Mumbai, India

City Waste Management Profile

URBAN OCEAN

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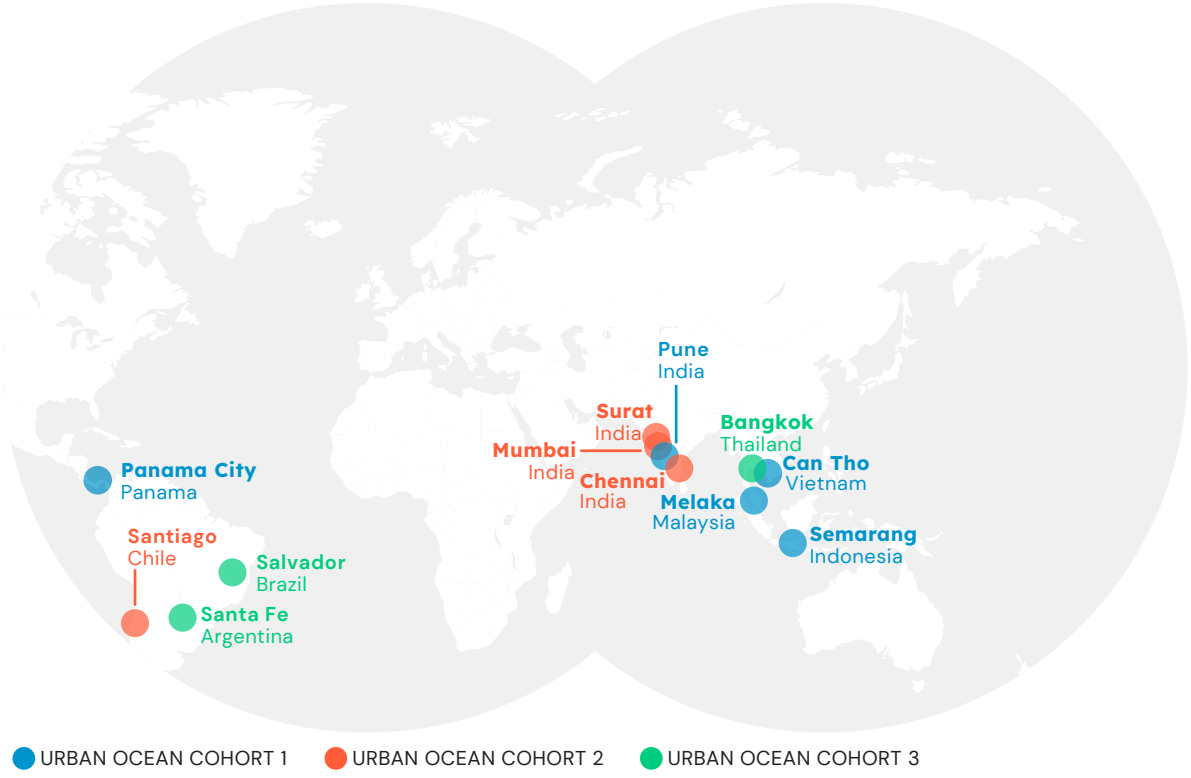
1. Introduction to Urban Ocean

Urban Ocean is a capacity-building and accelerator program for cities that champions circular-economy principles, builds awareness of ocean plastic pollution and assesses waste management systems. It aims to work with city leaders to bring new ideas, partners and resources together to solve interrelated resilience challenges related to waste management; reducing plastic leakage; and protecting water bodies and the ocean. The program demonstrates how actions to improve waste management and recycling can provide resilient and sustainable solutions that reduce ocean plastic pollution and address key city priorities, such as improving public health, supporting economic development, and reducing greenhouse gas (GHG) emissions. Furthermore, Urban Ocean provides cities with the opportunity to showcase leadership and share knowledge and experience across the Resilient Cities Network (R-Cities) community and beyond.

The program is jointly led by R-Cities, Ocean Conservancy, The Circulate Initiative and Brihanmumbai Municipal Corporation (BMC), together with the local implementation partner the Centre for Environment Education.

FIGURE 1
Urban Ocean cities map



Overview of the Urban Ocean Challenge

Cities are home to over half of the global population and account for nearly three-quarters of global greenhouse gas (GHG) emissions (IPCC, 2021). No climate nor social target will be met without a deep transformation of urban centers towards a more inclusive, sustainable, and resilient path. Approaching urban waste management systems through a resilience lens reveals complex, interrelated ramifications for social, economic, and environmental indicators. In 2018, the International Labor Organization estimated that the waste management sector alone has the potential to create 45 million jobs globally by 2030 while reducing GHG emissions by 15 to 20%. Additionally, circular economies offer a USD 4.5 trillion economic opportunity by reducing waste, stimulating innovation, and creating employment by 2030 (WRI, 2021). Currently, plastic usage is growing and continues to be a threat to public and environmental health in the ocean and in cities. A huge opportunity exists for city governments to implement policies and projects that promote a more resilient and circular waste sector in their cities. Now is the time to set out on the path towards a more resilient urban–ocean relationship that highlights the importance of preventing marine plastic debris.

Program objective

The Urban Ocean program aims to collaborate with urban leaders to gather new ideas, partners, and resources to address interconnected challenges related to resilience in waste management, reduce plastic leakage and protect water bodies and the ocean. Urban Ocean provides a platform for ocean advocates and urban leaders to join forces in developing comprehensive solutions that meet the needs and priorities of governments, cities, communities, and other stakeholders to create real and lasting impacts.

Cohort 2 Cities

Urban Ocean works closely with cities to demonstrate tangible solutions and highlight progress in addressing waste management challenges. The first cohort of Urban Ocean cities included Pune (India), Can Tho (Vietnam), Panama City (Panama), Semarang (Indonesia) and Melaka (Malaysia). The work further expanded to four additional cities in Cohort 2 – Chennai, Surat and Mumbai (all India) and Santiago (Chile) – to expand the geographic scope of the program, expand the waste management, circular economy and resilience ecosystem, increase collaboration with local governments and establish effective waste management systems that generate environmental, social and economic co-benefits to cities.

Methodology

This report summarizes the information collected to develop a resilience-oriented analysis of the urban waste management system in Mumbai. The profile was developed in collaboration with R-Cities, Ocean Conservancy, The Circulate Initiative, Brihanmumbai Municipal Corporation and the Centre for Environment Education. The analysis comprised desk research, a collaborative workshop with city stakeholders, and interviews. Table 1 presents the stakeholders who were consulted as part of the program.

TABLE 1
Interviewed stakeholders

Government/Public/ Intergovernmental agencies

Brihanmumbai Municipal Corporation

United Nations Development Programme

Non-governmental organizations/ Philanthropic organizations

Dasra

Green Communities Foundation

Global Alliance for Incinerator Alternatives

Har Ghar Hara Ghar

Welfare groups

Stree Mukti Sanghatana

Slum Sanitation Programme

Kachara Vahatuk Sharamik Sanghatana

Waste service providers

Recircle

R U R Greenlife

Skrap Waste Management Solutions

Dry-waste center operators (around 25)

Informal waste recyclers at Kurla Scrap Yard, Mankhurd, Mumbai

Civil Society

Earth5R

Sustainability 101

Academia

University of Mumbai

Tata Institute of Social Sciences

2. About the City Waste Management Profile

As part of Urban Ocean, cities create a City Waste Management Profile, in which a city's waste management systems are presented, including technical and sustainability aspects, along with formal and informal actors in the system. The City Waste Management Profile ("the Profile") examines major disturbances and stresses prevalent in the city that impact the city's waste management system. It brings together existing data and information collected in the initial phases of the program to allow the city to assess the risks and vulnerabilities of the system and to support project design.

The Profile seeks to provide insight for the city to better plan and identify appropriate solutions to increase the resilience of its waste management system, reduce plastic leakage into the environment and improve the city's ability to respond to, adapt to or otherwise address current and future shocks and stresses. It summarizes the baseline assessment conducted in each city in the Urban Ocean program and highlights the most relevant data and information to address urban resilience, ocean conservation and plastic pollution.

The profile encourages a more holistic approach to existing challenges and supports cities in the development of individual solutions suited to their specific history, economy, demographics and culture while being aligned with the city's unique institutional, environmental and financial resources. An added benefit of being part of Urban Ocean is that cities can learn from each other by comparing common elements in their respective Profile.

3. Mumbai and its Resilience Journey

The city of Mumbai is located on the western coast of India, on a narrow peninsula that lies between the Arabian Sea to the west, Thane Creek to the east and Vasai Creek to the north. The city is surrounded by the sea on three sides and has a coastline of 146 km. With an area of 458 km2 and density of more than 28,000 persons per km2, Mumbai is the most populous city in India. Geographically, the city of Mumbai is divided into three: the island city (or main city), the western suburbs and the eastern suburbs.

In terms of governance, the Brihanmumbai Municipal Corporation (BMC) is the administrative authority that governs the city. The BMC is led by the Municipal Commissioner and four additional municipal commissioners, one for each division and one for spearheading special projects across the city. The city has 24 administrative or municipal wards for convenience of city administration.

Economically, the city was once the center of India's cotton textile industry. Later, its manufacturing sector diversified and today Mumbai is the financial hub of

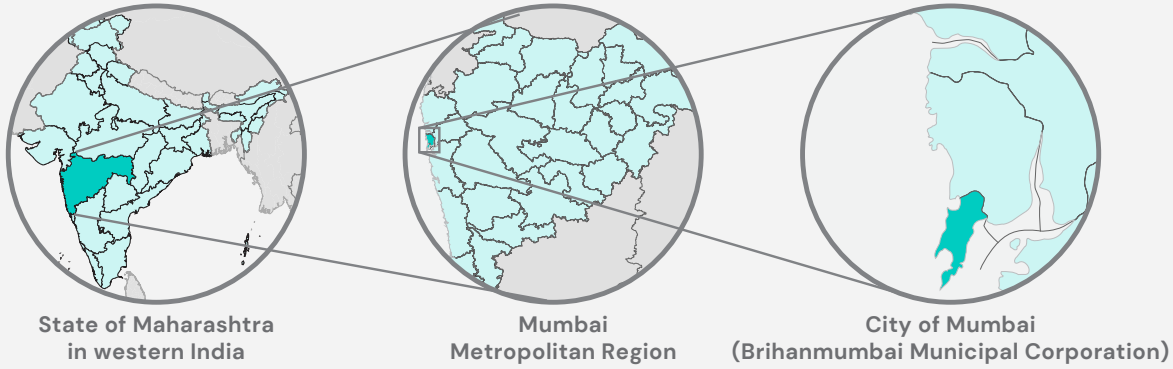


FIGURE 2
Socio-demographic indicators

12.44 million
Population (Census, 2011)

28,426[1] per km²
Population density (Mumbai Climate Action Plan 2022)

437 million USD
(3,659 Cr INR)–) out of the total city budget of 39,027 Cr INR ($4.6 billion USD) which is 10 percent of total city budget (Praja Foundation, 2021)

458 km²
Area (Mumbai Development Plan 2034)

42%
Population in informal housing (Mumbai Climate Action Plan 2022)

1 Density is higher (considering area and population of 2011) due to the increase in population after 2011.

India. Textile mills have played a significant role in the development of the city. They provide economic growth and employment, attracting the working class to the city for work opportunities and income. With the shift in its economy, the industrial-heritage journey of these mills and their impact on the city's fabric are symbolic of the change and development that the city has witnessed over several decades.

Mumbai is also the commercial hub of India, with its financial sector including the Reserve Bank of India and most of the leading banks in the country. The two largest national stock exchanges are based in the city. The Hindi film industry, known popularly as Bollywood, is India's largest film industry and is located in Mumbai. Employment plays a major role in attracting people to the city and Mumbai continues to witness a massive influx of people every year, adding pressure on the infrastructure of the city which is consistently operating at maximum capacity.

Mumbai is one of the densest megacities in the world, at 28,400 persons per km2 with just 1.1 m2 of open space per person. Only 6 percent of the total land in the city is made up of open public spaces. (Mumbai Metropolitan Region Environment Improvement Society, 2016) This has led to impacts such as poor living conditions, overcrowded transport systems and pollution, among others.

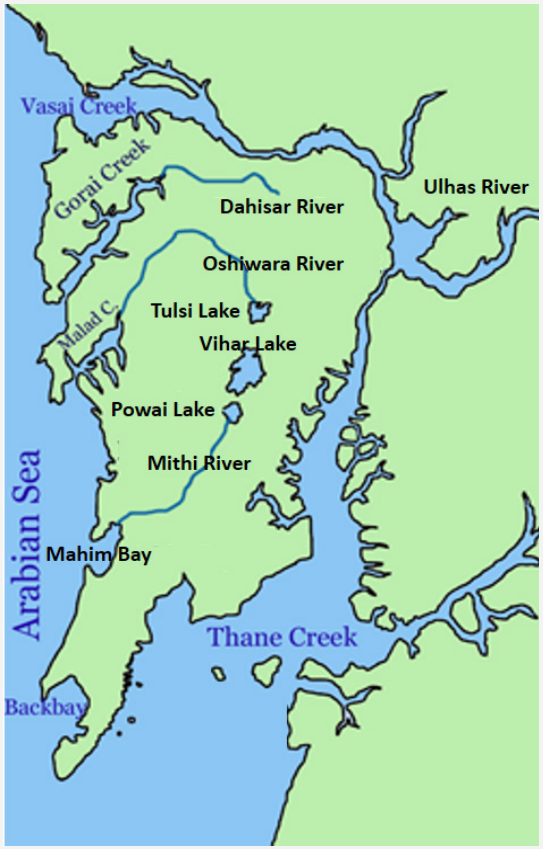
Mumbai's Connection with Rivers and the Ocean

The coastal area of Mumbai features commercial ports and beaches. The city is drained by the Mithi, Dhaisar, Poisar and Oshiwara rivers that originate from the Powai–Kanheri ranges in the Sanjay Gandhi National Park, a protected area to the northeast of the city. (Brihanmumbai Municipal Corporation, 2022) Mumbai's struggle with waterlogging and floods is the result of several limitations to the city's storm water drainage system. This includes Mumbai's reliance on its river ecosystems, of which the Mithi River is a key component (World Resources Institute, 2022). The Mithi originates from the outfall of Lake Vihar and has an inlet from Lake Powai downstream. The river crosses several areas of the city before draining through Mahim Bay into the Arabian Sea.

FIGURE 3
High population density in the city

Source: The Zolo blog, 2020

FIGURE 4
Waterbodies in Mumbai



Source: Adapted from Wikimedia Geography of Mumbai

Development and encroachment of areas along the Mithi in the last 25 years have drastically degraded its water quality, with discharge of domestic sewage, solid waste and industrial pollutants into the water (Maharashtra Pollution Control Board, 2019). This has severely impacted the storm water drainage capacity of rainwater, increasing the instances and frequency of flooding in the city. In addition, reports by the Central Pollution Control Board (CPCB) state that major sea outlets and beaches in Mumbai have been polluted by untreated sewage and/or surface pollution, including solid waste, with the average maximum biological oxygen demand recorded at the major beach outlets being six times higher than the norm prescribed by the CPCB,[2] indicating severe pollution levels in these waterbodies.

Mumbai has a 146 km coastline and most of the city is at sea level. According to the Mumbai Climate Action Plan (MCAP) 2022, the eastern coast is characterized by large mangrove swamps, rich in their biodiversity, while the western coast is mostly sandy and rocky, with few mangroves and wetlands closer to the creeks. These mangrove forests guard the city against tidal erosion, support an ecosystem of flora and fauna and help reduce urban flooding, besides being productive carbon sinks. The Mumbai Development Plan 2034 has demarcated these ecologically sensitive areas, such as forests, mangroves, waterbodies and areas under the Coastal Regulation Zone-I, as natural areas where no building development is permitted.

Key Shocks and Stresses Impacting the City's Waste Management Systems

With a population of over 12 million people, continuing urbanization and migration from within India, Mumbai is experiencing enormous stresses on its infrastructure and public-service systems. Real estate and infrastructure, not cognizant of the local physical landscape and ecosystems, have stressed the natural ecosystems, which are being exacerbated by climate risks. Mumbai is among the cities most vulnerable to climate change-induced hazards, such as sea level rise, untimely rain, coastal floods, storm surges and inland urban flooding, as cautioned in MCAP 2022.

Improper waste disposal in canals, storm water, and drainage lines hamper water flow and create flooding. Waterlogging also impacts waste collection services, resulting in further accumulation of solid waste around waterlogged areas. The accumulation of waste and resultant flooding are health hazards and pose a risk to the natural and built environment.

2 According to CPCB (https://cpcb.nic.in/nwmp-data), the average maximum biological oxygen demand recorded in all the major beach outlets was 19 mg/l in 2019, much higher than the norm prescribed for beaches by the CPCB of < 3 mg/l. The maximum biological oxygen demand of the Mithi River was 50 mg/l, showing high pollution from untreated sewage and waste disposal. Biological oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms to break down the organic material present in a given water sample at a certain temperature over a specific time period. A high biological oxygen demand indicates a high level of microbial pollution.

MCAP 2022 highlights that solid-waste disposal, especially via methane emissions from landfills, is responsible for 0.96 million tons of CO2 equivalent (50 percent of the total of 1.93 million tons of emissions) from the waste sector.

Extreme climate events have already caused severe losses to the city's economy and its people. For instance, the floods in Mumbai in 2005 resulted in 410 deaths and displaced several thousand, particularly in low-income areas. The city witnessed the heaviest recorded rainfall in a single day in India, which devastated transportation, telecommunications, power and financial services. The floods resulted in an estimated loss of $109 million USD in local business revenue (Stecko & Barber, 2007).

People living in slums and informal housing are much more vulnerable to such risks, especially in low-lying areas, which are prone to flooding, and on slopes, which are prone to landslides. The dumping or accumulation of solid waste in streams, estuaries and drains reduces the flow of water, increasing these risks. Additionally, the livelihoods of people working in the informal sector are typically more vulnerable, as many of these people are dependent on daily wages. It is estimated that, by 2050, the Mumbai Metropolitan Region will be the world's largest urban agglomeration, with about 42.4 million people (Hoornweg & Pope, 2016). With continued migration, including internal migration, the proportion of population potentially at risk will be immense. In addition, large-scale and often unregulated construction activities, high levels of motorized transport, and mismanagement of solid waste leading to fires in waste dumps, have led to increasing air pollution, which adds to the health risk for the city's residents..

Building Resilience through Waste Management

Waste management in Mumbai is linked to critical shocks and stresses, such as flooding, landslides, GHG emissions, health hazards and the precarious nature of livelihoods related to waste management and recycling, disproportionately impacting vulnerable communities in slums and informal settlements. Actions to strengthen waste management systems can help build resilience against these shocks and stresses.

Sustainable waste management is among the strategic areas identified in the Mumbai Climate Action Plan 2022, which emphasizes the promotion of decentralized systems for source segregation and recycling.

Approaching urban waste-management systems from a resilience perspective reveals the complex and interrelated ramifications on social, economic and environmental factors in the city. Waste management needs to be tackled in an integrated manner with the objectives of reducing waste, managing the existing waste efficiently to reduce leakage into waterbodies, promoting sustainable innovations and impacting livelihoods. Sustainable and resilient actions to improve waste management and recycling can provide resilience co-benefits such as improving livelihoods, reducing GHG emissions, improving health and well-

FIGURE 5
Monsoon flooding

Source: Zee Business, 2019; News18, 2023

being and reducing environmental degradation.

Mumbai has undertaken several initiatives and innovative approaches in solid-waste management over the last few decades. However, with ever-increasing migration and limited land availability in the city, waste remains a key stress. To address the interrelated resilience and waste challenges, Mumbai joined the Urban Ocean program in 2023. The program aims to develop actions based on rigorous research and stakeholder engagement, define opportunity areas in each participating city and conceptualize ideas ready to pilot or implement.

The program was implemented as below:

TIMELINE

2020

Urban Ocean program launch (cohort 1)

Launch of the Urban Ocean program in Can Tho (Vietnam), Panama City (Panama), Melaka (Malaysia), Pune (India), Semarang (Indonesia).

2022–2023

Launch of the program in Chennai, Surat, Mumbai (all in India) and Santiago (Chile)

- Circularity Assessment Protocol (CAP)
- City Waste Management Profile
- Opportunity Assessment Tool with participatory workshops
- Proposal design

Reflections on the issue of municipal waste and how it filters into the environment and waterways of the region.

Identification of key challenges and opportunities requiring sustainable solutions with resilience co-benefits.

2024

Project Statement and presentation

Creation of a compelling case for the project's importance, impact and sustainability.

Presentation of projects to potential implementation and funding partners.

4. Policy and Governance

Governance structure

The Brihanmumbai Municipal Corporation is the richest civic body in India (The Hindu, 2024). Like all cities in India, the BMC consists of a deliberative wing, comprising elected representatives of local wards, and an administrative wing composed of appointed city officials. These include the Municipal Commissioner and additional commissioners, along with the staff of various departments, ensuring the city's day-to-day operations.

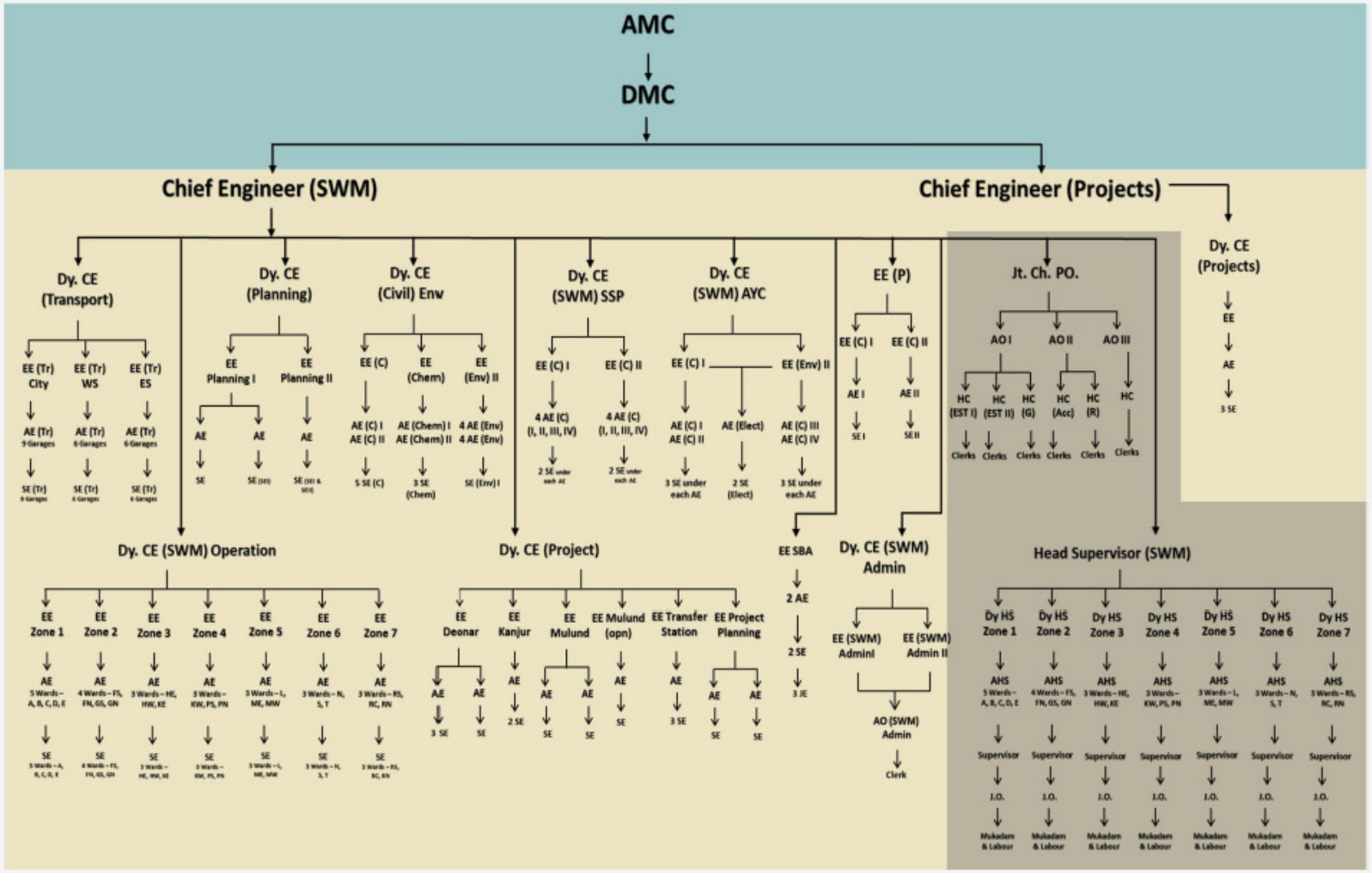
The Municipal Commissioner is appointed by the state government to head the administrative staff of the municipal corporation, implement the decisions of the corporation, and prepare its annual budget. Under the Municipal Commissioner, there are additional municipal commissioners. Departments and zones are equally distributed among the additional municipal commissioners for supervision and operations. There are deputy municipal commissioners appointed to assist the additional municipal commissioners in their responsibilities. Under the deputy municipal commissioners, in the Solid Waste Management Department sits the Chief Engineer who oversees a large staff of deputy chief engineers, executive engineers, assistant engineers, superintendent engineers and field staff (see Figure 7).

The city is divided into seven zones and 24 administrative wards, alphabetically named from A to R/North. Each ward is headed by an assistant commissioner, formerly known as a ward officer, whose responsibilities include supervising and checking technical aspects of the development and maintenance of the ward office and serving the citizens.

FIGURE 6
Mumbai's 24 administrative wards

FIGURE 7

Administrative structure of solid waste management department



Source: Vision 2030 Handbook on Solid Waste Management, Brihanmumbai Municipal Corporation, 2022

National and local regulations and guidelines

The tables below present the stakeholders and guidelines that govern solid-waste management in Mumbai.

AUTHORITY	POLICIES AND PLANS	DESCRIPTION
National Government – Ministry of Housing and Urban Affairs	Swachh Bharat Mission (SBM)	The SBM is a national initiative launched by the Government of India to improve cleanliness and sanitation in cities across the country. The mission covers over 4,000 cities and towns and aims to provide sanitation facilities, including toilets, waste disposal systems, and clean drinking water, to all households. The primary objectives of the SBM are to enhance the quality of life in both rural and urban areas, increase sanitation coverage and implement effective solid-waste management practices. The mission also addresses challenges such as inadequate waste segregation, lack of community awareness about waste management, and the burning of municipal solid waste in various areas.
National Government – Ministry of Environment Forests and Climate Change	Solid Waste Management (SWM) Rules 2016	The Ministry of Environment, Forests and Climate Change introduced the Solid Waste Management Rules in 2016. The rules concern the management of solid waste in urban areas and outline various objectives and timelines for effective waste management. These include identifying suitable sites for waste processing and landfill facilities, enforcing waste segregation at source, implementing door-to-door collection of segregated waste, managing construction and demolition waste separately, establishing waste processing facilities and sanitary landfills, and undertaking bio-remediation or capping of old dump sites. The implementation of these rules has specific timelines ranging from 1 to 5 years, depending on the task. Overall, the rules aim to improve solid-waste management practices across the country and promote sustainable waste disposal methods.
National Government – Ministry of Environment Forests and Climate Change	Plastic Waste Management (Second Amendment) Rules 2022	The Ministry of Environment, Forest and Climate Change has decreed the Plastic Waste Management (Second Amendment) Rules (2022), which came into force in February 2022. The rules further amend the Plastic Waste Management Rules (2016) with several changes including definitions of terms like biodegradable plastics, importer, plastic packaging, recyclers, reuse, use of recycled plastic, waste-to-energy, post-consumer plastic packaging waste, and pre-consumer plastic packaging waste. They also specify protocols for compostable and biodegradable plastic materials and impose extended producer responsibility (EPR) for plastic packaging. Additionally, the rules introduce provisions for imposing environmental compensation based on the "polluter pays" principle for non-compliance with the rules.

National Government – Central Pollution Control Board		Statutory organization that formulates technical guidelines and action plans at the national level for all types of waste management.
State Government – Department of Environment Forests and Climate Change	Maharashtra State Action Plan on Climate Change (MSAPCC):	The action plan outlines Maharashtra's strategy for addressing climate change impacts and enhancing resilience. It includes measures to mitigate GHG emissions, adapt to climate change impacts and promote sustainable development.
	EPR	The Ministry of Environment, Forest and Climate Change issued the Plastic Waste Management Rules (2016) and the Solid Waste Management Rules (2016) to manage plastic waste in India. These rules mandate generators of plastic waste to minimize its generation, avoid littering, ensure segregated storage and hand over segregated waste. The rules also outline the responsibilities of local bodies, gram panchayats, waste generators, retailers and street vendors in managing plastic waste. The Plastic Waste Management Rules (2016) impose EPR on producers, importers, and brand owners for both pre-consumer and post-consumer plastic packaging waste. The guidelines provide a framework for implementing EPR and detail the roles and responsibilities of producers, importers, brand owners, the Central Pollution Control Board, the State Pollution Control Board or pollution control committees, recyclers, and waste processors. The guidelines state that the definitions given in the Plastic Waste Management Rules (2016) apply unless specifically mentioned otherwise in the guidelines.
State Government – Maharashtra Pollution Control Board	Construction and Demolition Waste Management Rules (2016)	These rules mandate the proper management of construction and demolition waste generated from building and infrastructure projects in Mumbai, including recycling and reuse, to minimize the environmental impact of such waste.
	E-waste Management Rules (2016)	These rules govern the management of electronic waste (e-waste) generated from discarded electronic and electrical equipment in Mumbai, including collection, recycling and disposal, to prevent its adverse impact on human health and the environment.

City Government – Brihanmumbai Municipal Corporation	Mumbai Solid Waste Management bye-laws	The Brihanmumbai Municipal Corporation has established bye-laws under Section 461(ee) of the Mumbai Municipal Corporation Act (1888) to regulate all matters related to the collection, removal and disposal of solid waste. These bye-laws were approved by the corporation under Resolution No. 724 dated 31 October 2006 and confirmed by the Government of Maharashtra.
	Mumbai Development Plan 2034	The Mumbai Development Plan 2034 is a long-term urban planning document that outlines the city's strategies for land use, infrastructure development, affordable housing, environmental sustainability and resilience planning. It aims to guide Mumbai's growth and development over the next couple of decades by addressing key issues such as housing shortages, transportation challenges, environmental conservation, and economic development. The plan emphasizes creating a more livable, sustainable and resilient city for its residents.
	Mumbai Climate Action Plan	The sectoral priority of solid-waste management recognizes that the city needs to focus on the "4R" approach (reduce–reuse–recover–recycle) to manage its waste in a sustainable and inclusive manner. To do this, the city must implement actions such as segregation at source, organic waste composting, processing of dry waste to recover, and recycling and reusing construction and demolition waste as building material.

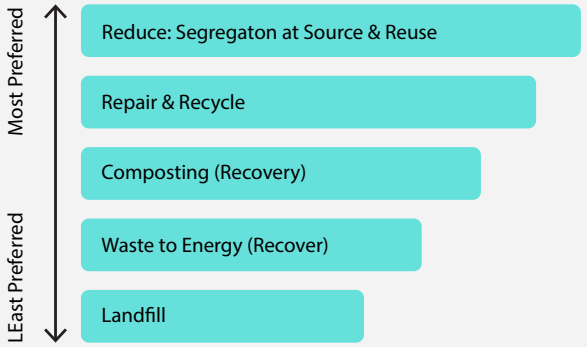
Key City Strategies and Projects for Waste Management

The Mumbai Climate Action Plan 2022 suggests creating value from waste by decentralizing municipal waste management through inclusive climate solutions. The plan will help integrate a climate lens within these initiatives and enhance the city's efforts in sustainable waste management. This priority recognizes that the city needs to focus on the 4R approach to manage its waste in a sustainable and inclusive manner:

The plan set targets for the city to: reduce the waste disposed of in landfill sites by 40 percent by 2030; segregate waste; strengthen collection systems; and decentralize waste management for recovery and recycling of 80 percent of plastic and paper by 2050 for healthier communities and ecosystems.

The BMC has also launched the Vision 2030 Action Plan for Solid Waste Management (Brihanmumbai Municipal Corporation, 2022), which focuses on improving circularity, sustainability and operational efficacy to continually improve citizen experience, bringing a positive transformation in citizens' behaviors towards waste management and sanitation practices, and increasingly embracing technology.

FIGURE 8
The 4R approach for the waste sector in Mumbai



Source: MCAP 2022

FIGURE 9
Targets to Actions as per MCAP 2022

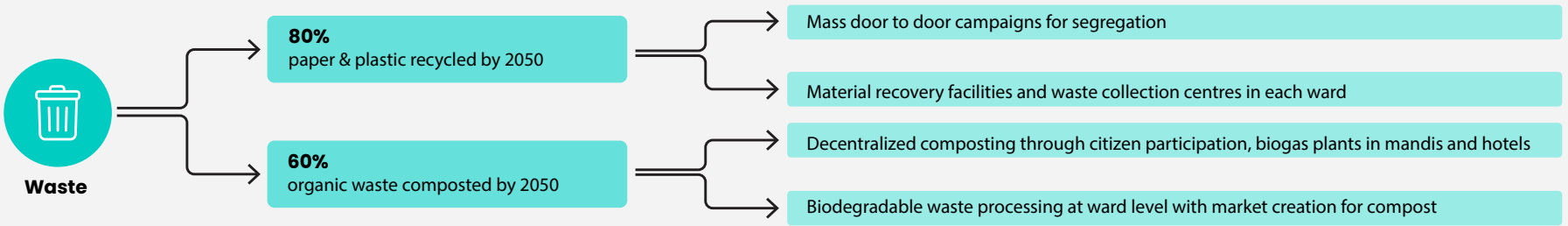
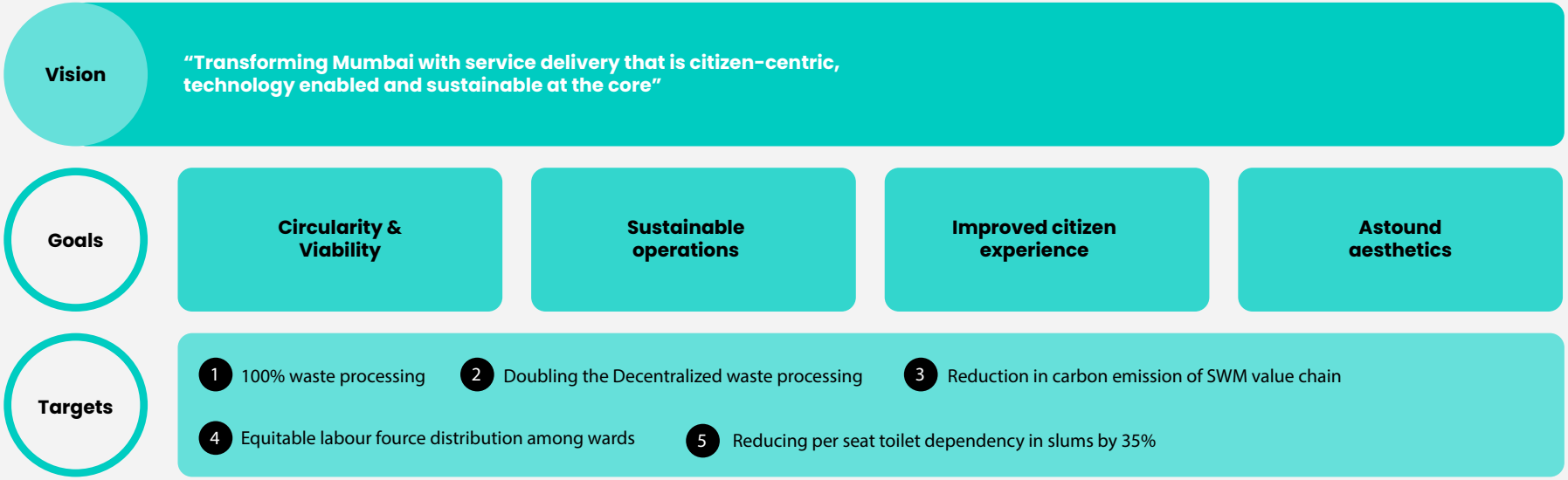


FIGURE 10
Vision, goals and targets for SWM in the Mumbai Action Plan Vision 2030



5. Mumbai's Waste Management System

Overview of Mumbai's waste management system

The city generates approximately 7,000 Metric Tons (MT) of waste per day, though several reports document varying numbers ranging from 6500-11,000 MT. This waste is collected primarily through door-to-door collection. The city has four refuse transfer stations (at Gorai, Kurla, Mahalaxmi and Versova Lagoon) where waste collected from nearby wards through small refuse vehicles is collected. At the refuse transfer stations, the waste is loaded into large, closed-body refuse vehicles and transported to landfills for final treatment and disposal. The city also has 46 dry-waste centers (DWCs) of varying sizes and capacities spread across all the wards. These centers help the city manage its dry waste in a decentralized manner, where the dry waste collected is segregated, sorted and sent to either recycling facilities or landfills. According to the Mumbai Environmental Status Report 2021, there are two functioning landfills in the city – namely, Deonar and Kanjurmarg. Most of Mumbai's waste is collected and treated at the Kanjurmarg processing site using bioreactor technology and windrow composting. The waste not sent to Kanjurmarg is disposed of at the Deonar landfill without treatment.

Waste Generation and Characterization

Waste generation rates in Mumbai typically range from 0.45 to 0.85 kg per capita per day (Pendse, 2012), which is higher than the average waste generation rate in India, which stands at 0.57 kg per capita per day (Kaza, Yao, Bhada-Tata, & Woerden, 2018). The MCAP 2022 highlights the city's waste composition:

→ plastic waste (3 percent)

→ paper and metals (3 percent)

→ organic wet waste (73 percent)

→ organic dry waste (3 percent)

→ sand and stones (17 percent)

Only a negligible amount of paper and plastic waste is recycled, while only 9 percent of organic waste is composted while the rest is landfilled. Although the BMC created the Greater Mumbai Cleanliness & Sanitation bye-laws in 2006 to allow the authorities to fine citizens and societies for non-segregation and burning of waste, source segregation still remains a challenge for the city.

FIGURE 11

Waste Management System in the city

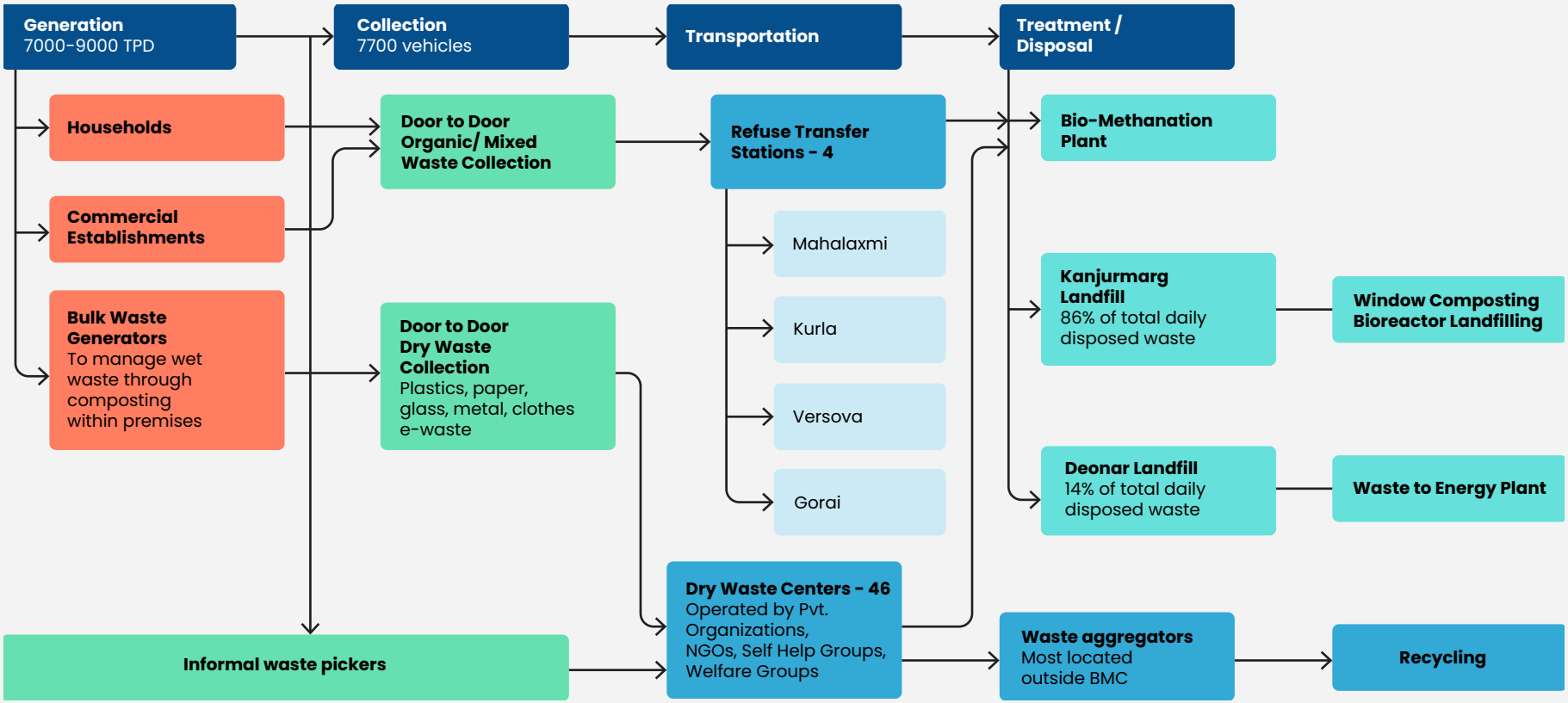


FIGURE 12

Waste composition in Mumbai (MCAP 2022)

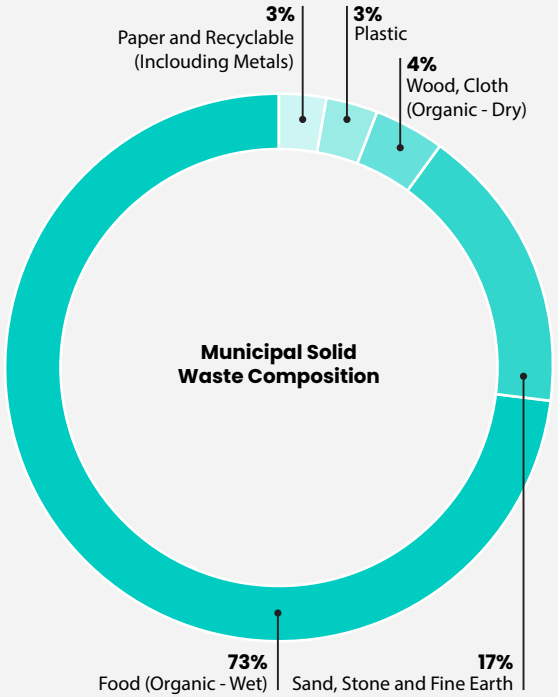
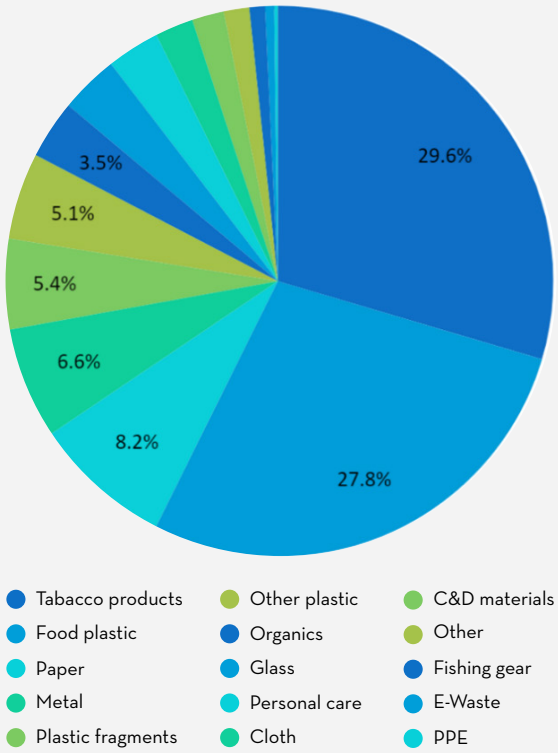


FIGURE 13

Litter items as per the Circularity Assessment Protocol findings



According to the CAP assessment, Mumbai has a smaller percentage of plastic in its waste stream compared to the national average and compared to other Urban Ocean cities in India, such as Surat (7 percent), Chennai (6 percent) and Pune (8 percent). However, over half of all litter items identified in the assessment were either in the category of tobacco products (all of which contain plastic) or food plastic.

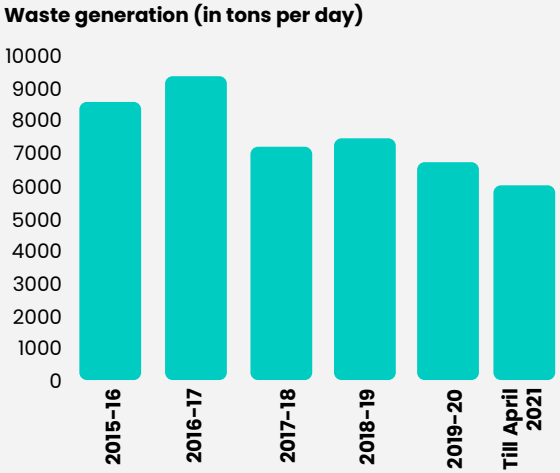
Recent efforts to manage waste and reduce the amount of waste going to landfills have been made by implementing the Solid Waste Management Rules (2016), which has reportedly led to decreased waste generation. For example, the city mandates bulk-waste generators to treat their organic waste themselves.

However, despite these efforts, Mumbai's sheer volume of waste requires segregation of waste at source, reuse/refill systems, recycling, efficient transportation systems and innovative decentralized waste management practices. It is crucial to address these issues to ensure effective and sustainable solid-waste management in the city.

To minimize plastic waste, the use and manufacturing of plastic bags less than 50 microns in thickness was banned in 2016. Alternatives to single-use plastic bags, such as paper and reusable bags, are seen, although the CAP identified that plastics were still provided by the surveyed businesses, making up 50 percent of the collected items by count. Of these plastics, the most common was single-use plastic.

FIGURE 14

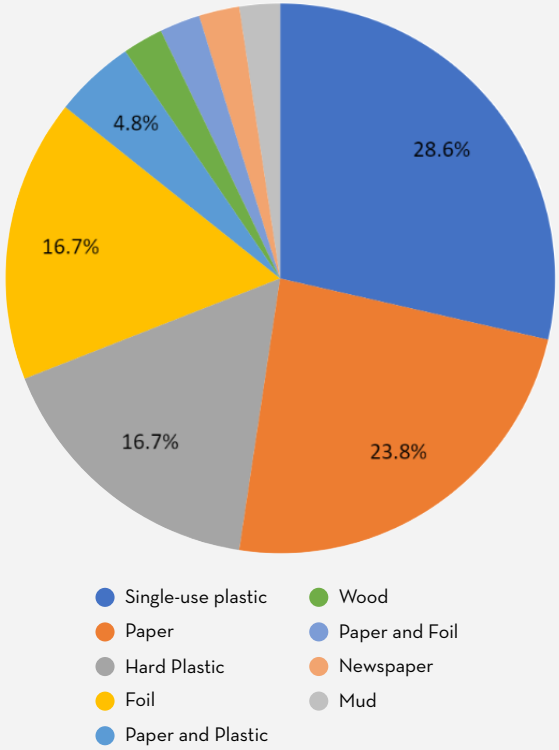
Reduced waste generation in the city since implementing the Solid Waste Management Rules (2016) whereby bulk generators must treat their waste onsite



Source: Mumbai Environmental Status Report, 2021

FIGURE 15

Material breakdown of to-go items from food vendors and restaurants from the Circularity Assessment Protocol findings



Waste Collection and Transportation

Waste collection in Mumbai is primarily undertaken through door-to-door collection. The density of the habitats, especially in slums and on hilly terrain in certain areas, poses significant challenges for doorstep collection, as it is difficult for waste collection vehicles to navigate congested, narrow, sloping streets. BMC has deployed tricycles in some of these settlements for more effective waste collection.

The BMC has appointed private agencies for the collection and transportation of solid waste. All wards have dedicated vehicles and work shifts are allocated for collection and transportation of solid waste using these vehicles. Each vehicle makes two to three trips per day to collect solid waste from households. Various vehicles, such as compactors, skip vehicles, refuse vehicles, bulk refuse carriers, four-wheel-drive cars, excavators and stationary compactors, are deployed to collect and transport municipal solid waste.

FIGURE 16
Collection of waste from residential and commercial areas

FIGURE 17
Collection of roadside waste

FIGURE 18
BMC's waste collection tricycles that encourage waste segregation in slums

The challenges to waste collection include:

→ the large population to be serviced

→ the density of settlements

→ difficulties of access in some areas (especially slums)

→ inadequate source segregation

→ the diversity of waste generators within service areas, including:

- formal and informal residential sites
- eateries
- commercial sites
- micro-industries
- institutional generators

→ a very high proportion of floating population in some wards

→ waste generated by crowded events.

Additionally, considerable accumulation of waste is observed in Mumbai's waterbodies. Flooding due to blockages, especially in the rainy season and during extreme weather events, poses additional difficulties for waste collection and management.

Dry-waste Centers

The BMC has 46 dry-waste centers operating in all the wards, with 96 vehicles dedicated to collecting and transporting dry waste to these centers. They are run by about 30 organizations, including private organizations, non-governmental organizations (NGOs), self-help groups and welfare groups. DWCs play a central role in the city's strategy to expand its recycling capacities, which can be supported by mass awareness campaigns, increased infrastructural capacities and better waste-management data at the city level.

The BMC provides the space for these centers and vehicles for waste collection. DWC operators oversee the dry-waste collection, employ waste pickers and sorters, and send the sorted dry waste to recyclers. Depending on the space available, DWCs handle the collection, segregation, storage and processing of dry waste. Dry waste includes materials such as paper, plastic, metal and glass. By diverting dry waste from landfills, DWCs help reduce the environmental impact of waste disposal and promote recycling and resource recovery. In many cities, such centers serve as key hubs for waste segregation, where waste pickers and workers manually separate different types of dry waste. This segregation is vital for ensuring that recyclable materials are properly sorted and sent for recycling rather than disposed of in landfills.

A crucial aspect of these DWCs is their incorporation of waste pickers into the formal waste management ecosystem. DWCs contribute to the informal economy by providing livelihood opportunities for waste pickers and workers involved in waste segregation. These centers help create a value chain for recyclable materials, allowing waste pickers to earn income by collecting and selling valuable materials such as plastic bottles, glass, paper and metals. DWCs also buy waste from informal waste pickers not participating in the formal waste management system, further reducing leakage into the environment, waste burning and waste being sent to landfills. DWCs are crucial in managing recyclables, enabling resource recovery of waste collected from households in the city and promoting circular-economy practices within the city's waste management system.

A preliminary assessment of DWCs undertaken as part of the Urban Ocean program indicated that there may be opportunities to build on their achievements and further enhance their effectiveness to yield improved quantity and quality of recyclables in the waste management system. To investigate this further, a workshop was organized in February 2024 with the operators of the DWCs in collaboration with the BMC to identify common challenges, pressing needs, and support required of the city. The workshop was well attended, with representation from 25 centers in the city.

FIGURE 19
Dry-waste centers

FIGURE 20
Snapshots from the DWCs operators' workshop in Mumbai

Land, Infrastructure and Space Availability at the DWCs

An 11-month agreement is signed between the BMC and the DWC operator, under which the BMC provides land and infrastructure support, such as water, electricity, and waste collection vehicles, to all the DWCs.

The DWC's size depends on available parcels of land, as earmarked in the city's development plan. Currently, operating DWCs are of varying sizes. Of the DWCs that attended the workshop, four have an area of less than 500 m2, indicating compact and generally manual operations. Meanwhile, DWCs with larger areas (more than 1,000 m2) have mechanized systems such as conveyor belts for sorting, additional storage space and greater capacity to handle higher quantities of waste each day.

Larger and better-planned DWCs have toilets within the premises, first-aid facilities, signage and adequate space for managing their waste sorting and pre-processing operations. Some operators mentioned holding regular meetings with their workers and focusing on worker welfare, for instance through provision of safety gear, insurance and monthly allowances.

The operational efficiency and capacity of DWCs that are relatively smaller (less than 500 m2) are restricted by overcrowding and difficulties in accommodating the necessary equipment for waste segregation and storage. For example, six out of the seven DWCs run by Parisar Bhagini Vikas Sanstha (Stree Mukti Sanghatana) have an area of less than 500 m2, with one as small as 20 m^2. Additionally, four out of the seven do not have electricity, hampering their ability to operate mechanized equipment such as bailing machines or conveyor belts. These challenges can be mitigated by improving the layout of the DWCs to optimize space and workflows, deciding the extent of material to be handled at smaller DWCs, providing basic infrastructural facilities and integrating into the material flow chain to enhance their efficiency in waste management.

Operations – A Typical Day at a DWC

The BMC has provided vehicles and drivers to each DWC for waste collection. Additionally, some DWCs have also deployed their own vehicles to increase the quantity of waste collected each day. The day typically begins at 7 a.m., as the first trip for dry-waste collection commences. Each DWC follows a pre-determined route to collect waste efficiently. Despite challenges such as heavy traffic, DWC vehicles can undertake two to three trips each day. The second trip in the afternoon generally collects waste from commercial areas.

When the waste arrives at the center, it is a mix of paper, plastic, metal and hazardous waste. Before it can be sent for recycling, the collected waste is meticulously segregated into various grades of paper and cardboard, types of plastics, metal and glass. The segregated waste is then stored at the DWC and sold to aggregators or recyclers at negotiated prices, ensuring a systematic and sustainable waste management process.

In residential areas, vehicles typically receive a mix of household dry waste, including paper, cardboard,

FIGURE 21
Dry waste collection vehicles provided by BMC to the DWCs

plastic and glass bottles. In contrast, waste collected from commercial areas tends to be more uniform and consists mainly of bottles, food plastic waste, paper, cardboard and packaging materials.

One or two workers from the DWC accompany the collection vehicle to collect dry waste. Once the waste arrives at the DWC, it is weighed and segregated into seven to eight categories. The segregated materials are stored at the DWC. Once the waste is segregated, it is bailed (compressed) if a bailing machine is available, or separately packed and sent to recycling. The rejected or remaining non-recyclable waste is either sent to cement factories for co-processing or sent to landfills.

While the BMC's provision of separate vehicles and drivers to each DWC is a positive step, operations in DWCs could be improved. Currently, these centers collect waste only from households that segregate waste. Improving efforts in household-level waste segregation will be the first step towards improving the quantity and quality of waste received at the DWCs. Depending on space availability, the process of segregating waste at the DWC could be optimized through mechanized equipment.

FIGURE 22
Inside the DWCs in the city

FIGURE 23
Sorted waste at DWCs

Workers' Wages

Workers are typically paid in one of the following ways:

→ Fixed daily wages, ranging 300–500 INR ($3.5–6 USD), depending on the location and norms of the center.

→ Wages based on the amount of waste segregated, such as 3 INR ($0.03 USD) per kilogram.

→ A monthly payment, which generally falls between 15,000 and 18,000 INR ($180–215 USD)

The informal work conditions and remuneration for workers at some DWCs may be of concern. There is a need to hire staff trained to handle waste with the provision of a decent salary. Strengthening and formalizing the economic contributions of these waste workers will help strengthen the waste ecosystem in the city.

Good practices from a few DWCs are as follows.

Aasara Welfare Association manages a DWC at Bandra West. They partner with household staff (who work in the households and are generally responsible for taking the waste out), small aggregators, sweepers, kabadiwalas (smaller waste aggregators), and scrap shops to increase the volume of dry-waste collection received at the center and recover more recyclables. Such local partnerships can be helpful to create sustainable dry-waste collection and recycling in the city.

ReCircle manages a DWC at Dahisar. Worker conditions are relatively good, including the use of safety equipment, healthcare support, regular medical check-ups, health insurance and ensuring the staff have access to healthcare facilities. ReCircle also ensures that the staff receives fair wages, which helps improve workers' livelihoods and contributes to a more sustainable and equitable work environment. Focusing on workers' welfare can be beneficial in improving working conditions in the DWCs in the city.

Parisar Bhagini Vikas Sanstha has integrated over 135 women waste pickers at seven DWCs, providing livelihoods and strengthening the role of informal women waste pickers in the city's waste management ecosystem. Several studies suggest that women have long been at the forefront of waste collection activities, especially in the informal sector. Inclusion of women and facilitation of the formation of self-help groups for waste management, as also indicated in SWM Rules 2016, can help the city provide livelihoods, safety and dignity to these workers.

Waste Treatment and Disposal

In 2018, the BMC issued an order mandating bulk-waste generators to set up biodegradable waste composting units. Around 50 percent of the bulk generators identified by the BMC are currently composting waste at source. The BMC is working towards increasing this proportion by levying fines and raising awareness among non-complying bulk-waste generators.

The city has four refuse transfer stations: Gorai, Kurla, Mahalaxmi and Versova Lagoon. At these stations, waste collected from nearby wards through small refuse vehicles is unloaded. The waste is then transferred to larger vehicles and transported to the dumping ground for final disposal.

According to the Mumbai Environmental Status Report 2021, there are two functioning landfills in the city: Deonar and Kanjurmarg. Most of Mumbai's waste is collected and treated at the Kanjurmarg processing site using bioreactor technology and windrow composting. Waste that is not disposed of or treated at Kanjurmarg is disposed of at the Deonar landfill without treatment.

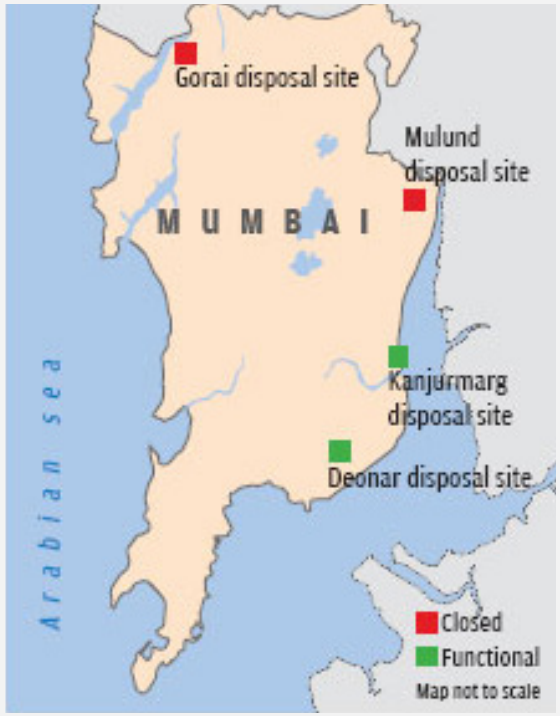
The Deonar landfill is the city's oldest, receiving approximately 14 percent of Mumbai's daily waste, with the remaining 86 percent going to Kanjurmarg. A third landfill at Mulund has stopped receiving waste and an effort to recover the land by processing the existing waste with suitable technology is in progress.

A fourth landfill at Gorai received waste from 1972 until 2007 and discontinued it thereafter, in accordance with a directive from the Hon. Supreme Court of India. In 2009, the Gorai landfill was officially closed.

The Deonar landfill has exhausted its capacity. A creek surrounds this landfill on three sides, and the continued landfilling of waste presents an ecological risk with a waterbody so close in proximity. There have been several instances of fires erupting at this landfill. A major fire broke out in February 2015, which was extinguished after 10 days of firefighting operations. After this incident, the BMC was ordered by the Bombay High Court to close the site by 2019 and develop waste treatment plants that can handle the waste in a responsible manner. Through an official request from the city to the Bombay High Court, an extension to continue its use was given until 2023. A waste-to-energy plant is proposed at the site which is expected to be functional for 25 years and will process 3,000 metric tons of waste at Deonar every day and generate 25–30 megawatts of energy (Hindustan Times, 2020). However, waste-to-energy plants have negative consequences because of associated GHG emissions and because they have no reuse or recovery of plastics for recycling. Urban Ocean partners recognize the need for implementable and circular solutions that hold plastics producers accountable for the full lifecycle of their products, cease the leakage of plastics into the environment, and incentivize reuse. In 2012, the Kanjurmarg landfill received authorization from the Maharashtra Pollution Control Board to process 1,000 tons per day of municipal solid waste by windrow composting and 3,000 tons per day by way of bioreactor technology.

Given the severe constraint of land availability and land prices in the city, alternative locations for landfills and waste treatment centers are scarce and difficult to secure.

FIGURE 24
Landfills in the city



Recycling of Waste

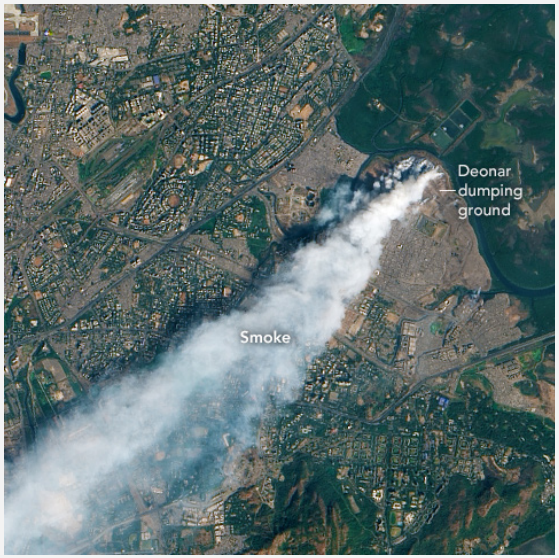
BMC data show that, in 2022, about 52,295 MT of dry waste was received at the DWCs and 1,277 MT of plastic was segregated for recycling. These 46 DWCs are spread across different wards of Mumbai, indicating a city-wide effort towards dry-waste management and recycling. Nearly 800 informal workers are engaged in these centers.

In Mumbai, like Pune, Bangalore and a few other cities in India, there have been efforts to integrate informal waste pickers, especially women, in waste collection and sorting. In 1998, Stree Mukti Sanghtana established the Parisar Bhagini Vikas Sangh with the BMC to support the livelihoods of women waste pickers, their children's education, and their access to social welfare (Stree Mukti Sanghatana, 2023).

FIGURE 25
Huge pile of city waste behind slums at Deonar landfill

Source: Mongabay, 2019

FIGURE 26
Satellite image of the fire breakout at Deonar landfill on 28 January 2016



Source: NASA, 2016

6. Key Findings and Opportunities

This section provides insights into strengthening Mumbai's solid-waste management initiatives with resilience co-benefits.

Challenges

Solid-waste management in Mumbai is complex due to the diversity of stakeholders and cultures, the large resident and floating populations with changing characteristics and above-average per capita waste generation, the number and nature of activities using different materials generating a variety of waste, and a very high proportion of informal- sector activities in the collection, sorting, transport, trading and processing of waste. The physical proximity of the waste systems to the waterbodies and ocean implies that waste leakage is quickly transported to the marine environment. The city is also vulnerable to the impacts of climate change as the waste sector is also a contributor to GHG emissions and waste accumulation in water bodies and low-lying areas, leading to flooding.

The BMC and various stakeholders, including citizens, formal and informal entrepreneurs, NGOs, civil-society organizations and corporates, are contributing to solid-waste management through multiple initiatives. Given the complexity and scale of the challenges, these initiatives are commendable. However, several challenges are yet to be overcome, as follows.

CLIMATE VULNERABILITIES

Mumbai is the most populous city in India and has one of the highest population densities in the world at 28,400 persons per km2. The city is severely constrained by its geography, being surrounded by the sea on three sides and occupying a small land area of around 460 km2. Largely built on reclaimed land, Mumbai is vulnerable to climate hazards, including sea level rise, storm surges, flooding, coastal erosion and cyclones. Research shows a large part of Mumbai is at risk of being submerged by 2050 (Kulp & Strauss, 2019). The city is also susceptible to landslides because of heavy rains that cause many fatalities and physical damage every monsoon. With a business-as-usual scenario and no corrective actions to address the impending climate risks, Mumbai's total losses for a once-in-a-100-year return period event are projected to triple by the 2080s. The contribution of indirect losses to total losses would increase from 14 percent in the present-day situation to 18 percent in the 2080s (Hallegatte, 2013) Also, by 2080, the likelihood of urban floods such as the July 2005 event is more than double (Ranger, Hallegatte, & Bhattacharya, 2011) Mumbai's climate action plan lays out a comprehensive strategy to mitigate and adapt to expected climate change impacts. Strategic and sustainable local actions are needed to achieve the ambitious goals set out in this plan.

LOW LEVELS OF SOURCE SEGREGATION

The Environment Status Report 2020-21 for Mumbai reports 82 percent waste segregation. However, this segregation is not at source but at the DWCs, where waste is separated into various categories like plastic, paper, glass and metal to be sent for recycling. Improvement in waste segregation at source can lead to cleaner material being received at these centers and improve the amount of recyclables recovered. Primary reasons behind this low level of segregation at the source include the need for a shift in attitudes, lack of enforcement backed by strong collection systems, and lack of trust among citizens that household-level waste segregation will be efficiently handled and not mixed during collection.

There is also a need to continuously strengthen waste collection, especially in low-income, dense areas or slums, where providing door-to-door collection services can be a challenge. Waste dumping and leakage into waterbodies and waste burning implies a gap in collection services.

Discussions with representatives of DWCs also suggest that housekeeping staff or domestic workers keep certain "clean recyclable waste materials" to sell on their own, causing waste collectors to lose potential earnings. Since waste collectors depend on income from the sale of recyclables (to supplement any collection fees), such diversion can discourage them from providing efficient waste collection services.

OPEN DUMPING OF WASTE IN WATERBODIES

The BMC has a wide network of water bodies including rivers and creeks. Man-made blockages in these rivers and drains from sewage inflows and haphazard dumping of garbage have emerged as primary contributing factors behind waterlogging in the city. Reports by the Central Pollution Control Board state that major sea outlets and beaches in Mumbai are being polluted by untreated sewage and surface pollution, including solid waste, with average maximum biological oxygen demand recorded at the major beach outlets being six times higher than the norm prescribed by the CPCB, indicating high levels of pollution severely impacting the aquatic life and surrounding environment. In October 2020, a National Green Tribunal order also stated that creeks, rivers, and the sea along Mumbai's coastal stretch are under threat from continuous discharge of toxic and untreated waste that is thrown directly into nallahs by the public and those residing in informal settlements. Over the past years, the BMC has undertaken several efforts towards managing solid waste in the city's water bodies, including improving efficiency in waste collection, purchasing excavators to clean up the rivers and drains, desilting waterbodies and regular coastal clean-up drives.

DRY WASTE RECOVERY AND END-OF-CYCLE

Several reports note that waste recovery in Mumbai is low. A 2021 report by Praja notes that Mumbai has only been able to recover 35 percent of waste material over the last five years – compared to 80 percent recovery expected from Urban Local Bodies according to the SWM Rules (2016). This can be improved by leveraging the existing DWCs and strengthening their operations so that they can be optimized in the dry-waste material chain. Focus on improving the working conditions and livelihoods of women waste pickers and the possibility of linking the formation or strengthening of groups of women waste workers to corporate social responsibility and EPR could be further explored.

The establishment and expansion of waste treatment facilities (such as landfills and incinerators) must carefully factor in their proximity to human habitation and the potential health risks they might pose. The existing landfills have caused severe environmental and social hazards affecting human and environmental health. Mumbai currently does not have city-level solid-waste management that promotes decentralized management at the ward level. Centralized strategies tend to be resource heavy, with a focus on the transport of waste rather than waste reduction, segregation and recycling, which is essential for Mumbai given the increasing trend of waste generation and a severe shortage of space.

MATERIALS LEAKAGE

As the Urban Ocean CAP for Mumbai also shows, tobacco sachets, cigarettes, plastic food wrappers, and multilayered plastics are predominantly the materials that are most likely to escape collection and leak into the environment.

Though regulations are in place to reduce single-use plastic, there is a need to improve monitoring and enforcement, continue outreach campaigns and improve the availability of alternatives. EPR is not yet an effective driver to significantly reduce the production and use of plastic packaging, especially low-value and difficult-to-recycle multimaterial or multilayered plastics. However, the city can strengthen the building blocks for EPR systems, including information and documentation of material flows, and improve decentralized micro-infrastructure for waste.

Opportunities

The following opportunities can help strengthen solid-waste management systems and address the leakage of plastic waste into the environment and waterbodies. The opportunities identified either build upon existing innovations and systems or have been highlighted by the city and stakeholders as key concerns for which new approaches need to be developed.

STRENGTHENING DRY-WASTE CENTERS

In Mumbai, DWCs play a crucial role in the city's waste management ecosystem. These centers help the city manage waste in a decentralized manner, where the waste collected from the city is segregated, sorted and sent either to be recycled or to landfills. DWCs play an important role in recovering and managing recyclables from the waste collected from households and commercial entities in the city and promoting circular-economy practices within the city's waste management system. Improving the efficiency of these centers is an immediate opportunity identified by the BMC. This is also highlighted in the city's CAP.

Based on the DWC workshop undertaken with the city and DWC operators, aspects like defining clear roles and responsibilities for all parties, well-defined contracts, improving the layout of each DWC to optimize space and workflows, improving working conditions, deciding the extent of material to be handled at smaller DWCs, providing basic infrastructure and integrating DWCs into the material flow chain to enhance their efficiency in waste management can improve the functioning and efficiency of the DWCs.

IMPROVING PUBLIC AWARENESS OF SOURCE SEGREGATION AND SERVICES PROVIDED BY DWCS

Each DWC is allotted a vehicle to collect and transfer dry waste. Along with measures to enhance DWC efficiency, localized communication, and citizen engagement, strategies are also needed to enhance waste segregation, which is the first step towards receiving cleaner and higher quantities of recoverable waste in the DWCs.

Improved public awareness can lead to:

- Improved source segregation levels
- Improved quality of dry waste collected and sent for recycling
- Improved quantity of waste collected per trip
- Improved efficiency of collection.

IMPROVING WASTE MANAGEMENT IN SLUMS

About 54 percent of Mumbai's population (an estimated 6 million) lives in slums, which are very dense settlements, often posing challenges for waste segregation and collection. Through hyperlocal strategies for outreach and communication and by strengthening and supporting community-based agencies, it may be possible to enhance solid-waste collection and management services in slums. The learnings from the work of Parisar Bhagini Vikas Sangh, which works on citizen engagement, inclusion of waste pickers and provision of livelihoods, can be leveraged and scaled up in the city.

Efforts by NGOs, such as the Green Community Foundation, that have innovated plastic-waste collection from slums and low-income communities, can also be encouraged. These plastic-collection models encourage communities to take responsibility for their plastic by reducing the usage of plastic, storing clean plastic waste at home, and handing over the clean plastic to the volunteers for recycling, promoting voluntary segregation and collection of plastic waste. Drives such as giving groceries in exchange for plastic waste have also proven successful. They also provide community training, demonstrate segregation and provide bags and drums for dry-waste collection and recycling.

Building upon such an opportunity is especially relevant to check the dumping of waste in creeks and rivers adjoining these underserviced slums and low-income communities.

PLASTIC-WASTE ANALYSIS

Currently, the city lacks data on the generation of plastic waste by consumers and the extent of recycling within the informal sector. The volume of plastic packaging entering commercial markets and reaching customers has not been estimated. Approaches to estimate the waste generation and extent of capture for recycling would clarify the gaps and strengthen the system. The Urban Ocean program, through its Circularity Assessment Protocol, provides a comprehensive assessment of plastic waste in the city, which can be used by the BMC for data-driven decision making on interventions that the city can implement.

TACKLING ILLEGAL OPEN DUMPING OF WASTE FOR CLEANER WATERBODIES

Mumbai has been grappling with river and coastal pollution for decades. This came to the forefront after the 2005 floods in Mumbai, and the BMC has undertaken multiple initiatives, such as rejuvenation of waterbodies, installation of effluent/sewage treatment plants, and trash traps in waterbodies to deal with this issue. However, open dumping of waste in waterbodies has been persistent and there is an urgent need to identify the causes and address this issue at source. This opportunity can reduce environmental and public health hazards, improve flood management, improve living conditions and be conducive to a positive visual image of a cleaner city in the long run.

STRENGTHEN THE RECYCLING ECOSYSTEM

The scrap trade in Mumbai is largely informal. Networks and connections are very important to growing one's business, getting good prices and surviving competition. However, there are advantages to more professional networking and strengthening the association between actors in the recycling ecosystem. Examples include sharing machinery or equipment, finding buyers and sellers for specific types of materials, supply chain optimization, information exchange, innovation, and policy dialogue. This may require further discussion among scrap trade-related actors, especially connecting and communicating with existing associations and networks.

This recommendation is based on a few operators reporting, during the DWC workshop, that they face an accumulation of Multi-Layer Plastic (MLP) due to the low value of the material. On the other hand, some aggregators stated that they were looking to procure larger quantities of MLP to be used for a range of products. A registry of operators and recyclers and materials bought and sold can help strengthen the recycling ecosystem. At a larger scale, drivers like a country-level policy change in EPR rules or technical solutions to easily recycle this fused material may be needed to enhance MLP recycling.

ZERO-WASTE WARDS THROUGH ADVANCED LOCALITY MANAGEMENT

Mumbai's Advanced Locality Management (ALM) program is one of the earlier efforts of citizen–government partnerships for SWM in India. Initiated in 1997, ALMs are still operational in Mumbai. These are voluntary groups of residents and commercial establishments like residents' associations that are involved in civic initiatives in their neighborhoods, including waste segregation, composting, maintenance of green and open spaces and rainwater harvesting. The activities conducted by ALMs are carried out in collaboration with the BMC.

While ALMs are involved in a range of issues, there is an opportunity to strengthen the focus of ALMs on local waste management to develop local systems and micro-infrastructure of source segregation, oversight for collection, decentralized waste management strategies, promoting reuse-and-refill behavior, avoiding dumping, burning and mismanagement, and promoting the recycling of waste.

ZERO-WASTE EVENTS	Numerous events occur in the city every day, each contributing to bulk-waste generation. This can be minimized through adjustments in local bye-laws and guidelines, toolkits, training and orientation to promote zero-waste events. The city can work towards - • Guidelines for zero-waste events • Communication material for such events • A list of service providers that can help event management agencies tackle event waste • A list of service providers that can provide alternatives to single-use plastics • Sustainable use of material for events set up and management
ADVOCACY EFFORTS ENABLING A SHIFT FROM PLASTIC TO SUSTAINABLE PACKAGING FOR TOBACCO PRODUCTS	The CAP documented 9,438 litter items in 27 transects of 27 sample areas, of which tobacco products such as sachets and cigarettes, and food plastic such as plastic food wrappers, were a high proportion. The manufacturers are within the country. However, there is a high carbon footprint associated with getting the products to the stores. The assessment had similar findings in Pune and Surat, and this may be the case in cities across India. This small-sized and lightweight plastic waste is widely littered and easily leaked into the environment, especially into waterbodies and the ocean. There is a need to enforce a change of packaging material for all tobacco products. Policy interventions and engagement with producers may enable this change.
EPR IMPLEMENTATION	There is a need for reinforcement of EPR and an understanding of how the city can benefit from enabling recycling. The MCAP 2022 also notes that the BMC Solid Waste Management department may collaborate with the Maharashtra Pollution Control Board and private companies to develop a comprehensive strategy, rules and a framework for enhancing the implementation and reporting of EPR by 2025. The expected impact is enhancing the quantity of e-waste and plastic waste being recycled. The opportunity can also help streamline the financial benefits for improving the livelihoods and work conditions of informal sector workers.

7. Glossary of Terms

Biological Oxygen Demand: Biological oxygen demand is the amount of dissolved oxygen needed by aerobic biological organisms to break down the organic material present in a given water sample at a certain temperature over a specific time period. A high biological oxygen demand indicates a high level of microbial pollution.

Bio-remediation: Bioremediation is a process that uses microorganisms to degrade organic waste

BMC: Brihanmumbai Municipal Corporation. BMC is the administrative authority that governs the city of Mumbai

CAP: Circularity Assessment Protocol. Assessment protocol developed by the University of Georgia to identify and analyze waste streams, particularly plastics

CPCB: Central Pollution Control Board of India

CSR: Corporate Social Responsibility

Dry Waste: Dry waste comprises of things like paper, glass, plastic, cardboard, Styrofoam, rubber, metal, food packaging material, etc

DWC: Dry Waste Centre. A DWC receives, separates, and prepares recyclables to be sold to an end buyer. A DWC uses a combination of equipment, machines, and manual labor to separate and prepare the materials

EPR: Extended Producer Responsibility

GHG: Greenhouse gas

ILO: International Labour Organization

INR: Indian Rupee

MCAP: Mumbai Climate Action Plan

MSW: Municipal Solid Waste. Waste that originates in homes and establishments such as commercial establishments, hotels and educational establishments

NGO: Non-governmental organization

OC: Ocean Conservancy

PPP: Public–Private partnership

PWM: Plastic Waste Management

R-Cities: Resilient Cities Network

SBM: Swachh Bharat Mission

SHG: Self Help Group. SHGs are voluntary groups of people, generally women, with equal interests, who come together to generate livelihood for themselves

SWM: Solid Waste Management

TCI: The Circulate Initiative

TPD: Tons per day

USD: United States Dollar

Wet Waste: Wet waste typically refers to organic waste usually generated through kitchens in households and commercial eating establishments. This can include food

WRI: World Resources Institute

URBAN OCEAN

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