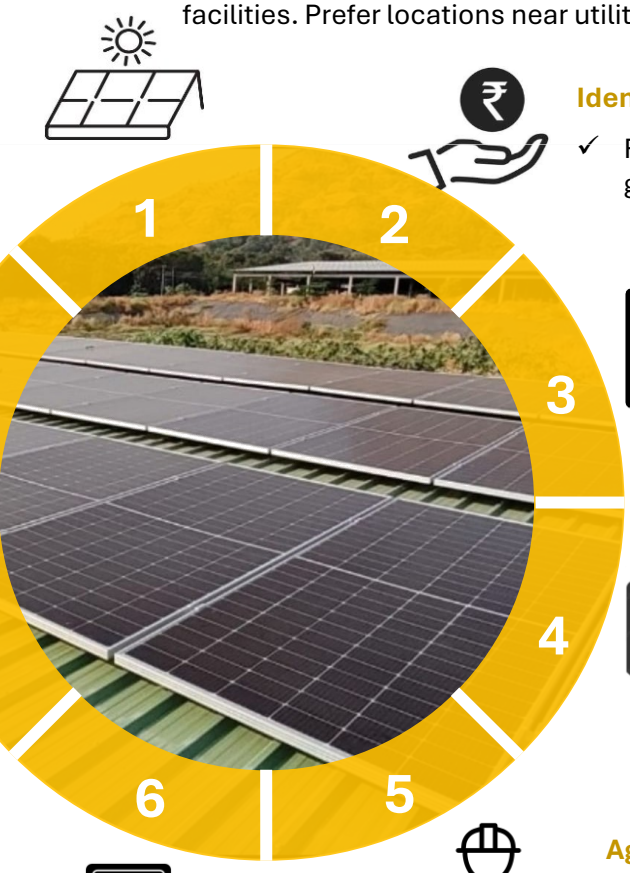
Solar energy systems are key green infrastructure in urban areas, providing clean energy, reducing carbon emissions, and lowering energy costs. They support sustainable development by powering public utilities and enhancing energy security while contributing to climate change mitigation.

The Majhi Vasundhara Abhiyan and Swachh Bharat Mission 2.0 promote solar energy use for urban sustainability. These initiatives encourage installing solar panels in public spaces like government buildings and community centres to reduce reliance on conventional energy. Solar power is also promoted for non-potable uses such as street lighting and water treatment, supporting cleaner, greener cities across Maharashtra.

Steps for solar installation in your city

Location Selection

- ✓ Select building rooftops or open lands near WTP/STP/SWM facilities. Prefer locations near utility or facility structures.



Identify Finance Source

- ✓ Finalize financing from own revenues, CSR funds, government schemes, MVA prize money

General Body Approval:

- ✓ Seek approval from GB / Chief officer through a resolution

Technical Estimate & Approval:

- ✓ Share the GB resolution copy and application letter, along with a geotagged photo of the site, to MEDA via email
- ✓ MEDA officials will visit the site, determine the on-grid/off-grid solar system and prepare an estimate based on power requirements
- ✓ Pay 1% of the estimated cost as TS fees to obtain approval from MEDA

Agency Selection:

- ✓ Develop and issue tender for private consultant selection for implementation and O&M

Net Meter Connection:

- ✓ Apply to MSEB for net meter connection, pay security deposit based on the load.
- ✓ DISCOM authorities will conduct a field visit and issue an order for net meter installation.

Key Lessons

1. **Prioritize with energy Audits:** Target large consumers like water supply first.
2. **Use Existing Space:** Deploy panels on rooftops/grounds to cut costs.
3. **Consider PPP:** Use performance-based models to reduce capital burden and scale.
4. **Monitor & Meter:** Use online monitoring and net-metering for transparency and returns.
5. **Involve Community:** Contract local SHGs for maintenance to ensure performance and create jobs.
6. **Report Results:** Consistently track and report savings (kWh, INR, CO_2) to justify future investment.

Pioneering cases

Integration of solar energy into water-sanitation infrastructure in Vita, Karad, and Ichalkaranji has reduced dependence on fossil fuels and grid electricity. A total of 205 kW of decentralized solar capacity was installed across water and sanitation facilities, including water treatment plants, pumping stations and sewage treatment plants, using a mix of on-grid and off-grid systems tailored to city needs. Between March 2023 and August 2025, the installations generated over 370 MWh of clean electricity, delivering significant cost savings of about ₹30 lakh while reducing CO_2 emissions by approximately 265 tonnes. Beyond emissions reduction, the initiative improved energy security, ensured continuity of essential sanitation services during power outages, and demonstrated a scalable, phased approach - from energy audits and site assessments to installation, monitoring, and long-term O&M - offering a replicable model for climate-resilient urban services.

Solar project at WTP

Solar project at STP

Solar project at FSTP

Solar project at pumping station

Energy Transition in Municipal Fleet

Transportation is third highest emitter in municipal services after water and sanitation services. It also has an impact on the revenue expenditure budget of local governments as fuel cost for vehicles is one of the major components of the overall municipal revenue budget.

Shifting to Electric vehicle or clean fuel will significantly reduce GHG emissions in transport sector and will also provide the local government an opportunity for generating the revenue through using the public land for setting up charging infrastructure .

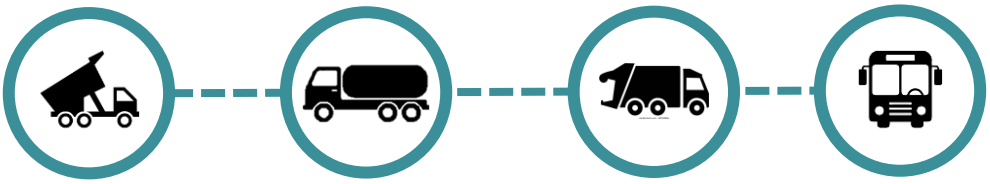
Climate Benefits

- *GHG Emission reduction*
- *Improved air quality*
- *Reduction in local temperature*

Policy support for EV transition

- Maharashtra EV policy, 2025 focuses on 30% adoption across all new vehicle registrations and proposes a phased transition of government vehicle fleet to EVs. Six urban agglomerations are prioritized for transition of city utility vehicles into EVs
- Swachh Bharat Mision – MoHUA has recognised the integration of EVs into waste collection and sanitation operations as a transformative measure, with many cities deploying e-rickshaws to replace diesel vehicles in solid waste management
- PM – E bus Sewa and PM – E Drive schemes support EV transition city bus fleets as well as other municipal utility vehicles

Transition Potential: Scope for transitioning ~ 14,500 in door-to-door waste collection vehicles across 428 Urban local bodies of Maharashtra state



Garbage tippers | Sewer suction / Jetting machines / Water tankers | Compactors / street sweepers / bin-lifters | City Buses

Preparing for EV transition

Vehicle Procurement

1. Mapping of vehicle requirements
2. Identifying available market vendors
3. Leverage existing govt. financial schemes
4. Procurement of vehicles or retro fitment

Operational Infrastructure

1. Calculating electricity load for charging
2. Mapping available public land for charging station
3. Enhancing transformer load / setting up charging / battery swapping station
4. Exploring the alternative fuel like – CNG, biofuel

Pune Municipal Corporation (PMC) has begun integrating electric vehicles (EVs) into its solid waste management fleet as part of its broader sustainability and mechanisation efforts. PMC procured 10 electric garbage tipper vehicles (each with ~2 tonne capacity) to supplement its conventional fleet and lower operational emissions and costs. In addition to these larger EVs, PMC initiated a pilot project to electrify around 150 pushcarts with electric kits to support waste pickers and improve last-mile manual collection.

Navi Mumbai Municipal Corporation (NMMC) has initiated purchase of 50 EV 3-wheelers to collect solid waste in narrow lanes as part of its broader clean mobility and municipal services agenda. Additionally, it has announced plans to roll out public EV charging stations across the city in a PPP model, creating 48 charging points to support two-, three- and four-wheel EVs and accelerate adoption in civic operations and public transport.

Nashik Municipal Corporation (NMC) has begun integrating electric mobility into its urban services as part of a broader clean air and sustainable transport agenda. NMC initiated the deployment of smaller electric vans to collect garbage in narrow lanes and slum areas, with an initial fleet of six e-vans operated by women self-help groups under the National Urban Livelihood Mission to improve door-to-door collection where conventional vehicles struggle to access. Additionally, NMC has been actively expanding electric vehicle charging infrastructure - commissioning seven EV charging stations across key locations and planning a total of 20–29 stations funded under the National Clean Air Programme with about ₹10–₹12 crore allocated.

9

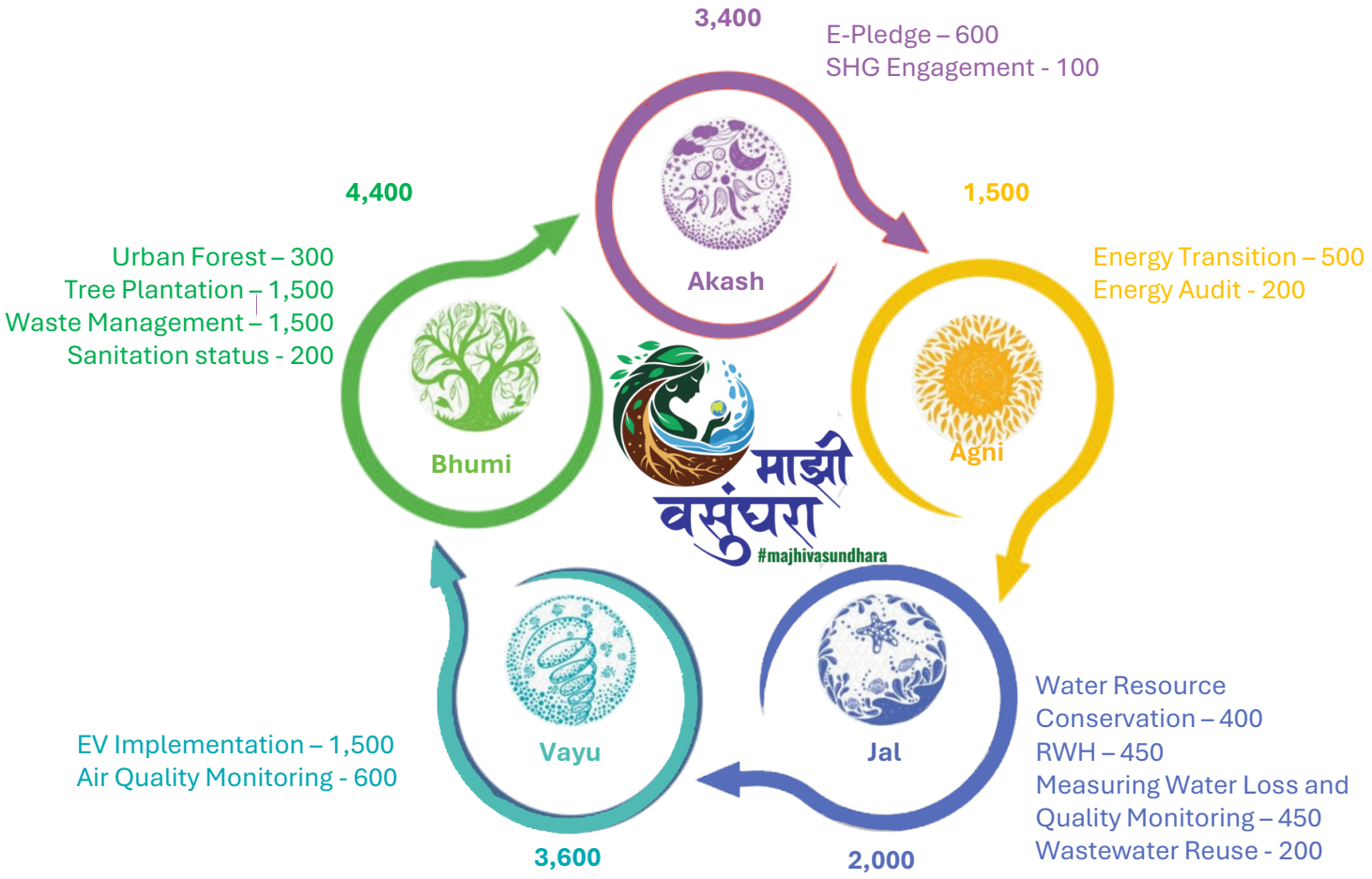
Monitoring Needs for Efficiency and Sustainability

Monitoring Needs for Efficiency and Sustainability

Climate-resilient water-sanitation services cannot be achieved or sustained without robust, continuous monitoring. Systematic monitoring helps identify vulnerabilities in infrastructure and improvement needs in service delivery, quality and access, especially for low-income and climate-exposed communities. It enables early detection of service failures, supports timely corrective action, and informs adaptive planning and investment decisions. Monitoring also strengthens accountability by tracking performance against resilience objectives, ensuring that water and sanitation services remain functional, inclusive, and safe under current and future climate conditions. Embedding climate-responsive indicators into routine monitoring is therefore a foundational step towards building services that can anticipate, absorb and recover from climate shocks while protecting public health and dignity.

Enabling framework - Majhi Vasundhara toolkit and annual assessment

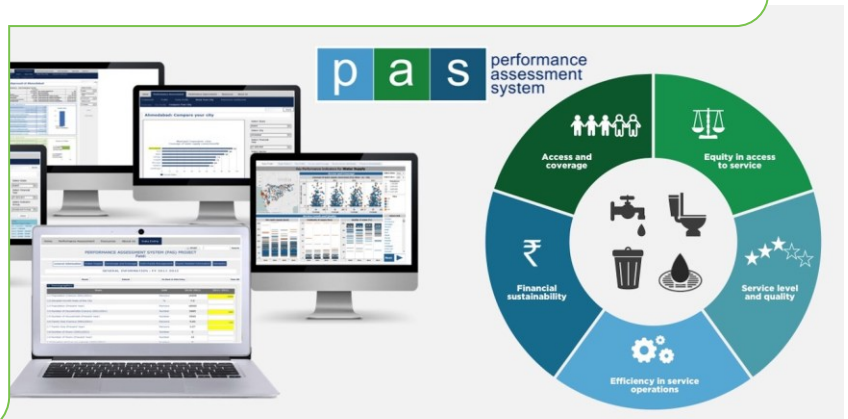
The Majhi Vasundhara Abhiyan own toolkit and annual assessment function as a monitoring tool for the mission. Local bodies implement the adaptation and mitigation activities outlined in the toolkit from April to March and at the end of each cycle, local bodies submit information and supporting documentation in a prescribed format on the MIS portal, which is assessed through desktop review and third-party field verification. Based on the assessment, high-performing local bodies are recognized and awarded across respective verticals. The Mission provides continuous guidance and monitoring through its state-level team and divisional field teams in the form of webinars and workshops to ensure effective implementation of the toolkit. During the assessment cities are scored on a framework of total 14,900 marks across its 5 themes and various sub-themes.



PAS – SLB framework for reporting water and sanitation outcomes

The PAS–SLB framework provides a structured and standardized approach for reporting and tracking water supply and sanitation outcomes across urban local bodies. Anchored in the Service Level Benchmarks (SLBs) notified by the Government of India and operationalized through the online Performance Assessment System (PAS) platform, the framework enables cities to measure service performance using clearly defined indicators on water, sanitation and solid waste management service delivery in terms of access, quality, reliability, efficiency, equity and financial sustainability.

Over 15 years, PAS has grown into one of India's most comprehensive databases, tracking service levels across 800+ cities, including all in Maharashtra, and covering 115 million people. By aligning with national programs like AMRUT and Swachh Bharat Mission, PAS has enabled evidence-based policymaking, performance benchmarking, and service improvements at city, state, and national levels.



SMART technology options for monitoring water and sanitation

In the context of climate change, where impacts are fast-moving, localized and increasingly unpredictable, traditional manual data collection and reporting systems are often slow, error-prone and unable to capture real-time service delivery issues. SMART technologies are increasingly becoming relevant and accessible for cities to support real-time data-driven decision-making. Current Government programs are enabling the adoption of these technologies to strengthen monitoring, service delivery and accountability.

Drone surveillance

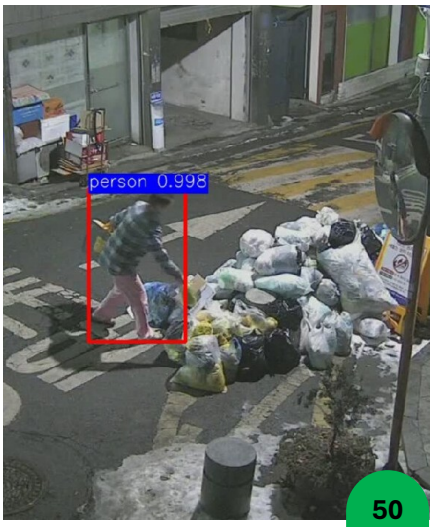
Remote sensing

Artificial Intelligence and Machine Learning for Computer Vision

Robotics and automation

Integrated Command and Control Centres (ICCCs) act as centralized digital platforms that integrate data from multiple sources—SCADA systems, IoT sensors, GIS layers, mobile/web platforms, weather alerts and utility dashboards.

Internet of Things (IoT) sensors



10 Inclusivity and Community Engagement

Communities Combating Climate Change

Under the Majhi Vasundhara Abhiyan (MVA), community engagement is a crucial element to attain the goals of the mission. As part of the Promotion and Education (Akash) and awareness activities aspect of MVA, community participation for climate-resilient water and sanitation should be explored.

Steps for implementation

1. Identify Activities including suggestions from stakeholders

- **Awareness activities** relating to IHHT, scheduled desludging, water conservation and proper disposal of waste
- Sensitization activities for **gender inclusivity** - women groups participating in community led initiatives and feedbacks
- **Collaborations between community and youth groups** for conducting tree plantations, community clean up drives, IHHT demand mobilization
- **School sanitation** related activities focusing on proper MHM for adolescent girls

2. Reaching out to target Stakeholders

Community	Youth Groups	Schools
Community Based Organization ✓ Women self Help Group ✓ Resident welfare associations (RWAs) ✓ Non – governmental Organizations (NGOs) ✓ Religious community groups and trust **Ward-Level Committees** ✓ Sanitation committee ✓ Education committee	✓ **College Groups** ✓ **College Alumni Groups** ✓ **Mitra Mandals**	✓ **Parents Teacher Groups** ✓ **School Trusts** ✓ **Government and ZP school groups**

3. Allocate Funding

- **Prize money – Majhi Vasundhara**
- **Mission funds (IEC funds)**
- **Own budget allocation**
- **CSR funds**

4. Use of existing channels and platforms to strengthen and sustain community participation

Digital and Social Media Platforms for reaching out to community

Use of existing municipal infrastructure such as public boards or announcements in public areas

Cultural Events and Festivals; Disaster Management Platforms; Community Radio or Local TV

SHG Engagement – convergence with NULM

Under MVA 5.0 and NULM, engaging Self-Help Groups (SHGs) in the provision of municipal services is one of the key focus areas. It has been observed that, with opportunities and some handholding support, SHGs can perform at par with, or even better than private service providers. These guidelines will help ULBs identify suitable activities for the SHGs and formally engage them.

Communities, in the form of SHGs, can play an important role as service providers. As members of the local community, their knowledge of local conditions and social networks can be leveraged to address some of the complex problems related to climate change.

Process of engaging SHGs

1. **Preparation Phase:** Identifying activities for SHGs, finalizing selection criteria and publishing notice inviting applications form SHGs/ALF
2. **Application support**: Orient SHGs/ALFs on application process, roles, and responsibilities, and ensure timely receipt of adequate applications
3. **Appointment of SHGs**: Scrutinize applications, approve selected SHG/ALF and issue signed work order from CO/Commissioner
4. **Capacity Building:** Train selected SHG/ALF members on project implementation and monitoring with support from ULB technical staff.
5. **Monitoring and Payments:** Regularly monitor work progress, review issues and ensure timely payments to SHG/ALF.

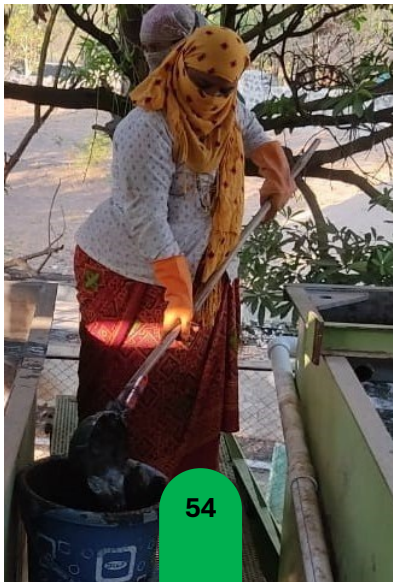
Pioneering examples

Cases from across ULBs of Maharashtra

SHG engagement for FSSM	Septic tank desludging in Latur, Vasai – Virar, Medha and Kuruduwadi	O & M of Grey Water treatment plant in Sinnar	Cleaning of community toilets in Hingoli and Khopoli	Urban Forest and Garden O & M in Sinnar, Wai and Karad
				
SWM and Other activities				
	Awareness campaign in Hingoli, Mira-Bhayandar	SWM in Bhadrawati, Tuljapur, Panchgani	O & M of MHM machines in Wai and Vita	ULB office cleaning in Rahuri, Wai

Sinnar's experience of engaging SHGs: In 2021, Sinnar Municipal Council (SMC), with support from CWAS, engaged SHGs for operation and maintenance of their garden and urban forest at their Fecal Sludge Treatment Plant (FSTP) site, where the treated used water was to be reused. CWAS supported SMC to engage the SHGs through a formal SHG only tender that included simple eligibility criteria and contract terms which were conducive to engage SHGs on a long-term basis and safeguarded their interests. SMC also provided them necessary trainings to provide the service efficiently. The SHGs performed well and met SMC's expectations. Drawing inspiration from this experience, in 2022, SMC engaged SHGs through the similar process for operation and maintenance of its Grey Water Treatment Plant and maintaining the garden around it. The SHGs at both the treatment plants successfully completed their term of 3 years, after which SMC floated the tender again and on-boarded new SHGs. With the idea of engaging SHGs institutionalised within the Council, SMC has also engaged SHGs for operating their municipal council building's canteen. Some of the SHG members also work at the solid waste management site through a contractor for waste segregation.



Scaling up and sustaining SHGs

ULB building and office operation	Water and Sanitation services	Other ULB work
• Establish and operate ULB's service centers (computer, typing, Xerox, citizen facilitation). • O&M of ULB libraries, reading halls, gardens, parks and playgrounds. • Provide cleaning services for offices, hospitals, municipal schools, colleges and public facilities. • Procure stationery and cleaning materials through CLF or livelihood centers.	• Door-to-door waste collection, transport, segregation, processing and disposal. • Establish and operate MRF, vermicomposting plants etc. • O&M of STPs, FSTPs, GWTPs, and reuse treated water for parks/urban forests. • Provision of septic tank desludging services. • Maintenance of CTs/PTs. • Water supply services: bill distribution, collection, new connections, quality testing. • Spraying insecticides to control malaria, dengue and typhoid.. • Maintenance and repair of hand pumps and public taps. • Awareness activities related to health and sanitation.	• Operate canteens, cafeterias, and mid-day meal schemes. • Tailoring of uniforms/bags. • Run tourist facilitation centers • O&M of solar power plants. • Rainwater harvesting, watershed, and water conservation works • Conduct surveys, awareness campaigns and adult literacy programs. • Manage shelters for homeless, elderly, children, and hostels. • Implement slum development, disaster management and environmental awareness works. • Carry out maintenance of road, footpath, streetlight.

To engage the SHGs and sustain their engagement, it is important that the ULBs acknowledge their potential, give them an opportunity and provide them necessary support. Support from the ULBs and other stakeholders will build confidence amongst the SHGs and further strengthen and expand their role in the municipal service provision.

Operational Modalities

1. **Tender for SHGs only**
2. **SHGs friendly contract clauses** (relaxation in EMD, tender fee, penalties etc.)
3. **On time payment by ULB and reporting by SHG**
4. **Bank linkages and accounting training**
5. **Geographical proximity to work areas**
6. **Women friendly workspaces**

Local government and other stakeholders support

1. **Chief officers and ULB staff support and trust**
2. **Active participation of NULM officer in capacity building and hand holding**
3. **Resource organization support for training and access to credit**

11

Financing Climate Response

Financing Climate Resilient Water and Sanitation Services

Cities need funding or a source of financing for their climate projects to implement the adaptation, mitigation, and resilient projects. India's flagship national programmes, especially including Jal Jeevan Mission, AMRUT and Swachh Bharat Mission, offer robust institutional platforms and financial resources. The strategic opportunity lies not only in creating standalone "climate projects", but in reframing the water and sanitation investments for climate-resilient development. By aligning these programmes with climate finance principles, such as risk reduction, adaptive capacity and sustainability, India can strengthen their climate relevance while staying focused on national development goals.

Options to integrate climate finance

Existing flagship programs

India's ongoing programmes provide opportunities to demonstrate how climate resilience can be embedded within existing investments. A growing share of projects under ongoing missions such as AMRUT, SBM, Jal Jeevan Mission, incorporate climate-resilient features, such as drought-proofing, flood protection, used water reuse, and energy efficiency, indicating that climate considerations are increasingly embedded in urban development, even when not explicitly framed as climate projects.

Green Bonds

Green bonds can be used to raise capital for infrastructure projects. The Govt of India is offering incentives to cities to raise municipal and green bonds.

Ghaziabad Municipal Corporation issued municipal green bonds in BSE and raised Rs.150 crore. Funds of these green bonds are used for the construction of a tertiary treatment plant (estimated cost approximately Rs. 239.39 crore) to benefit industries in Ghaziabad.

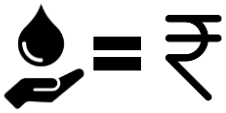
Carbon Credits

Project bundling which reduce carbon emissions can be done to quantify the volume of carbon emissions saved and avail carbon credits. These credits can be traded off / encashed in the market .

Indore Municipal Corporation was the first Indian civil body to earn carbon credits, making Rs 50 lakhs from selling credits against 1.70 tonnes of carbon dioxide in 2020.

Water Credits

Water credits can be thought of as a system of exchange where those who use less water than they are allotted are able to earn credits that they can then sell to those who need more water than they are allotted.



Junagadh MC in Gujarat issued 9 million water credits for saving one crore litres of water in its Hasnapur water reservoir which meets 30% of city's water demand. This has been approved by UNFCCC authorized agency – United Water Registry (UWR)

Climate and municipal budget integration

Integrating climate priorities into municipal budgets is essential to translate climate commitments into on-ground action. Climate–budget integration enables urban local bodies to systematically identify climate risks and align capital and operating expenditures toward mitigation and adaptation outcomes. By tagging climate-relevant projects and prioritising resilient infrastructure, municipalities can make more efficient and accountable investment decisions. This approach also helps cities ensure that routine municipal spending contributes to long-term climate resilience rather than locking cities into high-risk or high-carbon pathways.

- Assessment of overall municipal budget and budgeting process
- Integrating climate budgeting with municipal budgeting
- Capacity building and training of ULB officials
- Enhance property tax and other own revenue streams

Integrating water-sanitation and climate friendly line-items with municipal budgeting

- Avenues like Women and Child Welfare Fund
- Solar Initiatives
- Sanitation worker safety
- Landscaping initiatives
- Energy audits

Steps for linking climate budget with existing budget

1. Detailed review and analysis of Municipal Budget, existing programs and schemes. Identify water-sanitation and climate allocations and utilization

2. Undertake pre-budget consultation process. Budget inputs on possible allocations based on citizen's suggestions through pre-budget consultation meetings, applications, social media and forums

3. Identify existing water-sanitation and climate related state and national government programmes and schemes through various ministries:
   - AMRUT, SBM etc.
   - Solar subsidies and schemes: Roof-Top Solar program, PM Surya Ghar Muft Bijli Yojana, PM KUSUM etc.
   - Afforestation Schemes: NAGAR Van Yojana

4. Prepare climate-friendly, environment friendly and water-sanitation related budgetary line items and incorporate at departmental budgeting process

5. Finalization of Climate Budgetary line items in municipal budget. Thus, preparation and integration of climate budgets with municipal budgeting.
   City Budget Portal developed by CWAS, CEPT helps in preparing digitized climate friendly municipal budgets and budget briefs which help in understanding sectoral allocations

6. Adoption of projects at municipal level

Improvement in water-sanitation service resilience against climate impacts

ABBREVIATIONS

ALF	Area Level Federation
APFC	Automatic Power Factor Correction
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
CAPEX	Capital Expenditures
BCC	Behavior Change Communication
BOO	Build Operate Own
BOOT	Build Operate Own and Transfer
BOT	Build Operate Transfer
CAP	Common Alerting Protocol
CAPEX	Capital Expenses
CEA	Central Electricity Authority
CH4	Methane
CLF	Cluster Level Federation
CNG	Compressed Natural Gas
CO	Chief Officer
CO_2	Carbon di Oxide
CO_2 eq.	Carbon di Oxide Equivalent
COD	Chemical Oxygen Demand
COP	Conference of Parties
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CT/PT	Community Toilet/ Public Toilet
CSR	Corporate Social Responsibility
DEWATS	Decentralized Wastewater Treatment Systems
DISCOMS	Distribution Companies
DM	Disaster Management
DPR	Detailed Project Report
DRR	Disaster Risk Reduction
ECAM	Energy performance and Carbon emission Assessment and Monitoring
EMD	Earnest Money Deposit
EV	Electric Vehicle
FC	Finance Commission
FSTP	Faecal Sludge Treatment Plant
GB	General Body
GDP	Gross Domestic Product
GHG	Green House Gas
GPS	Global Positioning System
GR	General Regulations
GVP	Garbage Vulnerable Points
HHs	Households
ICLEI	International Council for Local Environmental Initiatives
IEA	International Energy Agency
IEC	Information, Education & Communication
IHHT	Individual Household Toilet
IMD	Indian Meteorological Department
IPCC	Intergovernmental Panel on Climate Change
KLD	Kilo Liter per Day
KW	Kilowatt
kWh	Kilowatt - hour
LIFE	Lifestyle for Environment
MAHAGENCO	Maharashtra State Power Generation Company Limited
MAVIM	Mahila Arthik Vikas Mahamandal
MC	Municipal Corporation
MEDA	Maharashtra Energy Distribution Agency
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Scheme
MHADA	Maharashtra Housing and Area Development Authority
MHM	Menstrual Hygiene Management
MIDC	Maharashtra Industrial Development Corporation
MLD	Million Liters per Day
MMT	Million Metric Tonnes
MoHUA	Ministry of Housing and Urban Affairs
MPCB	Maharashtra Pollution Control Board
MRF	Material Recovery Facility
MSEB	Maharashtra State Electricity Board
MT	Metric Tonnes
MVA	Majhi Vasundhara Abhiyan
MW	Megawatt
MWh	Megawatt - hour
NAPCC	National Action Plan on Climate Change
NDC	Nationally Determined Contributions
NDMA	National Disaster Management Authority
NGO	Non-Government Organization
NIUA	National Institute of Urban Affairs
N_2O	Nitrogen DiOxide
NRW	Non-Revenue Water
NULM	National Urban Livelihood Mission
OPEX	Operating Expenses
O&M	Operations and Maintenance
PAS	Performance Assessment System
PM KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan
PM 2.5	Particulate Matter
PNG	Piped Natural Gas
PPP	Public Private Partnership
RDF	Refused Derive Fuel
RRR	Reduce, Reuse, Recycle
RTO	Regional Transport Office
RWA	Resident Welfare Association
RWH	Rainwater Harvesting
SAPCC	State Action Plan on Climate Change
SBM	Swachh Bharat Mission
SBR	Sequencing Batch Reactor
SCAC	State Climate Action Cell
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goal
SHG	Self Help Group
SLB	Service Level Benchmark
SOP	Standard Operating Procedure
STP	Sewage Treatment Plant
SWM	Solid Waste Management
TDR	Transfer of Development Rights
TSS	Total Suspended Solids
ULB	Urban Local Body
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USAB	Upflow Anaerobic Sludge Blanket
UV	Ultraviolet
WASH	Water, Sanitation and Hygiene
WTP	Water Treatment Plant

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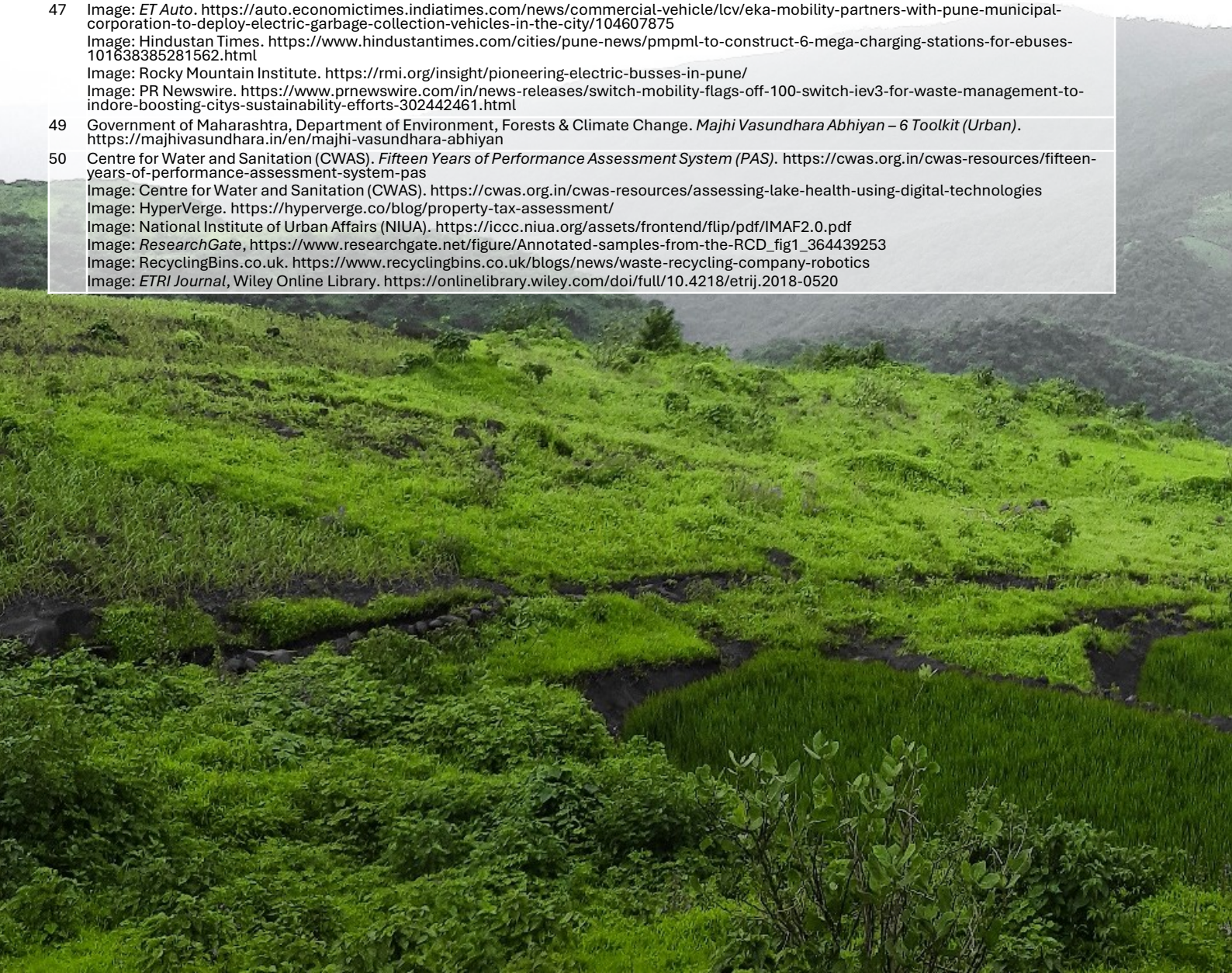

Aiming for a clean green and healthy future for Maharashtra!

This Guidebook is developed under a MoU between the Environment & Climate Change Dept. of Govt. of Maharashtra and the Center for Water and Sanitation at CRDF-CEPT University.

"Majhi Vasundhara" (My Earth) is Maharashtra's environmental initiative focusing on the five elements: Earth, Water, Air, Energy, and Sky, encouraging citizens and corporates to take pledges for small, daily eco-friendly actions like conserving water, reducing plastic, promoting renewables, and enhancing green cover, aiming for collective change through e-pledges and community participation. The program, run by the Environment & Climate Change Dept., involves activities, awareness campaigns, and aims to build sustainable habits for a better future.

The Center for Water and Sanitation (CWAS) is a part of CEPT Research and Development Foundation (CRDF) at CEPT University. CWAS undertakes action-research, implementation support, capacity building and advocacy in the field of urban water and sanitation. Acting as a thought catalyst and facilitator, CWAS works closely with all levels of governments - national, state and local to support them in delivering water and sanitation services in an efficient, effective and equitable manner.

सत्यमेव जयते

LiFE Lifestyle for Environment

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MUMBAI CLIMATE WEEK

CWAS CENTER FOR WATER AND SANITATION
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