URBAN OCEAN

PROJECT STATEMENT

Mumbai

Reducing Landfilled Waste and Marine Litter in Mumbai

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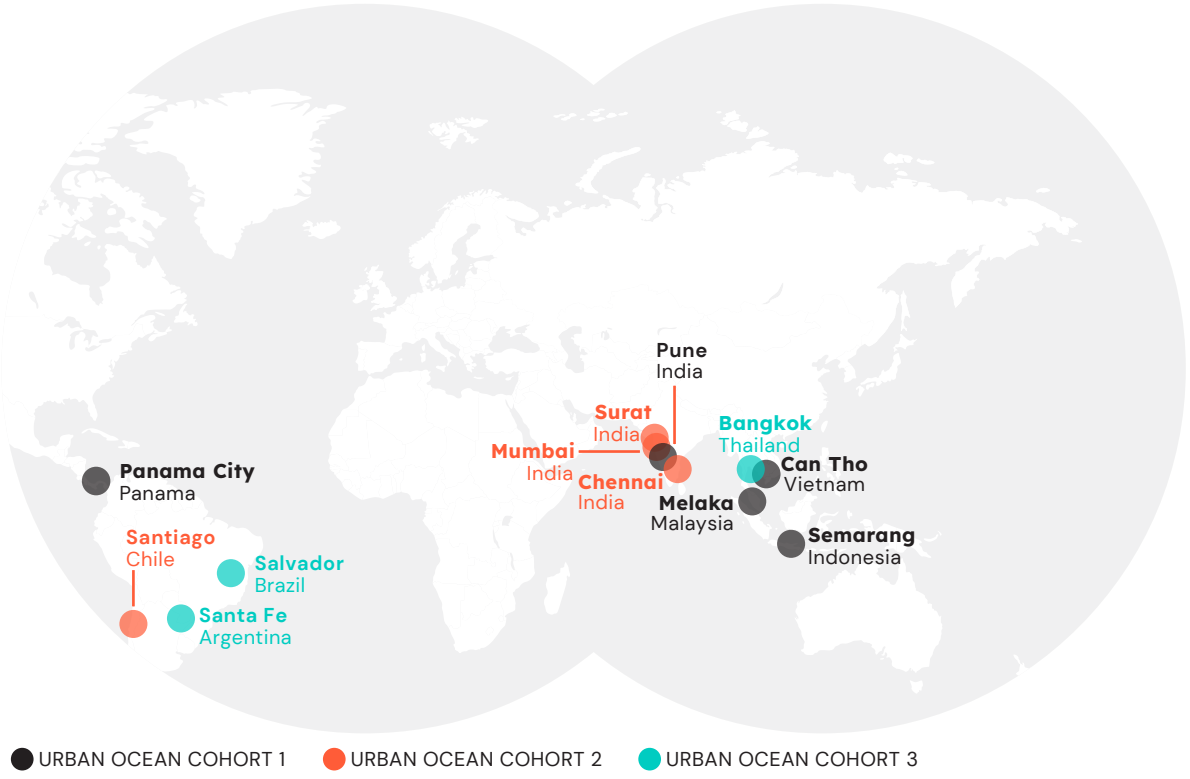
1. Introduction

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 waterbodies 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 community and beyond.

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



Program objective

Urban Ocean provides a platform for ocean advocates, city leaders and partners to join forces with other allies to develop comprehensive solutions that meet the needs and priorities of governments, cities, communities and other actors to create meaningful and sustainable impact. The program provides and coordinates baseline assessments to gauge the efficacy, challenges and opportunities of existing waste management systems. Urban Ocean instigates intentional questioning to identify priorities that participating cities could develop and implement to improve waste management, reduce plastic pollution and create circular solutions and conditions that also address social inclusion, public health, environmental protection and reduction of greenhouse gas emissions. Once opportunities are identified, Urban Ocean supports cities to attract support to implement solutions.

Program approach

Urban Ocean supports cities to develop strategies and projects designed to address the interrelated challenges of ocean plastics and community resilience. The program approach in cities is Figure 1.

Project statement

This project statement is the result of two years of work and dedication by the Mumbai Urban Ocean team and trusted partners to develop specific actions that the city hopes will advance solutions to address plastic waste challenges. The project statement is based on the results of a Circularity Assessment Protocol (CAP), a rigorous gap assessment process and several one-on-one interactions and consultation sessions that helped the city pinpoint the best opportunities for impact. It outlines the context and the needs of the city on which the project is built. It provides the city's vision and outlines the desired impact.

FIGURE 1
Urban Ocean program approach

Preparation Forum

Sessions related to resilience, plastic policy, science-based solutions, finance and circularity incubators

Innovation dialogues with the private sector

Gap Assessment

Circularity Assessment Protocol (CAP)

Framing session

Participatory session

Solutioning tool

Opportunity assessment

Project Design

Project proposal development

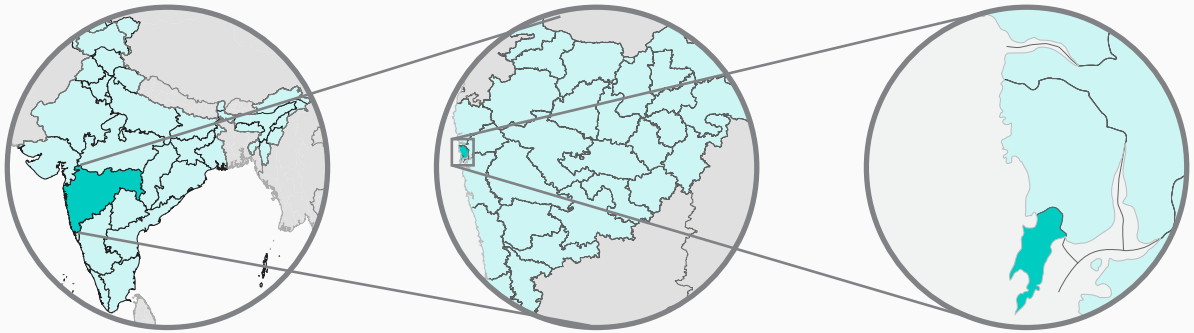
2. City context

Mumbai is located on the western coast of India and is the capital of the state of Maharashtra. It is India's commercial hub and its most populous city. The city continues to grow in population: a government census in 2011 reported 12 million residents in the city while, as of 2023, several city reports as well as international reports estimate this count at 18-20 million. Originally a cluster of seven islands until the 1800s, which later fused to form the present-day city, Mumbai is divided into three geographic sections: the island city (or main city), the western suburbs and the eastern suburbs. According to the Mumbai Development Plan 2034, the city covers a total area of 458 km2. The Brihanmumbai Municipal Corporation (BMC) is the administrative authority that governs the city. The city is part of the Mumbai Metropolitan Region, which covers more than 6,000 km2 of area and consists of nine municipal corporations, including the BMC.

The BMC has seven zones and 24 administrative or municipal wards. Each ward has its own ward office and ward officer responsible for services in that area. The BMC is led by the Municipal Commissioner and four senior Indian Administrative Services officers as additional municipal commissioners – one for each division and one for spearheading special projects across the city.

Economically, the city was once the center of India's cotton textile industry. Later, its manufacturing sector diversified. Now, Mumbai serves as the financial hub of India. The financial sector further solidifies its central economic role, with the Reserve Bank of India being located in the city, along with most of the leading banks in the country.

FIGURE 2
Geographical context of Mumbai



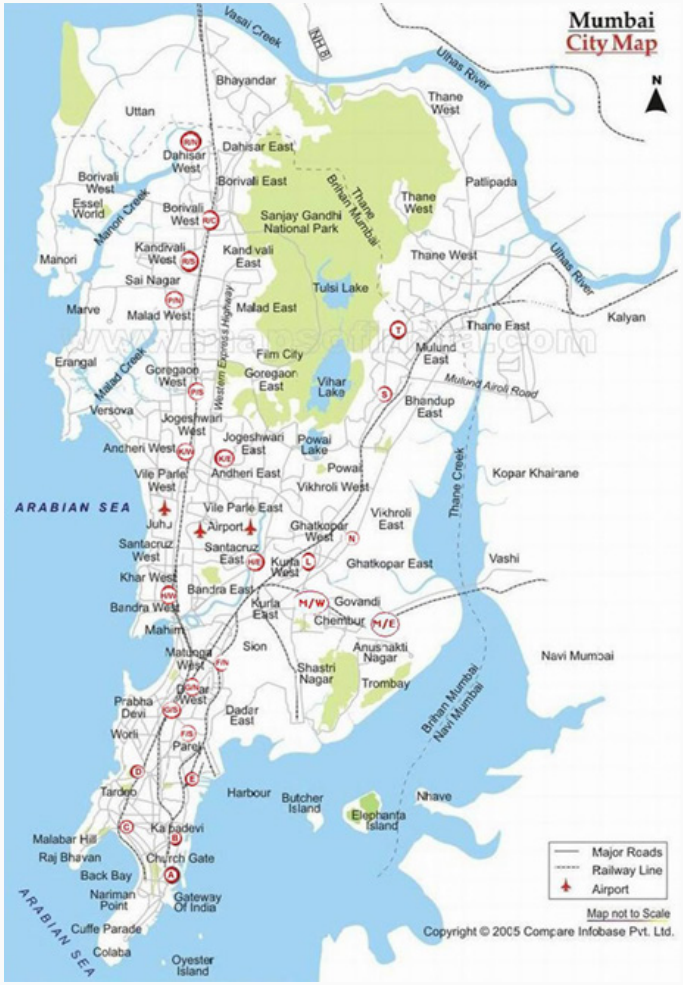
State of Maharashtra in Western India | **Mumbai Metropolitan Region** | **Brihanmumbai Municipal Corporation**

Furthermore, the two largest national stock exchanges are based in the city. The Hindi film industry, known popularly as Bollywood, India's largest film industry is located in Mumbai. Employment opportunities play a major role in attracting people to Mumbai, with the city witnessing a massive influx of people over recent decades. The Mumbai Metropolitan Region received 2.48 million migrants in the 1991–2001 period. While for most other Indian metropolitan cities, migration is largely from within the same state, Mumbai is an exception where 63 percent of migrants are from other states and 36 percent are from within Maharashtra. Meanwhile, in BMC, of the total increase in population between 1991 and 2001, 60 percent was the result of natural increase, and about 40 percent was due to migration.[1] This has led to huge pressure on the city's infrastructure, which is consistently operating at maximum capacity.

Soaring population growth has driven up the demand for land, but since the city is surrounded by the ocean on three sides, it is severely constrained for land availability. So, land is highly valuable due to its scarcity. Many migrants who arrive in the city cannot afford the skyrocketing real estate and end up living in "chawls",[2] slums or informal settlements that provide accommodation for very affordable prices but that lack proper infrastructure. Slums occupy less than 10 percent of Mumbai's land mass but house 40-50 percent of its population.[3]

Mumbai is one of the densest megacities in the world, with a population density of 28,400 people per km^2. On average, each citizen of Mumbai has only 1.1 m^2 of open space – the international standard is 11 m^2 per person. Only 6 percent of the land in the city is made up of open public spaces.[4]

FIGURE 3
Map of Mumbai



Source: Compare Infobase Pvt. Ltd.

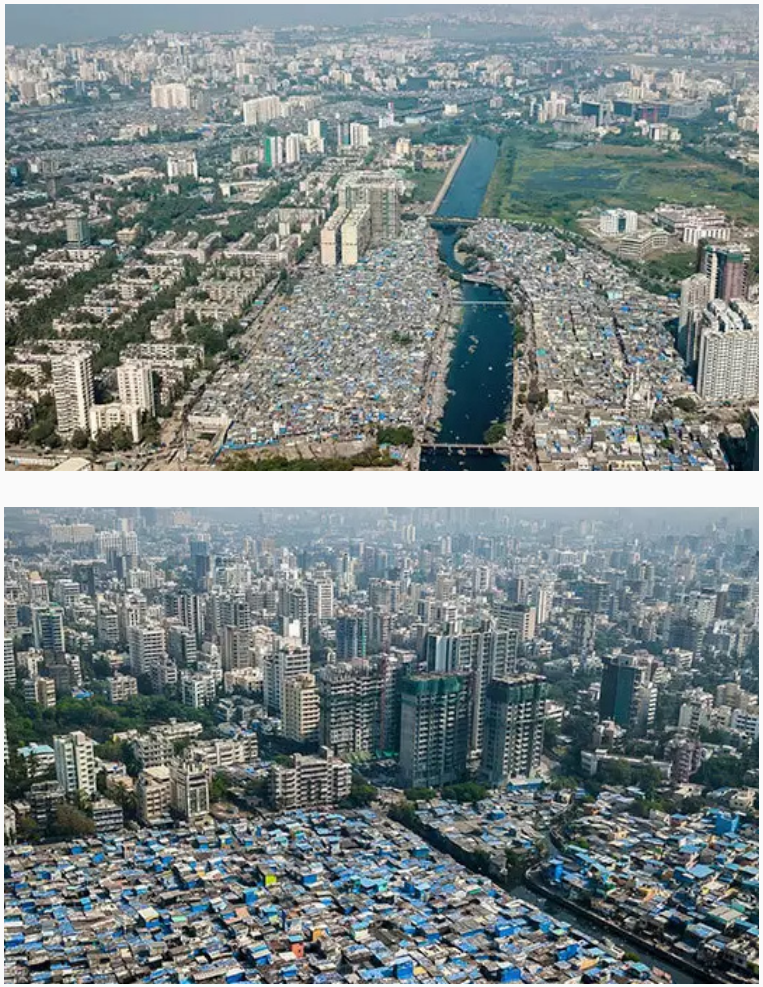
1 Indorewala, H. et al. (2017). "City Résumé Mumbai". Kamala Raheja Kamla Raheja Vidyanidhi Institute for Architecture and Environmental Studies. https://mdl.donau-uni.ac.at/binucom/pluginfile.php/402/mod_page/content/22/KRVIA_1_K.pdf.

2 Chawls of Mumbai have acted as one of the city's most important forms of affordable housing since the pre-independence era in India. Large tenement complexes built during Mumbai's industrial boom from the 1850s through the first half of the 20th century, chawls once housed workers from the ports and textile mills of what was then called Bombay. Each unit typically houses entire families in single rooms with shared/communal washing facilities. While some of these chawls are redeveloped into modern residential apartments, many still remain in the city serving as low-cost housing to migrants. Source: Bloomberg, 2023. https://www.bloomberg.com/news/features/2023-11-01/mumbai-chawl-tenements-helped-build-the-megacity-but-they-are-under-threat

3 Biswas, S.K. (2013). "Play! Tactics & strategies for public spaces in Mumbai's informal city". Observer Research Foundation. www.orfonline.org/wp-content/uploads/2013/08/Tactics-strategies.pdf.

4 Adarkar Associates. (2016). "Inventorisation of Open Spaces & Water Bodies in Greater Mumbai". Mumbai Metropolitan Region Environment Improvement Society. www.mmreis.org.in/images/research/Open-Spaces-Water-Bodies.pdf.

FIGURE 4
Slums in Mumbai



Source: Unequal Scenes, Johnny Miller

FIGURE 5
Chawls in Mumbai

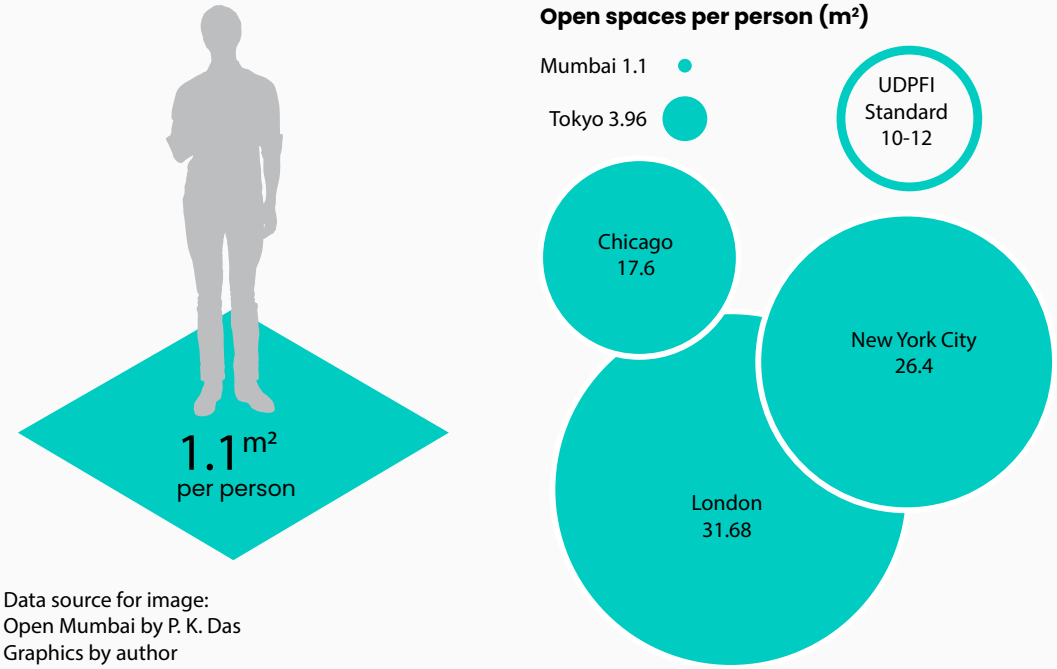
Source: Bloomberg, 2023

Dahisar, Mithi, Oshiwara and Poisar are Mumbai's four rivers, which flow into the Arabian Sea through the Malad, Mahim, Marve and Thane creeks, respectively. These rivers originate in the Sanjay Gandhi National Park, a protected area to the northeast of the city. The city has three lakes: Vihar, Tulsi and Powai. Mumbai has a coastline of 146 km, and most of the city is at sea level – the average altitude ranges from 10 to 15 meters. According to the Mumbai Climate Action Plan (MCAP) 2022,[5] the eastern coast is characterized by large mangrove swamps, rich in their biodiversity, while the western coast is mostly sandy and rocky with a 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 performing the function of productive carbon sinks. The Mumbai Development Plan 2034 has demarcated these ecologically sensitive areas, such as forests, mangroves, waterbodies and areas under Coastal Regulation Zone 1 as natural areas where no (built) development is permitted.

As the city is surrounded by the ocean on three sides, Mumbai is one of the most vulnerable cities to climate change hazards, with stresses including urban flooding, heat waves, sea level rise and storm surges. The Sixth Assessment Report by the Intergovernmental Panel on Climate Change, published in 2023, predicts that increased rainfall will in turn increase the number of flooding events. Sea level rise projections for 2050 predict that the Arabian Sea could flood Mumbai at least once every year. Mumbai is a member of the C40 Cities Network. In 2020, Mumbai signed C40's Deadline 2020 commitment

5 BMC. (2022). "Mumbai Climate Action Plan". https://mcap.mcgm.gov.in.

FIGURE 6
Space constraints in the city



Data source for image:
Open Mumbai by P. K. Das
Graphics by author

Source: Observer Research Foundation, Data source for the image: Open Mumbai by P.K Das

FIGURE 7
High population density in the city

Source: The Zolo blog, 2020

aligned with the Paris Agreement to reduce greenhouse gas emissions by 50 percent by 2030, to support the Government of India in achieving its Nationally Determined Contributions and become a net zero emitter by 2050.

The MCAP highlights floods in 2005, which resulted in 410 deaths and displaced thousands, particularly in the low-income areas. The vulnerability of the city's infrastructure and overwhelming socioeconomic inequalities were revealed by the disastrous monsoon rains and flooding that year. The city witnessed the heaviest recorded rainfall in a single day in India, which had a devastating impact on transportation, telecommunications, power and financial services. The flood resulted in an estimated loss of $109 million USD in local business revenue.[6] For 10 days, suburban and low-lying areas near the Mithi River remained waterlogged and without services, appropriate shelter, potable water or food.

The scale and dynamic nature of Mumbai, combined with its demography, ecology, geography and economy, make the development and implementation of disaster management, climate action and other city-level plans inherently difficult. The sheer size of the city increases its vulnerability to disaster risks. The MCAP highlights urban flooding, urban heat, coastal risks, landslides and air pollution as the primary climate risks that the city faces today. Mumbai's greenhouse gas emissions inventory states that the stationary energy sector is responsible for 72 percent of Mumbai's total emissions, followed by the transportation sector (20 percent) and the waste sector (8 percent). Of the 8 percent from the waste sector, 50 percent is due to solid waste – mainly emissions from landfills.

Because of the complex challenge of managing such a large and dynamic city, the BMC's prevailing approach to waste management has been increasingly inclined towards innovative solutions to better manage solid waste, including increasing awareness of waste segregation and decentralizing waste management. The MCAP has set sustainable waste management as one of the six sectoral priorities that the city will work towards to create value from waste by decentralizing municipal waste management through inclusive climate solutions.

6 Stecko, S. and N. Barber (2007) "Exposing Vulnerabilities: Monsoon Floods in Mumbai, India". UN Habitat. https://staging.unhabitat.org/downloads/docs/GRHS.2007.CaseStudy.Mumbai.pdf.

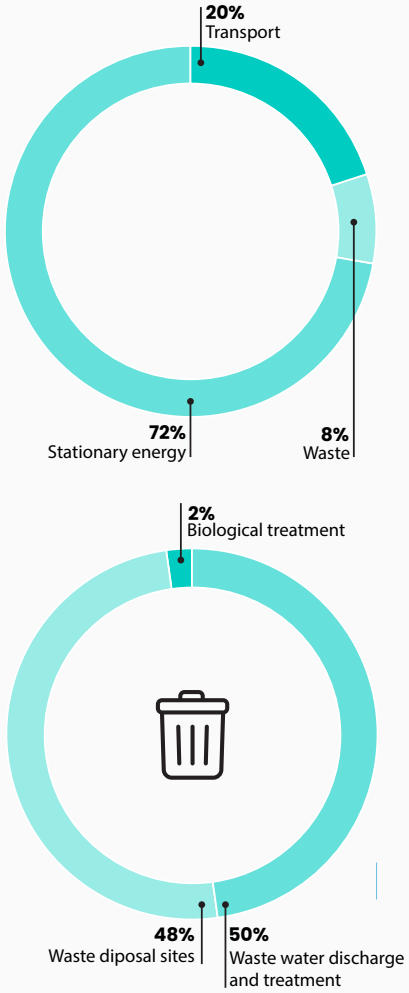
FIGURE 8
Floods in the year 2005

Source: Zee Business, 2019

FIGURE 9
Impact of floods on public transit systems

Source: Hindustan Times, April 2022

FIGURE 10
GHG emissions in Mumbai per sector

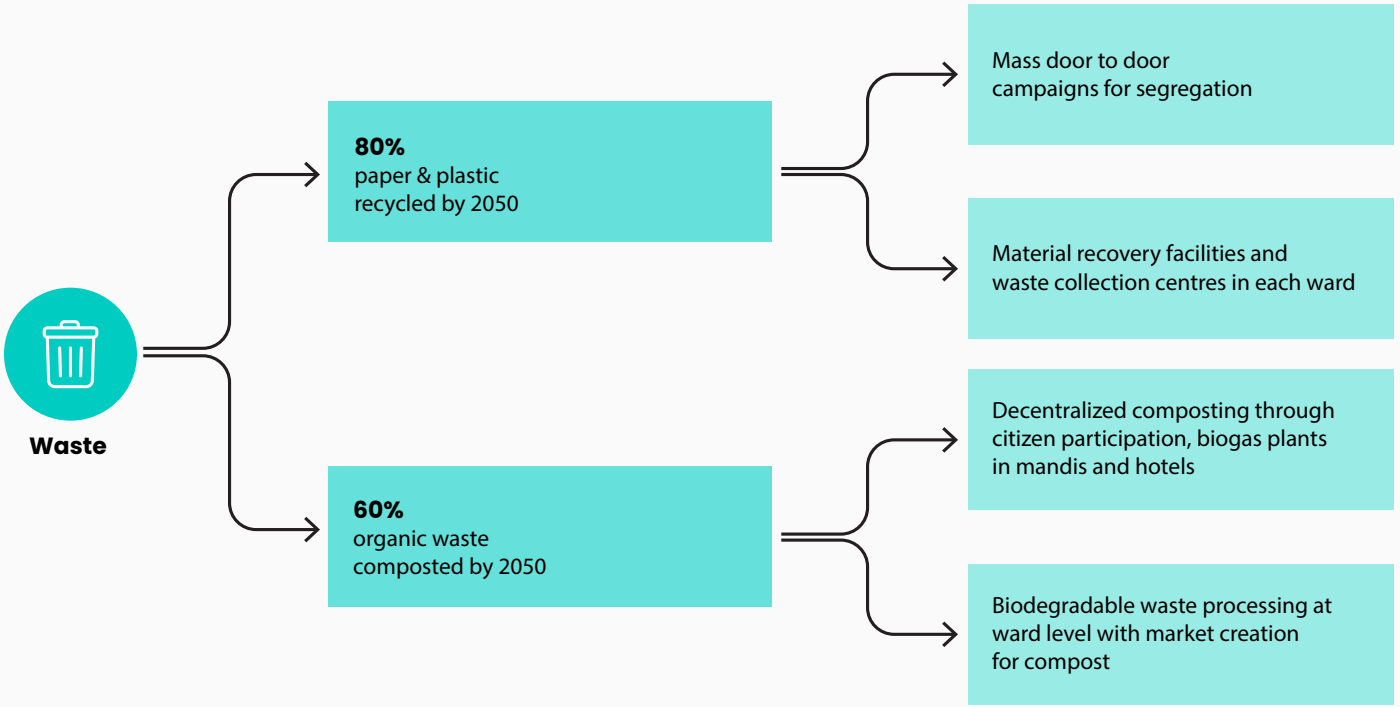


Source: MCAP 2022, analysis by WRI India

Mumbai's waste management system

The Mumbai Climate Action Plan defines "Sustainable Waste Management – Adopting an inclusive and zero-landfill waste management strategy" as one of the six sectoral priorities that the city wants to prioritize for climate resilience. To advance the goal of zero-landfill waste management, the city has set ambitious targets and a focus on the "4R" approach (reduce, reuse, recover, recycle) towards sustainable waste management.

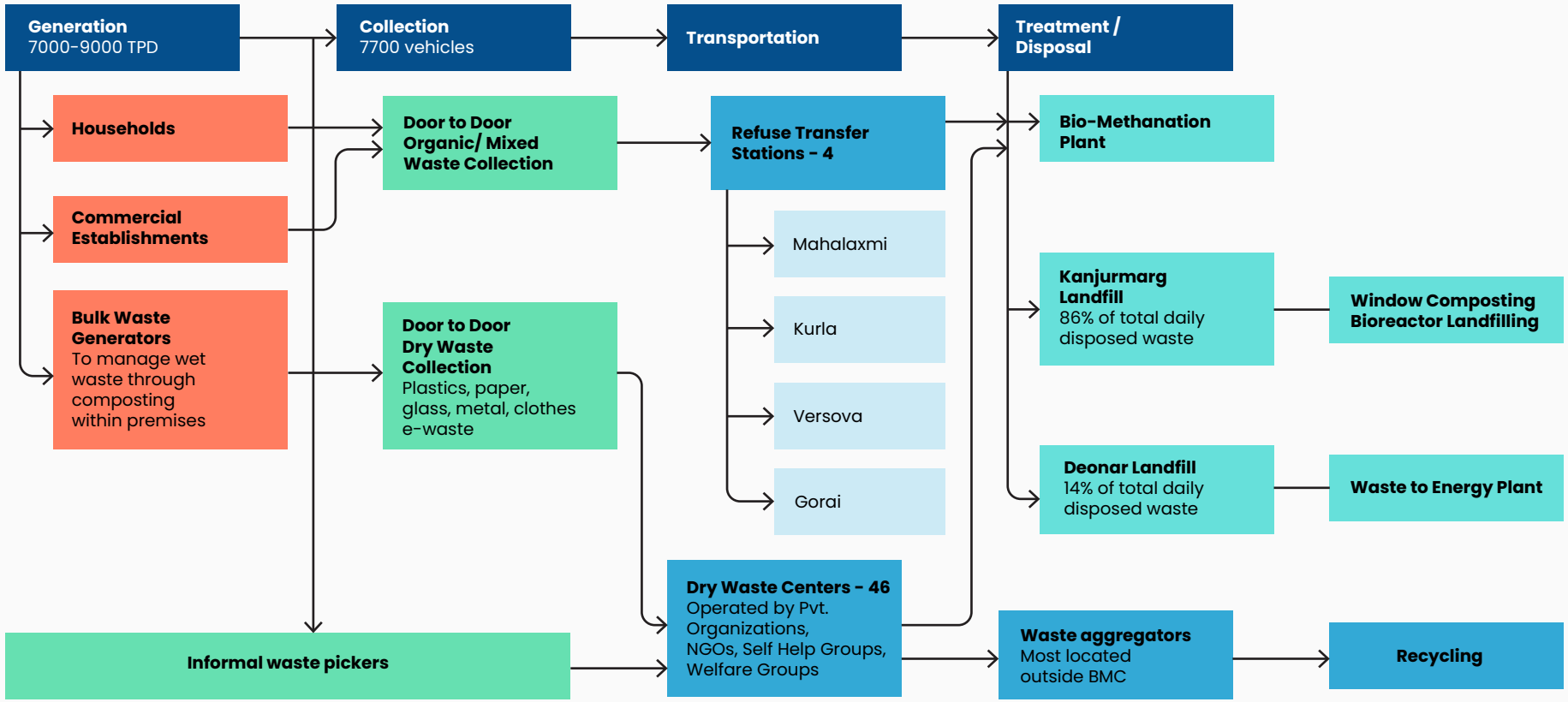
FIGURE 11
Targets for waste management from the Mumbai Climate Action Plan 2022



Source: MCAP 2022, analysis by WRI India

Solid-waste management in Mumbai is the responsibility of the Brihanmumbai Municipal Corporation's solid-waste management department. Mumbai's waste management system is represented in Figure 12.

FIGURE 12
Mumbai's solid-waste management system



Solid-waste management in Mumbai is the responsibility of the Brihanmumbai Municipal Corporation's solid-waste management department. Mumbai's waste management system is represented in Figure 12.

Several reports by the state and city governments estimate the amount of solid waste being generated at 7,000–9,000 tons per day. The Environmental Status Report 2021 by the BMC highlights the city's waste composition, which shows that organic waste forms the highest proportion at 73 percent, followed by construction and demolition waste at 17 percent, plastic waste at 4 percent, and paper and metals at 3 percent.

Additionally, the Mumbai Circularity Assessment Protocol, a key baseline assessment of plastic waste and circularity within the city conducted as part of the Urban Ocean program, shows (Figure 13) that around 30 percent of the litter in the city is composed of tobacco products, around 28 percent is food plastic and around 8 percent is paper. However, the MCAP suggests that only a negligible amount of paper and plastic waste in the city is recycled, while only 9 percent of organic waste is composted and the rest is landfilled.

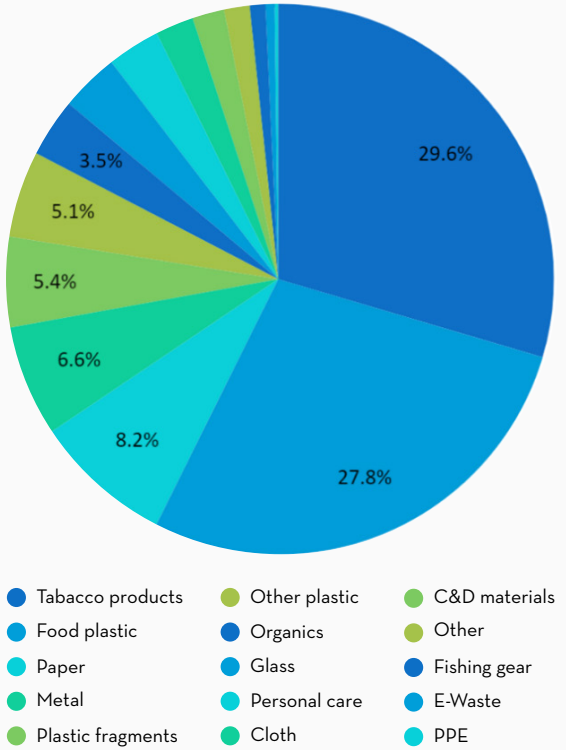
The BMC created the Greater Mumbai Cleanliness and Sanitation Bye-laws in 2006 to enable the authorities to fine citizens and residential complexes who indulge in mismanagement, non-segregation and burning of waste. However, segregation of waste at source remains a challenge for the city. Municipal Solid Waste (MSW) is collected through door-to-door collection and transported by deploying different types of vehicles.

The city has four refuse transfer stations at Mahalaxmi, Kurla, Versova Lagoon and Gorai, where MSW collected from nearby wards is collected using small refuse vehicles. At the refuse transfer stations, the waste is loaded into large, closed-body refuse vehicles and transported to landfills for final disposal.

The BMC has 46 dry-waste centers (DWCs) of varying sizes and capacities spread across all the wards of the city. These centers help the city manage waste in a decentralized manner, where the waste collected from the city is segregated, sorted and sent to either recycling or landfills. The BMC has floated tenders for an additional five DWCs with a capacity of 100 Metric Tons (MT) per day and expandable up to 250 MT per day, indicating the need for such centers to handle dry waste. The DWCs play a central role in the city's strategy to expand its recycling capacities, which is supported by mass awareness campaigns, increased decentralized infrastructural capacities, and maintaining waste management data at the city and ward level.

These DWCs are operated by about 30 organizations, including private organizations, non-governmental organizations, self-help groups, and welfare groups. 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. A crucial aspect of these DWCs is their incorporation of waste pickers into the formal waste management ecosystem. The DWCs also buy waste from informal waste pickers, offering them a rupee higher than the market rate for a kilogram of each product.[7]

FIGURE 13
Mumbai Circularity Assessment Protocol analysis of litter items



7 Virani, S. (2022). "Inside a dry waste segregation centre in Mumbai". Citizen Matters Mumbai. https://mumbai.citizenmatters.

FIGURE 14
14 Waste Collection

FIGURE 15
Dry-waste centers

According to the Mumbai Environmental Status Report 2021, there are two functioning landfills in the city at Deonar and Kanjurmarg. Most of Mumbai's waste is collected and treated at Kanjurmarg using bio-reactor technology and windrow composting. The waste not collected 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 stopped receiving MSW in December 2018 and an effort to recover the land by processing the existing waste with suitable technology is in progress.

A fourth landfill at Gorai received municipal solid waste from 1972 until 2007, when it was discontinued by directive of the Supreme Court of India. Around 2.34 million metric tonnes of waste was disposed of at the Gorai landfill after which it was officially closed.

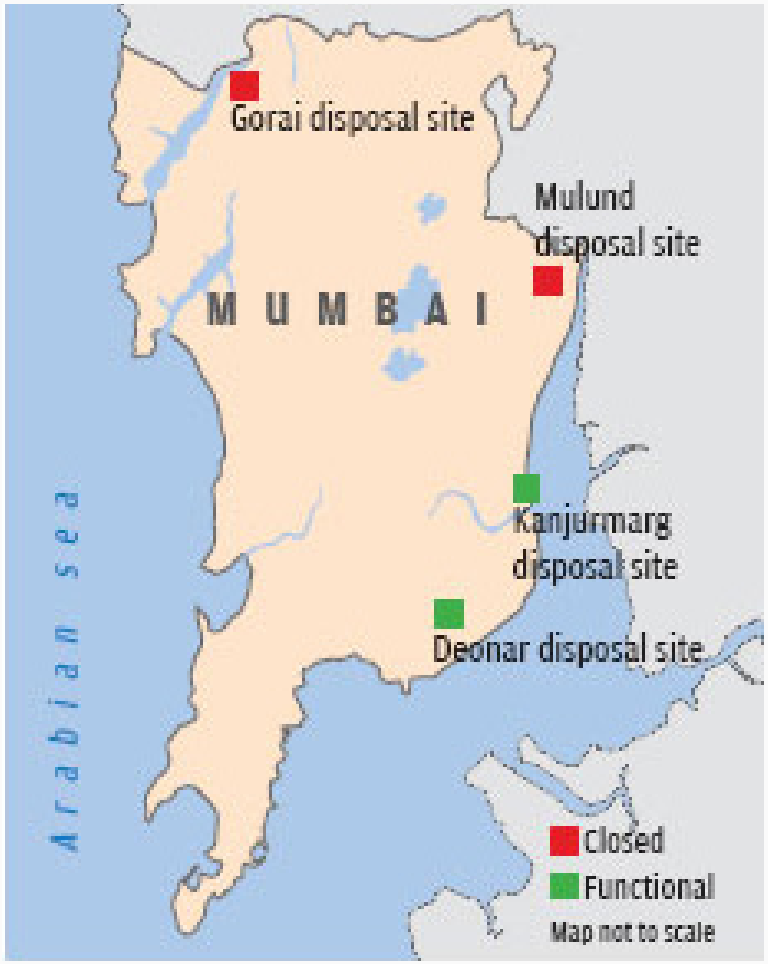
The Deonar landfill has exhausted its capacity to receive waste, however 14 percent of the city's disposed waste is still sent to this landfill. A creek surrounds the landfill on three sides and the continued landfilling of waste represents an ecological risk with a waterbody so close in proximity. There are also inhabitants in slums and informal settlements neighboring the landfill who report severe health issues. Educational institutions and non-governmental organizations in the city have continued to raise the issue of poor living conditions among residents near the landfill. There have also been several instances of fires erupting at the Deonar landfill. A major fire broke out in February 2015, which was only 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 and appropriate manner with minimum environmental and health consequences. 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 MT of waste at Deonar every day to generate 25-30 megawatts of energy.[8] It is important to note that waste-to-energy plants have negative consequences because of associated GHG emissions and no reuse and 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.

Both operating landfills have high population density near them and have faced several protests from political parties in opposition, residents and environmentalists for the serious environmental and health hazards they pose, especially health risks for people living and working in the vicinity of the landfills. 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.

in/photo-story-dry-waste-segregation-centre-mumbai-36557.

8 Thakker, M. R. (2020). "Let us dump waste at Deonar ground till 2023, BMC tells HC". Hindustan Times. www.hindustantimes.com/cities/let-us-dump-waste-at-deonar-ground-till-2023-bmc-tells-hc/story-3TBmYFjbxr0d7aQFEsczNJ.html

FIGURE 16
Locations of landfills



Source: Down to Earth, 2016

FIGURE 17
Deonar Dumping Ground

Source: Scroll.in, 2019

3. Policies and key stakeholders in the waste management system

Actor and 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 focuses on addressing challenges such as inadequate waste segregation, lack of community awareness about waste management, and the burning of municipal solid waste in various areas. Swachh Bharat Mission has an institutional structure of government officials and private consultants who overview the mission progress at the national level as well as state level. At the city level, the solid-waste management (SWM) department is responsible for implementation and reporting. The cities generally also hire private consultants for implementation of the mission. The cities report their progress back to the state, who in turn reports back to the national government.

National Government – Ministry of Environment, Forests and Climate Change	SWM Rules 2016	The Ministry of Environment, Forest and Climate Change introduced the Solid Waste Management Rules in 2016, which focus on the appropriate and responsible management of solid waste in urban areas. The rules outline various objectives and timelines for effective waste management. These include identifying suitable sites for waste processing and landfill facilities, enforcing waste segregation at the source, implementing the door-to-door collection of segregated waste, managing construction and demolition waste separately, establishing waste processing facilities and sanitary landfills, and undertaking bioremediation or capping of old dump sites. The implementation of these rules has specific timelines ranging from 1 to 5 years, depending on the task at hand. Overall, the rules aim to improve solid-waste management practices across the country and promote sustainable waste disposal methods.[9]
National Government – Ministry of Environment, Forests and Climate Change	Plastic Waste Management Rules 2022	The Ministry of Environment, Forest and Climate Change has notified the Plastic Waste Management (Second Amendment) Rules (2022), which come into force on the date of their publication in the Official Gazette. 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 the imposition of environmental compensation based on the "polluter pays" principle for non-compliance with the rules.[10]
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 Pollution Control Board	Maharashtra State Action Plan on Climate Change (MSAPCC)	The MSAPCC outlines the state's strategy for addressing climate change impacts and enhancing resilience. It includes measures to mitigate greenhouse gas emissions, adapt to climate change impacts and promote sustainable development.

9 Government of India (2016). "Solid Waste Management Rules". https://cpcb.nic.in/rules-2/

10 Government of India. (2022). "Plastic Waste Management (Second Amendment) Rules". 2-amendment-pwmrules-2022.pdf (cpcb.nic.in)

	Extended Producer Responsibility	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 according to the rules. 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 extended producer responsibility 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 Bylaws	The Municipal Corporation of Greater Mumbai 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 2022	The sectoral priority of solid-waste management recognizes that the city needs to focus on the 4R approach 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 recycle and reuse construction and demolition waste as building material.

4. Translating challenges into opportunities

Challenges

The Circularity Assessment Protocol tool captured weaknesses and strengths in Mumbai's waste management, which were discussed in consultation sessions with the city officials and local stakeholders. The key challenges highlighted during these sessions are listed below:

1. High population density and limited land availability

Mumbai is the most populous city in India and serves as the core of the Mumbai Metropolitan Region, which is among the top ten urban agglomerations in the world. The city is severely constrained by its geography and occupies a small land area of around 460 km², surrounded by the sea on three sides. Given this limited land availability, the city has one of the highest population densities in the world at 28,400 persons per km². The city also has a high floating population that either migrates or travels to the city every day for employment opportunities. A substantial population in the city, around 40 percent, live in informal settlements or slums leading to a complex urban fabric and evident social and economic divides.

The city's high population, coupled with high floating population and booming economy, leads to high waste generation in the city every day. Even with several efforts being undertaken by the BMC to address the growing waste concerns, the city's waste management infrastructure and systems are strained and waste in Mumbai remains a challenge.

2. Climate vulnerabilities

Largely built on reclaimed land, Mumbai has undergone rapid development and continues to receive migrants from all around the country. The city is vulnerable to climate-induced hazards, including sea level rise, storm surge, flooding, coastal erosion and cyclones. Research Climate Central shows a large part of Mumbai is at risk of being submerged by 2050.[11] 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 with flooding, Mumbai's total losses for a once in a 100-year return period event is 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[12]. Also, by 2080, the likelihood of urban floods such as the July 2005 event will have more than doubled[13]. 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.

3. Illegal dumping practices in waterbodies

The BMC has a wide network of waterbodies including rivers, creeks and nullahs/drains. Apart from tidal variations, human-made blockages of 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

11 Kulp & Strauss (2019). "New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding". https://www.nature.com/articles/s41467-019-12808-z

12 Hallegatte, et al. (2013). "Future flood losses in major coastal cities". https://www.researchgate.net/publication/260701937_Future_flood_losses_in_major_coastal_cities

13 Ranger, et al. (2010). "An assessment of the potential impact of climate change on flood risk in Mumbai" https://link.springer.com/article/10.1007/s10584-010-9979-2

the Central Pollution Control Board (CPCB) state that major sea outlets and beaches in Mumbai are polluted from untreated sewerage and/or surface pollution including solid waste[14] with the average maximum biological oxygen demand recorded at the major beach outlets being six times higher than the prescribed norm by CPCB, indicating high levels of pollution severely impacting the aquatic life and surrounding environment. The Maharashtra Pollution Control Board, in an affidavit from 2019, mentions that creeks, rivers and the sea along Mumbai's 437.71 km² coastal stretch are under threat from MSW, with plastic waste being a type of waste found.[15] In October 2020, a National Green Tribunal order[16] also stated that the waterways are under threat from continuous discharge of toxic and untreated waste that is thrown directly into nallahs by the general public and those residing in informal settlements. Over the past years, the BMC has undertaken several efforts to manage solid waste in the city's waterbodies, including improving efficiency in waste collection, purchasing excavators to clean up the rivers and drains, desilting waterbodies and regular coastal clean-up drives, to name a few.

Figure 18 Solid waste in water bodies (Image Source: Report on Action Plan for Mithi River, Maharashtra Pollution Control Board 2019)

4. Low waste segregation rates at source

According to the Municipal Solid Waste Management Rules (2016) and the Swachh Bharat Mission by the national Government of India, cities have to ensure 100 percent segregation of waste at source. According to official reports, 82 percent of the waste is being segregated in Mumbai as of 2019–20.[17] This, however, is not waste segregated at source, as prescribed in the MSW rules. The increase in segregation from 53 percent in 2016–17 to 82 percent in 2019–20 can be partly attributed to the establishment of 46 DWCs in Mumbai[18] where waste is separated into various categories like plastic, paper, glass and metal to be sent for recycling.

While these DWCs are crucial for the city's waste management system, improvement in waste segregation at source will lead to cleaner material being received at these centers, improving the amount of recyclables recovered, which at present stand at approximately 25 percent[19].

The primary reasons behind this low level of segregation at source include a need for behavior change, a lack of enforcement backed by a strong collection system, and a lack of trust among citizens that household-level waste segregation will be properly handled post collection.

5. Low resource recovery rates

Only a negligible amount of Mumbai's plastic waste generated is recycled, which means most of the city's plastic waste ends up in the waterbodies, in landfills or in the environment. Formal collection and segregation are challenging and there is a heavy reliance on informal collectors supported by non-governmental organizations and waste pickers' associations to organize municipal waste collection and sorting for recycling in the city. There is a scope to improve recovery rates for recyclables and promote a circular economy of plastics and other dry recyclable waste, linked to waste segregation at source and strengthening linkages with the informal sector of recycling in the city.

6. Inadequate capacities of dumping grounds

Mumbai had four landfills, of which two are now

14 According to CPCB data (https://cpcb.nic.in/nwmp-data), the average maximum biological oxygen demand recorded in all the major beach outlets was 19mg/L in 2019, much higher than the norm prescribed for beaches by the CPCB of <3mg/L 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 organic material present in a given water sample at certain temperature over a specific time period. A high biological oxygen demand indicates a high level of microbial pollution.

15 Ansari, S. (2018). "Bombay High Court demands solution to coastal pollution". The Asian Age. www.asianage.com/metros/mumbai/310718/bombay-high-court-demands-solution-to-coastal-pollution.html.

16 Anthony, H. (2021). "Here's how Mumbai's most polluted river is being cleaned up" Citizen Matters Mumbai. https://mumbai.citizenmatters.in/how-mumbai-most-polluted-river-is-being-cleaned-up-25792.

17 Praja Foundation. (2021). "Report on Status of Civic Issues in Mumbai". www.praja.org/praja_docs/praja_downloads/Report%20on%20Status%20of%20Civic%20Issues%20in%20Mumbai%202021.pdf.

18 Dry Waste Centers in Mumbai. https://portal.mcgm.gov.in/irj/go/km/docs/documents/MCGM%20Department%20List/Solid%20Waste%20Management/Docs/DWSC%20-%20List%20of%20Centres%20PDF.pdf.

19 Approximate figures as suggested by BMC officials as of 2023.

closed. The condition of the remaining two landfills at Deonar and Kanjurmarg is poor, especially with Deonar already operating over capacity. Adding to the risk of continuing operations at a landfill over capacity, Deonar is surrounded by a creek on three sides, causing leakage directly into waterbodies. Deonar has also had several instances of fire outbreaks, with a major one in 2015, which required 10 days of firefighting operations to handle. Similarly, the landfill at Kanjurmarg is also in the vicinity of a creek and of mangroves. This location has also long been criticized by the city's environmentalists over possible damage to the area's mangrove ecology. Both the sites have high population density in their proximity and have caused serious environmental and health hazards, especially to the residents living in their vicinity.

In 2016, the Bombay High Court issued a stay on all new constructions in the city (with exceptions for buildings that are being redeveloped, repaired or reconstructed, along with medical and educational institutions) unless there was some solution to the increasing amount of waste being sent to the landfills and lack of compliance to the SWM 2016 rules. This stay was lifted in 2018 to explore the possibility of safe methods of permitting certain constructions in the city of Mumbai for a limited period to pave the way for further orders that may be passed.[20] Moreover, the order clarified that construction debris will not be disposed at the landfills, and alternate areas were provided by BMC for this waste.

20 Bar and Bench. (2018). "Dumping Ground – Supreme Court lifts ban on New Construction in Mumbai" www.barandbench.com/news/dumping-ground-supreme-court-lifts-ban-construction-mumbai.

FIGURE 19
Fire at Deonar dumping ground in 2016

Source: NASA, 2016

FIGURE 18
Solid waste in water bodies

Source: Report on Action Plan for Mithi River, Maharashtra Pollution Control Board 2019

Opportunities

During the Urban Ocean gap assessment phase, stakeholder consultations and participatory workshops were undertaken to identify the key opportunities and priorities for improving the city's waste management systems through a resilience lens. The opportunities listed are in line with the goals of the Mumbai Climate Action Plan and can advance the city's ambition for sustainable and circular waste management systems through the 4R principle.

1. Tackling illegal open dumping of waste for cleaner waterbodies

The city has been grappling with river and coastal pollution for decades. This issue has remained at the forefront since 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 and illegal 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 will have the potential to reduce environmental and public health hazards, improve flood management, improve living conditions and be conducive towards a positive visual image of a cleaner city in the long run.

2. Improving public engagement for increased waste segregation

Plastics enter the environment through various pathways, with major contributors being a lack of awareness on environmental and health hazards caused by open dumping, single uses of plastic products and inadequate source segregation, inadequate efforts to sensitize citizens, and mismanaged waste in the city. There is a need to improve waste segregation at source and to reduce the need for secondary segregation and improving the potential for recovery and recycling depending on the type of waste. Waste treatment often involves transportation to the treatment facility, which accounts for higher costs and carbon footprint. With the severe challenge of legacy waste that the city faces, the opportunity for improved awareness has the potential for communities to be key agents of change, for reduced leakage and pollution and for positive environmental and social impacts.

3. Strengthening recycling infrastructure for improvement in resource recovery

Resource recovery will reduce waste entering the landfills, leading to a reduction in emissions and to enhanced employment and economic opportunities in the city. This is crucial for Mumbai, which faces severe land constraints. Reduced waste reaching landfills can result in reduced pollution and greenhouse gas emissions from landfills and waste dumps and in reduced landfill fires. New businesses providing refill services and creating more sustainable products are emerging in the city, so there is also an opportunity to collaborate with the private sector.

5. Project overviews

This project statement for Mumbai comprises four projects that build on the opportunities identified, prioritize strengthening solid-waste management systems and address the leakage of plastic waste into the environment and waterbodies. The choice of the four projects resulted from a series of consultations with BMC officials and key stakeholders in the city. The projects tackle their challenges by activating collaborative and cross-sectoral efforts, rooted in effectuating change on the ground and building momentum for a circular and resilient Mumbai with resilience co-benefits. The projects identified either build upon certain existing innovations and systems or have been highlighted as key concerns for which new approaches need to be developed.

Goal: Strengthening Mumbai by reducing landfilled waste and marine litter

PILLAR 1: REDUCING LANDFILLED WASTE

Project 1 : Strengthening dry-waste centers

Components:

a) Improving segregation of waste at source and strengthening doorstep collection

b) Guidelines for efficiency and effectiveness of DWCs

c) Dashboard to connect recyclers and monitor the DWCs

d) Pilot for upgradation of one DWC

Project 2: Green event management

Components:

a) Preparing guidelines for green event management

PILLAR 2: REDUCING MARINE LITTER

Project 3: Reducing open dumping of waste in waterbodies

Components:

a) Minimizing waste dumping in the Mithi River

b) Minimizing waste dumping in creeks and nallahs

Recognizing the importance of local context and knowledge as key for building resilience, these solutions are rooted in addressing local stakeholders' needs to advance resilient solutions that can be scaled and implemented across the city.

Project 1: Strengthening dry-waste centers

Background

Dry-waste centers have been set up by the BMC as an integral element of the decentralized municipal solid-waste management system. After waste is transported from households and commercial establishments to the DWCs it is further sorted, cleaned (depending on space availability), aggregated and packaged as different recyclable materials for transport to recycling facilities. DWCs are the first stage where waste is prepared for recyclability. Material recovery facilities may also function as DWCs and vice versa.

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.

While DWCs serve an important function in the solid-waste management chain in the city in terms of separate collection and segregation of dry waste, there is an opportunity to upgrade and strengthen the efficiency of DWCs.

Goal/Rationale

Currently, about 46 DWCs of varying sizes and capacities are in operation in the city. DWCs are run by about 30 organizations, including private organizations, non-governmental organizations, self-help groups[21] and welfare groups.[22] These centers are crucial to the city's waste management chain, collecting dry waste from households across the city, segregating this waste further and sending the segregated waste for recycling. Brihanmumbai Municipal Corporation provides land and collection vehicles to these centers. The land is leased out on contract for 11 months at a time to the organizations operating these centers. These centers function at different levels of effectiveness depending on the operator and nature of operations. In addition to improving the recyclability of Mumbai's waste, DWCs are designed to tap into the informal waste sectors' efforts and provide connections to the formal waste-management ecosystem. The informal sector in India is crucial to the recycling industry, contributing to environmental sustainability, resilience and the circular economy of waste. Connection and interactions between the formal and informal waste-management sectors provide improved material recyclability and a more resilient population for the former, while providing pathways to social protections and dependable livelihoods for the latter. To capture more material and strive for inclusivity, DWCs also buy waste from informal waste pickers not participating in the formal waste management system, thereby further reducing leakage into the environment, waste burning and waste being sent to the dumpyard. DWCs are crucial in managing recyclables, enabling resource recovery from waste collected from households and commercial establishments in the city and promoting circular-economy practices within the city's waste management system.

21 Self-help groups are self-governed associations of around 10-20 people (generally women) who choose to come together for social empowerment and income-generating activities. These groups are linked to banks for disbursal of small loans for taking up livelihood options.

22 Welfare groups are associations or organizations that work for the social welfare of specific groups – in this case, the waste pickers – and work towards their holistic development through livelihood opportunities, health, education and economic development.

FIGURE 20
Manual waste sorting at DWCs

FIGURE 21
Plastic waste segregation at DWCs

A preliminary assessment of DWCs undertaken as part of the Urban Ocean program indicated that there may be opportunities to build on the achievements of the DWCs and further enhance their effectiveness to yield improved quantity and quality of recyclables. The workshop witnessed an overwhelming response, with representation from 25 centers in the city, indicating the need to address concerns with DWCs. The workshop provided insights on how these DWCs operate, their pressing challenges and support required.

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. 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 every day.

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, glass, and so on. 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.

FIGURE 22
Waste collection vehicles allotted by BMC to DWCs

FIGURE 23
Segregated and compressed plastic waste stored at DWCs

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.

Functional improvements in DWCs can yield better quantity and quality of recyclables in the waste management system. The following improvements are effective and proven to be employed in well-operated and successful facilities across Mumbai, Bangalore, Delhi and other cities in India. Though the context of Mumbai varies, primarily due to space constraints, these improvements can nevertheless be effective in strengthening the facilities in the city:

- Access to organized recyclers
- Effective contracts with the BMC
- Improved work conditions of waste workers and DWC management staff
- Optimum space utilization
- Manual-to-mechanized sorting
- Record keeping and transparency.

Findings in the CAP also suggest building on DWCs' successes to improve organization and spaciousness for more effective waste management and better working conditions. Towards this, actions to strengthen the DWCs are proposed.

Objectives

- Collaborate with the DWC operators to understand on-the-ground issues in DWC management and functioning. The aim is to further the understanding of the operations and management of DWCs to develop city-specific guidelines.
- Improve the quality of waste that the DWCs receive by improving source segregation from households and commercial establishments.
- Strengthen the efficiency of DWCs to improve resource recovery of recyclables, reduce the amount of waste going to the landfills and promote circular-economy principles in the city.
- Improve the working conditions of the waste workers in the DWCs to provide a safe working environment and reinforce links between informal waste workers and the formal waste-management system.
- Promote recycling and the circular economy of plastics and other dry waste and reduce the amount of waste being sent to the landfills.

Project components

a) Improving segregation of waste at source and strengthening doorstep collection

In recent years, the BMC has made several efforts to increase waste segregation at source. In 2017, the administration ordered all bulk-waste generators, such as housing societies and commercial establishments producing over 100 kg of waste, to manage the waste they generate by segregating the waste at source and composting the wet waste within their premises or outsourcing it. However, waste source segregation remains a challenge. Generating awareness among residents through citizen engagement on waste reduction, segregation at source and streamlining collection of dry waste will result in cleaner material being received in the DWCs and an increase in recovery of valuables.

Additionally, collection of waste is contracted to agencies other than those who manage the DWCs. These agencies generally collect waste from the gates of apartment blocks or residential societies. Waste from each household is taken to the gate or community bin by housekeeping agencies or workers employed by residential societies, or by residents themselves. The DWC managers noted that recyclables that fetch higher prices may be taken away by these workers, supplementing their income. This reduces access to these materials for the agencies directly engaged in recycling. While at an aggregate level, the quantity of recycling may not change, there may be an opportunity

to improve services by formalizing "doorstep collection". In Pune, doorstep collection service at a fee is provided across the city by SWaCH. SWaCH doorstep waste collectors are themselves engaged in recycling, and so also promote source segregation.

In neighborhoods where source segregation is higher, services from the private sector for reuse and refill systems for regular household products can be promoted to reduce the amount of plastic waste generated from single-use plastic packaging. Mumbai already has a few private players working in this space and collaboration with these players can be useful in promoting circular-economy businesses and reducing waste generation. These may include aspects such as:

→ **Waste segregation to address low-quality dry waste:** Source segregation is important to avoid mixing wet, dry and non-recyclable waste (which can potentially reduce the recyclability of dry waste) and to increase the quantity of dry waste being collected. Segregation at source is mandated by the SWM Rules 2016. To enhance segregation at source, the following measures may be adopted:

- Run public awareness campaigns to improve waste segregation, targeting specific areas where segregation is low. The areas can be identified in consultation with DWCs and collection vehicles, who are already aware of non-complying areas.
- Provide suitable bins for segregation in collection vehicles, if not already installed, or run separate collection services for different types of waste.
- Promote decentralized composting systems and services (at individual or apartment block level) to avoid mixing wet waste with recyclable materials.

→ **Test doorstep collection services in a neighborhood:** Pilot the introduction of doorstep collection services with a user fee as per the provisions of the SWM 2016 rules, evaluating for improvements in source segregation and service provision and potential for scale up.

→ **Encourage and enable civic groups to improve community engagement:** As a key stakeholder, the community groups in each ward from residential areas (including slums), self-help groups and among waste workers, can be enabled and encouraged to be drivers and change agents for responsible waste consumption and source segregation. This can help to elevate the voices and needs of the local stakeholders. Awareness of existing DWCs in the ward/locality and their services and promotion of the handover of dry waste to appointed collectors can be encouraged by these civic groups. They may also help acknowledge the important work undertaken by waste workers within their communities and foster respect and support for their services.

→ **Develop area-specific communication strategy** for waste segregation in consultation with concerned stakeholders such as waste collectors, residents and the BMC, using hyperlocal communication and public engagement approaches as needed, and linking to community concerns, such as public-service delivery, waste management, health and sanitation, air pollution and leakage of waste into waterbodies.

→ **Collaborate with reuse and refill businesses for neighborhoods with high segregation** and promote these practices through activities such as mass awareness drives, engagement with community groups and residents' associations and events like weekend markets. These businesses can play a key role in ease of access to a range of products and services and in making reuse and refill options convenient for residents. The city can collaborate with and support these businesses through opportunities such as access to locations and permits in areas with high waste segregation, endorsement and recognition of business through awards, incentives and access to government schemes for innovation and guidance and support to new businesses. Promoting these businesses will help create a market for reuseable and refillable products, which can in turn encourage more residents to choose these products, reducing the amount of plastic waste generated.

b) Guidelines for efficiency and effectiveness of DWCs

Generic guidelines or advisories for material recovery facilities have been prepared by the Ministry of Housing and Urban Affairs under the SBM–Urban.[23] Other guidance documents are also available, such as from Asian Development Bank. Considering the experience of recent years, constraints faced, and need for strengthening existing DWCs in Mumbai, it is proposed to develop city-specific guidelines that will be complementary to the national guidelines and assist in operation and management of these facilities. These may include aspects such as:

- Clearly defining the roles and responsibilities of the BMC and DWC operators to improve accountability and coordination. A list of suggested roles and responsibilities of the BMC and DWC operators is presented below for further discussion and integration into local SWM policy.
- Contracts with DWCs: BMC may consider increasing the duration of contracts with DWCs from 11 months to at least 3 years so that it is easier for DWCs to acquire equipment through external funding, retain experienced workers and staff, and plan long-term improvements to their functioning. The BMC can keep track of the center's performance and renew contracts accordingly.
- Upgrade facilities at the DWCs: Ensure provision of sheds, weighing scales, water and electricity connections, toilets, first aid and safety gear for the waste workers.
- One-window policy for DWCs: The BMC may appoint a nodal person and implement a streamlined process for all DWC-related matters, reducing bureaucratic hurdles and ensuring efficient operations.
- BMC ward office support: Ensure ward offices support the DWCs for route planning and communication with key stakeholders, enabling community outreach and enforcement where needed to enhance the efficiency of DWC operations.
- Regular communication with DWCs: BMC may facilitate strategic dialogues from time to time to assess the need for system-level changes towards enabling circular-economy approaches, streamline the operation of DWCs, and the respective roles and responsibilities.

Ensure regular pick-up of reject/non-recyclable waste to ensure optimum space utilization in the DWCs. As segregation increases, the amount of reject waste in the DWCs is expected to reduce. Meanwhile, DWCs can tie up with factories that can co-process the rejected waste so that it is not sent to landfills. It is important to note that co-processing can lead to increased GHG emissions, and the priority should be segregation and recycling of maximum waste.

c) Dashboard to connect recyclers and monitor the DWCs

Develop an application or a dashboard for monitoring the DWC operations, track the material flow chain, enhancing transparency and decision-making and, based on the data and trends, providing support to the DWCs as required. The dashboard can showcase existing recyclers in the city and can help create a connection between the DWCs and the recyclers. This aligns with the recently launched online platform by Ministry of Housing and Urban Affairs called Sansaadhan Portal designed to streamline the recycling supply chain across the country, facilitating communication for efficient exchange of recyclable/recoverable materials. The portal has been developed by the Ministry of Housing and Urban Affairs with support from German Society for International Cooperation.

d) Pilot for upgrading one dry-waste center

Based on the need and the interest expressed by concerned organizations managing DWCs, a pilot in one DWC can be implemented to strengthen the facilities in accordance with the guidelines proposed to be developed, and to adopt suitable best practices. The learnings from this pilot implementation can be taken forward by the city and be scaled up and replicated to other DWCs.

23 Ministry of Housing and Urban Affairs. (2020). "Swachh Bharat Mission – Urban: Advisory for Material Recovery Facility (MRF) for Municipal Solid Waste". https://sbmurban.org/storage/app/media/pdf/SBM%20Advisory%20on%20MRF%20for%20MSW.pdf

Implementation matrix

Component	Potential Partners	Possible funding sources	Year 1	Year2
Improving segregation of waste at source and strengthening doorstep collection	MC, Centre for Environment Education, DWCs operators, Stree Mukti Sanghatana	Corporate social responsibility (CSR) funding, SWM department, Mumbai Metropolitan Region Environment Improvement Society (MMREIS)		
Guidelines for efficiency and effectiveness of DWCs				
Dashboard to connect recyclers and monitor the DWCs				
Pilot for upgrading one DWC				

Project 2: Green event management

Background

Mumbai hosts many diverse events, such as weddings, conferences, trade fairs, exhibitions, art festivals, sports competitions and musical events, all with participant numbers which may reach tens or hundreds of thousands, depending on the event type and capacity. Protocols exist for permissions from the police and municipal authorities to charge penalties or fees for waste or nuisance creation. However, event organizers need more support to create events that minimize waste generation and implement sustainability plans and no such guidelines or statement of responsibilities for event organizers exist. Kerala developed a Green Protocol providing such guidelines in 2014 and has implemented it under the state's Suchitwa Mission[24] over the last few years.

Actions for implementation

1. Consultations: It is proposed to hold consultations on green event management to minimize plastic waste, especially single-use plastic, at such events.

Preparatory tasks may include:

→ Reviewing various guidelines for green or sustainable events and undertaking a consultation with key stakeholders such as Swachh Bharat Mission, relevant state government departments, large event organizers, event management consultants and agencies, venue managers, hotel and restaurant associations, suppliers, and proponents of green events including Kerala Suchitwa Mission and Green Key. The objectives of these consultations may include learning about the components of green event management and key factors of successful implementation and common challenges.

2. Preparation of guidelines for green event management in the city: Based on the workshop deliberations, guidelines for green event management will be prepared and disseminated (including placement of information on the BMC website and outreach to event organizers) to promote implementation of the green event guidelines.

Implementation matrix

Component	Potential Partners	Possible funding sources	Year 1	Year2
Consultations with stakeholders	Skrap, BMC	CSR, MMREIS		
Formulating green guidelines with key stakeholders				

24 Suchitwa Mission is a Kerala state-led mission, responsible for evolving implementation strategy, providing policy in the sector of various waste management issues (solid and liquid) and has been functioning as the nodal agency for assisting cities, municipalities and panchayats in all waste management aspects.

Project 3: Reducing open dumping of waste in waterbodies

Background

The BMC has a wide network of waterbodies, including rivers such as Mithi, Oshiwara, Dahisar, Poisar and creeks, canals and drains – crucial water courses in Mumbai. Apart from tidal variations, waterlogging is exacerbated by blockages of these rivers and drains due to sewage inflows and haphazard dumping of garbage. Every day, the city dumps 80–110 metric tons of plastic waste into drains and water channels, according to an application submitted by environmentalist group Vanashakti before the National Green Tribunal in December 2018.[25] Several reports have documented this as one of the key reasons for the 2005 flooding in the city. The heavily polluted Mithi River has been the focus of the Brihanmumbai Municipal Corporation's clean-up measures after the 2005 floods which caused large-scale destruction.

Goal/Rationale

In 2019, the Maharashtra Pollution Control Board mentioned in an affidavit that creeks, rivers and the sea along Mumbai's coastal stretch are under threat with plastic waste as a major source among municipal solid waste[26]. In October 2020, a National Green Tribunal order also stated that creeks, rivers and the sea along Mumbai's 437.71 sq. km. coastal stretch are under threat from continuous discharge of toxic, untreated waste that is thrown directly into nallahs by the general public and those residing in informal settlements. Over the past years, BMC has undertaken several efforts to improve solid-waste management in the city's waterbodies, including improving efficiency in waste collection, excavators to clean up the rivers and drains, desilting of waterbodies and regular coastal clean-up drives to name a few. Yet, the issue is multi-faceted with tremendous challenges such as open dumping in the waterbodies, lack of enforcement of penalization for open dumping and dense informal settlements and slums with inadequate access to waste collection services residing nearby river and waterbodies.

Project Components:

a) Minimizing waste dumping in the Mithi River

On 19 August 2005, the Government of Maharashtra formed a Mithi River Development and Protection Authority under the chairmanship of the Honorable Chief Minister of Maharashtra State to improve the condition of the Mithi River. Mithi carries the most waste of all waterbodies in Mumbai, according to a water quality analysis carried out by the Maharashtra Pollution Control Board[27]. The BMC has already proposed a diversion of sewage and industrial effluents generated along the river to the Dharavi Treatment Facility. The opportunity to reduce waste directly thrown in the river can be taken up in one of the neighborhoods in L ward as a pilot area, as suggested by the SWM department.

25 Chatterjee, B. and S. Fernandes (2019) "" www.hindustantimes.com/india-news/plastic-waste-flowing-into-sea-major-problem-in-mumbai/story-X7Kd5TrL46iRzIVQSreYbJ.html

26 The Asian Age (2018). https://www.asianage.com/metros/mumbai/310718/bombay-high-court-demands-solution-to-coastal-pollution.html

27 Citizen Matters, Mumbai (2021) https://mumbai.citizenmatters.in/how-mumbai-most-polluted-river-is-being-cleaned-up-25792

b) Minimizing waste dumping in creeks/nallahs

M-East ward adjoins a creek and hosts a highly vulnerable population in terms of the informality of the settlements, the socioeconomic profile, and the proximity to the Deonar waste landfill. The opportunity for improving waste services to the community and mitigating the leakage of waste in the creek can be materialized through partnerships with the M-Power Library and Study Centre and associated local community organizations. During the Covid-19 pandemic, a large survey was carried out by Tata Institute of Social Sciences and M-Power, which may provide insights useful for this opportunity.

Pilot projects in both locations would include the following components:

- A public survey to understand the causes of open dumping and assessment on waste collection coverage and waste collection points in the pilot neighborhood.
- Community engagement and outreach in the neighborhood.
- Assessing and testing the potential for infrastructure such as fencing to mitigate dumping into the river/ creek

FIGURE 24
Selected wards for the pilot

FIGURE 25
Open dumping of waste in water bodies

Implementation matrix

Component	Potential Partners	Possible funding sources	Year 1	Year2
Public survey to understand the causes of open dumping and assessment on waste collection coverage and waste collection points in the pilot neighborhood	BMC, Stree Mukti Sanghatana, Community associations for Mithi River BMC, M-Power team, M-East community associations for M-East Ward	CSR, BMC, MMREIS		
Community engagement and outreach in the neighborhood				
Assessing and testing the potential for infrastructure such as fencing to mitigate dumping into the river/creek, and testing the same				

6. Expected impact of project components

Social, environmental and economic impacts

The implementation of the four projects identified will help advance Mumbai's ambitious climate action goals, namely to improve recycling, supported by strategies to improve mass awareness and decentralized infrastructural capacities, decentralized composting and local capacity building. Given the scale and complexity of the city, decentralized neighborhood-level activities that are replicable and scalable are sustainable and build resilience to complex interrelated challenges affecting waste management. If well implemented, reduction in open dumping of waste into waterbodies, improvement in public awareness on source segregation and reduce–reuse–refill–recycle strategies, strengthening of dry-waste centers in the city and improved waste management in public events can result in the following.

Social impacts

- Improved awareness towards sustainable waste practices: Targeted efforts towards community driven solutions like increasing source segregation, and improved attitudes on refilling and reusing will lead to improved public awareness towards sustainable waste practices and understanding of consequences of improper waste disposal. Better informed citizens can help improve well-being, sense of community, quality of life and access to better economic opportunities.
- Improved well-being due to cleaner environment: Better waste management practices in the city can lead to a cleaner environment, including cleaner waterbodies and lower public health risks due to reduced disease vectors, improved access to cleaner public places, and lower exposure to pollutants and micro plastics in the environment. A cleaner environment will result in improved well-being among residents, especially vulnerable communities who may disproportionately feel the impacts of a compromised environment and inadequate waste management systems.
- Improved working conditions: Better waste segregation can lead to cleaner waste received at the dry-waste centers leading to cleaner waste handling and reduced exposure to contaminated waste among the workers in the DWCs. Upgrading the functioning of these centers will lead to improvement in the physical working conditions of the workers through access to basic facilities and cleaner environment.

Economic impacts

- Improved resource recovery: Comprehensive waste management strategies including waste segregation and promoting reuse can reduce waste generation and improve the quality of waste received for recycling, thereby improving resource recovery.Increase in livelihood opportunities for the informal sector: Improvement in DWCs and

an increase in recyclable material can enable more opportunities to engage informal workers in managing waste at these centers.

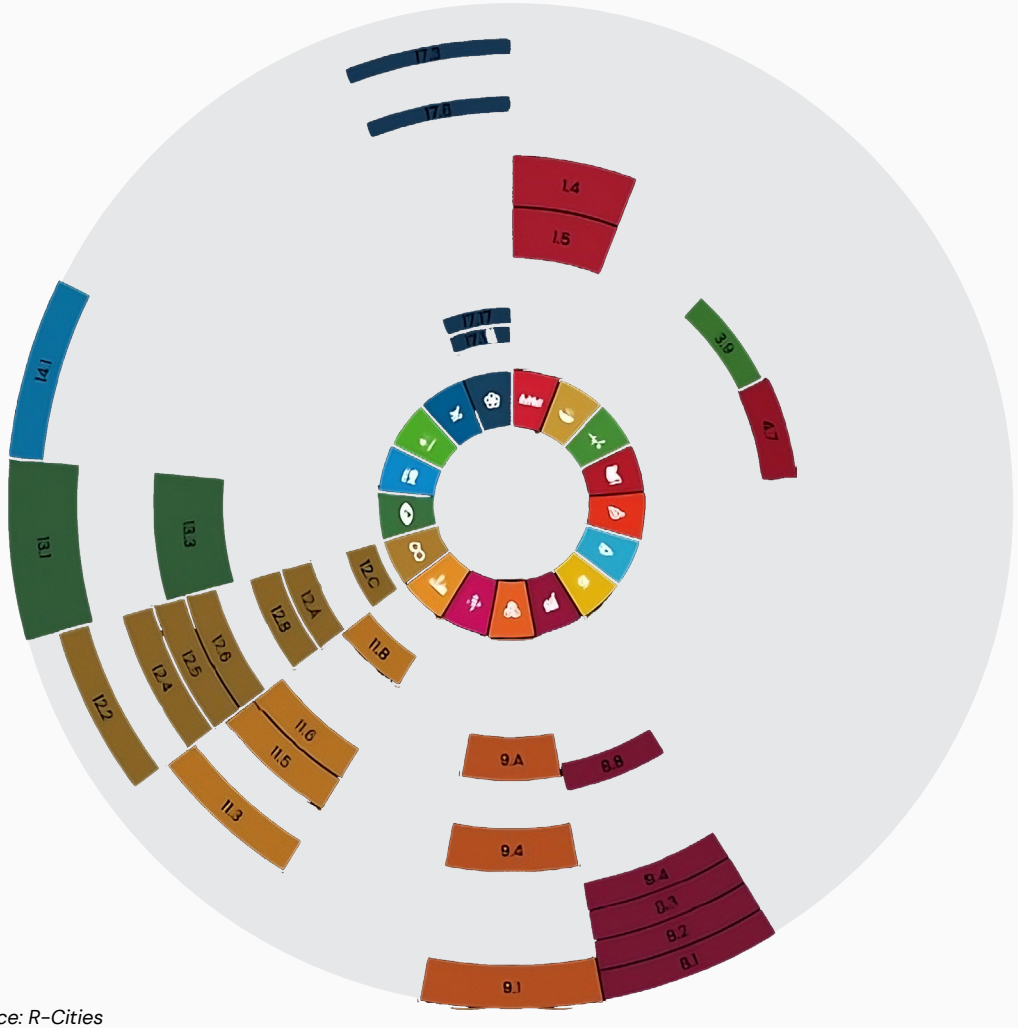
- Promotion of businesses and livelihood opportunities: More efficient and larger-volume recycling operations will help grow existing and new business in the recycling sector that support the circular economy, such as product design through recycling or upcycling, waste reuse, and remanufacturing.

Environmental impacts

- Cleaner waterbodies in the city: Adopting the strategies targeting an improved public awareness and waste collection will reduce the amount of waste that ends up in waterbodies throughout the city. Segregation and collection of recyclable materials such as plastics, glass and paper will help in reducing the leakage into the environment, reduce the instances of flooding due to solid waste creating blockages in waterways, and minimize environmental impacts like water pollution and environmental degradation.
- Reduction of waste going to landfills: By implementing recycling activities and encouraging waste segregation and reuse, communities can divert a substantial amount of waste away from landfills, reducing the strain on the almost exhausted landfills in the city. This will help manage the landfills better, lower waste leakage in the surrounding creeks and help improve the health of the surrounding natural ecosystems.
- Reduction in GHG emissions: Waste reduction solutions like segregation, recycling and reducing waste going to landfills can reduce GHG emissions and improve climate resilience. Optimization of routes around DWCs will also reduce the GHG emissions that are due to transportation of waste.
- Healing natural environments: Reductions in waste leaking into the environment will help improve natural ecosystems' health and improve the services they provide. For example, mangroves near the Kanjurmarg landfill are exposed to plastics and other waste leaked into the environment, thereby hurting marine nurseries through the ingestion of micro plastics by infant wildlife and impeding the nutrient uptake through mangrove roots. If these mangroves captured less waste, they would be healthier, support healthier marine wildlife, and ultimately provide more storm surge protection resulting from stronger root systems and capturing GHG emissions into the future.

Sustainable Development Goals

The projects directly and indirectly influence several United Nations Agenda 2030 Sustainable Development Goals:

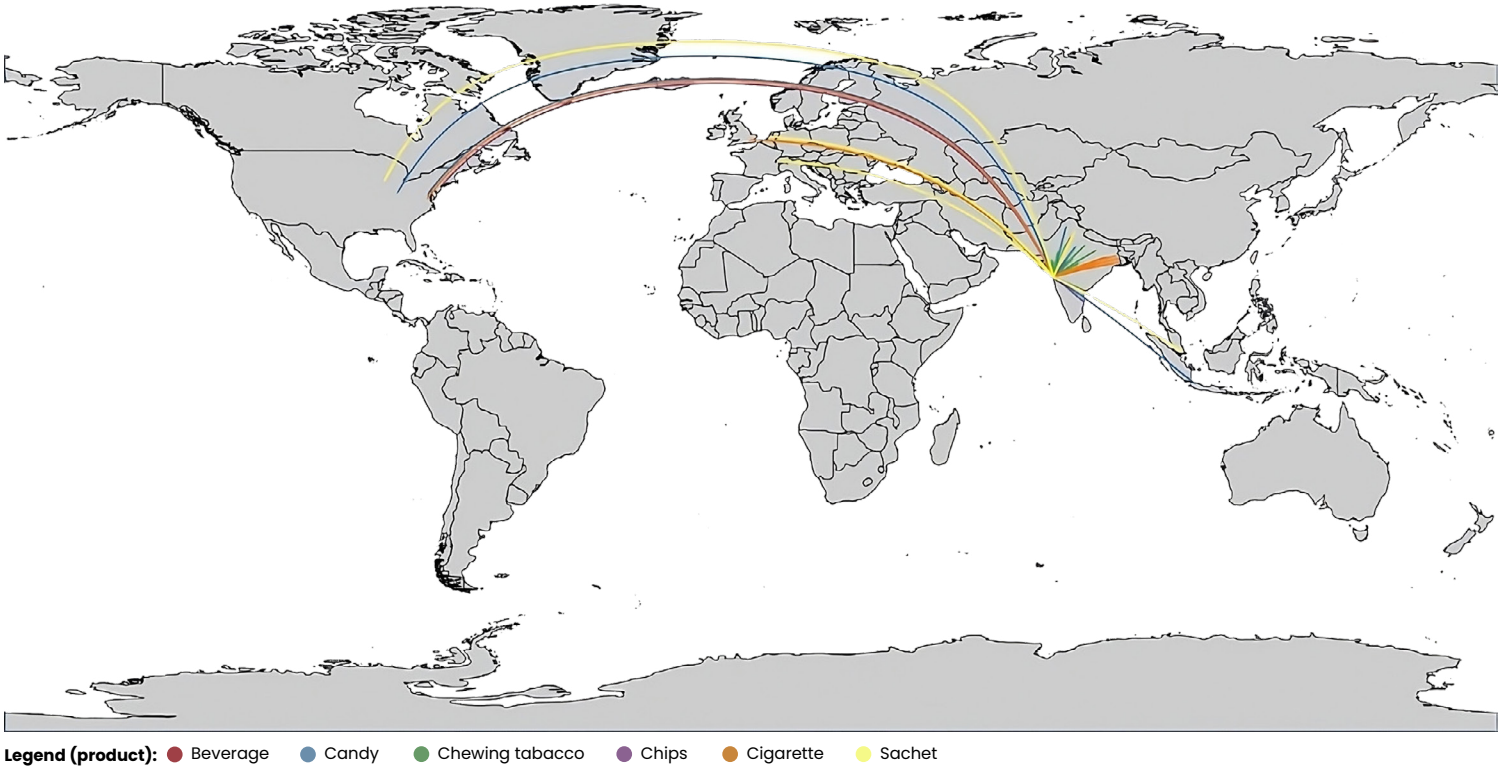


Source: R-Cities

7. Key long-term interventions

Leveraging corporate social responsibility of plastic-producing companies in Mumbai

Mumbai is the economic capital of India and, as stated in the CAP findings, plays host to many companies' head offices. This pool of private-sector companies can be leveraged for funding and volunteering opportunities under their CSR mandates in contributing to sustainable waste-management practices within the city.



	Distance (km)							
	Store to parent company				Store to product manufacturer			
Product	**Minimum**	**Maximum**	**Median**	**Average**	**Minimum**	**Maximum**	**Median**	**Average**
Beverages	1	12,512	1,121	1,731	1	1,126	437	456
Candy	4	13,150	4,652	4,794	104	1,516	957	789
Chewing Tabacco	42	1,655	654	668	0	1,263	438	590
Chips	0	12,512	419	3,324	31	1,635	358	638
Cigarettes	8	13,011	4,444	4,346	0	1,697	668	1,512
Sachets	3	12,965	5	3,550	7	1,374	133	567

Source: Mumbai Circularity Assessment Protocol

With the rise in businesses acknowledging their responsibility for waste, CSR programs and tie-up between the government and the private sector in waste management services can help the BMC secure development funds and can direct initiatives that are targeted and useful for the city and its business sector. The national government, under Swachh Bharat Mission, also promotes the use of funds from the corporate sector and contributions from individuals and philanthropists to achieve the mission's targets of waste segregation, recycling and responsible treatment in cities. Collaborations with companies like Bisleri, Nestle, Coco Cola and ITC Limited can be leveraged to create awareness in communities and improving segregated waste collection and recycling practices in the city. Initiatives like Bottles for Change by Bisleri can be endorsed and scaled up to reduce open waste dumping, littering in waterbodies and the ocean and bringing about behavioral change for appropriate means of plastic disposal and management.

Behavior change communication strategy for sustainable waste practices

A comprehensive long-term behavior change communication strategy for sustainable waste practices among citizens is crucial for the scale and socioeconomic complexity of Mumbai. A well-designed social and behavioral change communication strategy may be the key to a comprehensive approach that includes citizen engagement and context and fosters positive change at the local level.

The development of such a strategy needs to be informed by experiences, insights and data from previous work that has addressed the same challenge already undertaken by the city. The strategy can be localized, considering demography, socioeconomic characteristics and behavioral traits based on geographical context within the city. A long-term behavior change communication strategy should take into consideration long-term goals for waste management of the city, communication objectives, area-specific approaches for implementation and a monitoring and evaluation framework to assess impact.

These efforts should also match the expansion and strengthening of access to services in the city. These actions are critical to persuade citizens to cooperate on proper

waste segregation practices. Without waste segregation at source, the efficacy of the BMC in collection and processing are all compromised.

Scaling up projects

The interventions proposed in this project statement are unique, localized opportunities that can help the city address critical issues related to waste, with resilience co-benefits. Each pilot has created pathways, through collaborations with local stakeholders, to test solutions in selected neighborhoods or wards. These interventions will require municipal support and oversight at every stage to sustain and scale up. Post-implementation assessment of pilots can also provide valuable insights for any course correction, as needed, to improve operational efficiencies. Scaling up and replicating these tested interventions driven by the BMC to strengthen dry-waste centers, improve source segregation, prevent marine litter and strengthen green eve§nt management will help the city achieve expected impacts at scale.

8. Annex

Budgets

Project 1: Strengthening dry-waste centers

a)	**Improving segregation of waste at source and strengthening doorstep collection**		
No.	**Description**	**INR**	**USD**
1	Knowledge, attitude, practice survey	300,000	3,592
2	Project supervisor 35,000 INR per month for 24 months	840,000	10,057
3	Campaign team of two staff at 25,000 INR per month for 24 months	1,200,000	14,368
4	Communication material (handouts, posters, banners, certificates, miscellaneous)	200,000	2,395
5	Community consultations (100 consultations at 1,000 INR each in 24 months)	100,000	1,197
	Total	**2,640,000**	**31,609**
			Rounded to $32,000 USD

b)	**Guidelines for efficiency and effectiveness of DWCs**		
1	Development of guidelines through hiring of experts (200,000 INR for 4 months)	800,000	9,578
			Rounded to $10,000 USD

c)	**Dashboard to connect recyclers and monitor the DWCs**		
1	Application/portal development	1,000,000	11,973
			Rounded to $12,000 USD

d)	**Pilot for upgrading one DWC**		
1	Engineering consultancy services	1,000,000	11,973
2	Equipment/Infrastructure (tentative broad cost)	15,000,000	179,598
	Total	**16,000,000**	**191,571**
			Rounded to $200,000 USD
	Grand Total of all Components (a+b+c+d)		**$254,000 USD**

Project 2: Green event management

a)	**Improving segregation of waste at source and strengthening doorstep collection**		
No.	**Description**	**INR**	**USD**
1	Stakeholder consultations and workshops	300,000	3,592
2	Preparation of guidelines and dissemination materials	500,000	5,987
	Total	**800,000**	**9,579**
			Rounded to $10,000 USD

Project 3: Reducing open dumping of waste in waterbodies

a)	**Improving segregation of waste at source and strengthening doorstep collection**		
No.	**Description**	**INR**	**USD**
1	Public survey	3,00,000	3,592
2	Community engagement		
	Project coordinator (30,000 INR per month for 24 months)	720,000	8,621
	Campaign team (2 staff at 22,000 INR per month for 24 months)	1,056,000	12,644
	Communications material (handouts, posters, banners, certificates, miscellaneous)	500,000	5,987
3	Preparation of scope of work and budget for physical infrastructure to prevent dumping	1,000,000	11,973
	Infrastructure cost (tentative broad cost)	2,000,000	23,946
	Total	**2,387,000**	**66,762**
			Rounded to $67,000 USD

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
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
MSW	Municipal Solid Waste. Waste that originates in homes and establishments such as commercial establishments, hotels and educational establishments
Wet Waste	Wet waste typically refers to organic waste usually generated through kitchens in households and commercial eating establishments. This can include food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