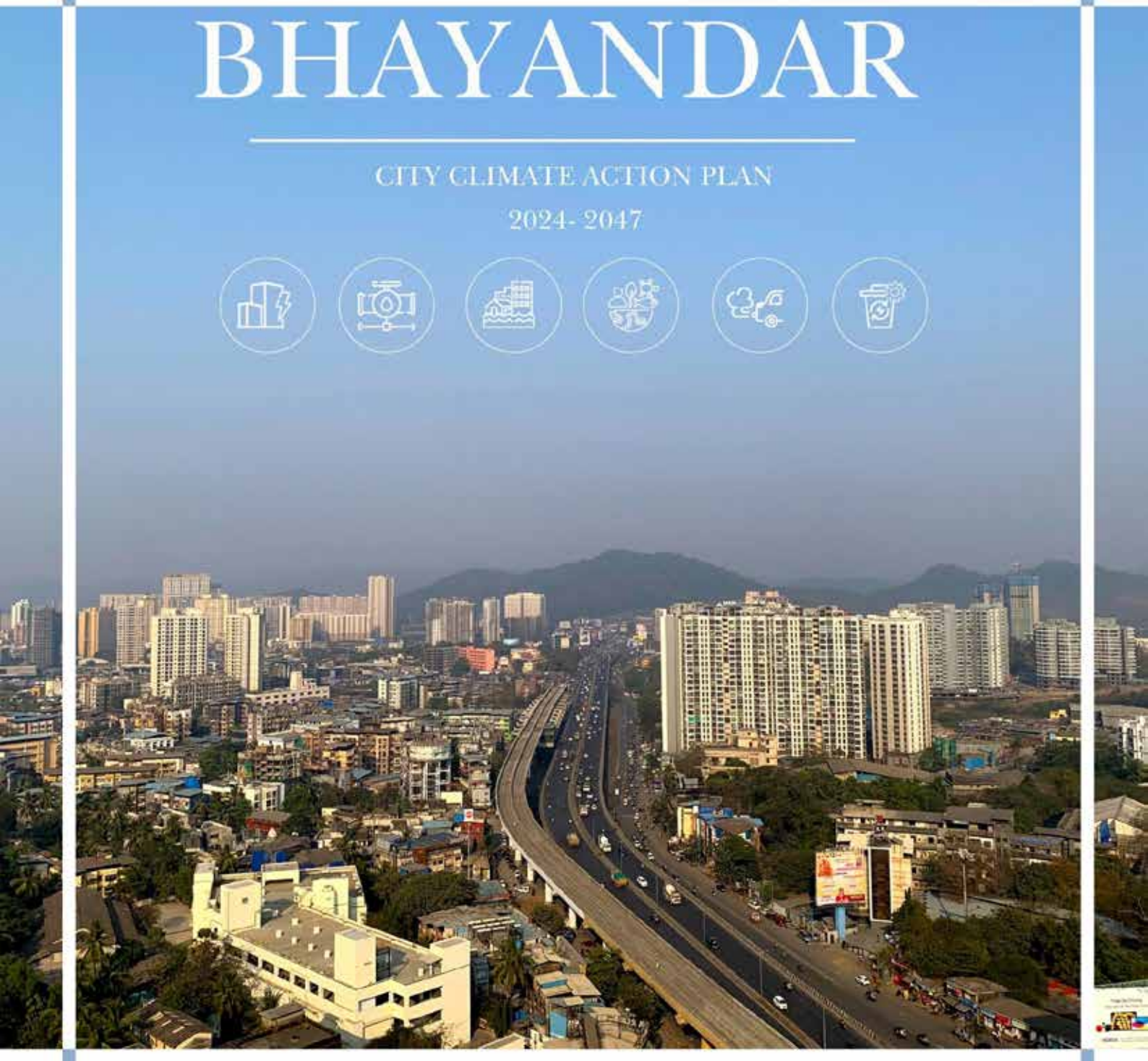
Aga Khan Agency for Habitat
India

MIRA BHAYANDAR

CITY CLIMATE ACTION PLAN

2024- 2047



SHAPING A CLIMATE-RESILIENT AND GREENER FUTURE

Aga Khan Agency for Habitat
India

Cover Page Photo: AKAH

MIRA BHAYANDAR

CITY CLIMATE ACTION PLAN
2024 - 2047

Foreword

Shri Radhabinod Aribam Sharma (IAS)
Municipal Commissioner & Administrator,
Mira Bhayandar Municipal Corporation

At the Mira Bhayandar Municipal Corporation, we envision Mira Bhayandar@2047 as a sustainable, inclusive, and resilient urban centre, aligned with the national aspiration of Viksit Bharat@2047. This vision seeks to transform Mira Bhayandar into a dynamic and prosperous city by the centenary of India's independence. As a vital urban node within the Mumbai Metropolitan Region (MMR), Mira Bhayandar plays an instrumental role in the region's growth, while embracing innovative and accountable solutions to emerging urban challenges.

The Climate Action Plan (CAP) represents a pivotal milestone in our commitment to sustainable urban development. Through this strategic initiative, Mira Bhayandar joins the select cohort of cities in Maharashtra that are proactively addressing the climate crisis. The CAP serves as a comprehensive blueprint to mitigate environmental risks, bolster urban resilience, and foster a healthier, greener future for generations to come.

Our collaboration with the Aga Khan Agency for Habitat India (AKAH) has been central to this endeavour. By incorporating multidisciplinary insights from experts, stakeholders, and local citizens, the plan robustly addresses key focus areas including urban flooding, air quality, energy efficiency, and sustainable mobility—establishing a foundation for long-term transformative impact.

This document is more than a roadmap; it is a testament to our collective resolve. The CAP reflects our unwavering commitment to progress, and its success will depend on sustained cooperation, accountability, and the active participation of all stakeholders.

I remain confident that, through united effort and steadfast determination, we will shape Mira Bhayandar into a model city—resilient in the face of climate challenges and exemplary in urban governance. Let us advance with optimism and purpose toward a future that is not only brighter for Mira Bhayandar but also an inspiration for cities across the nation.

Prerana Langa
Chief Executive Officer,
Aga Khan Agency for Habitat India

Climate change is no longer a distant challenge — it is an urgent reality shaping the lives of millions today. Cities, as engines of growth and hubs of human activity, are both vulnerable to climate risks and uniquely positioned to drive solutions. Recognising this, we embarked on a journey to develop the first Climate Action Plan for Mira Bhayandar, a bold and necessary step toward building a future that is both sustainable and resilient. This marks Maharashtra's fifth Climate Action Plan and a significant step towards advancing the state's net-zero vision.

At the Aga Khan Agency for Habitat, our approach to climate action is rooted in science, collaboration, and community engagement. This Climate Action Plan is not just a policy document — it is a roadmap that integrates climate-responsive strategies into urban planning, infrastructure, and governance. Through data-driven assessments, stakeholder consultations, and localised interventions, we have sought to create a plan that is both ambitious and actionable.

Beyond planning, we are implementing demonstrations of real, scalable climate solutions across housing societies, informal settlements, and schools. Energy-efficient retrofits in housing societies are achieving over 60% energy and 40% water savings, with Nav Yuwan Housing Society on track to become the world's first IFC EDGE Advanced Certified existing housing retrofit — a model for reducing residential electricity emissions, which account for 40.5% of Mira Bhayandar's total emissions. In informal settlements, cooling solutions are reducing indoor temperatures by up to 4°C, improving thermal comfort. Through the Green Schools Initiative, we are enhancing energy and water efficiency by 20%, creating healthier, more sustainable learning environments.

We extend our sincere gratitude to the National Institute of Urban Affairs (NIUA) for their support in shaping this vision. We also deeply appreciate the esteemed peer review experts from WRI, C40 Cities, ICLEI South Asia, IFC-World Bank, MAHAPREIT, WIPRO, CEE India, and The Infravision Foundation for their critical insights and contributions. Their expertise has strengthened this plan, ensuring a robust and actionable framework.

As we move forward, we recognise that this plan is just the beginning. We remain committed to partnering with Mira Bhayandar to achieve its 2047 climate targets, and we hope this initiative will serve as a model for cities across India. Climate resilience is not just a necessity — it is an opportunity to create healthier, more livable, and more equitable urban spaces.

We remain committed to this vision and invite all stakeholders to join us in shaping a future where cities are prepared, proactive, and thriving in the face of climate change.

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

We are standing at the crossroads of human history. Climate change is the greatest challenge faced by man in this century. The frequency as well as the intensity of extreme climatic events such as heatwaves, wildfires, sea level rise, droughts, floods and cyclones are increasing every passing year.

India is a party to all the major international conventions to combat climate change. As a signatory to the Paris Agreement, India seeks to limit global warming to 1.5°C by the turn of this century. Maharashtra is determined to share its responsibility to shoulder India's climate commitments. In fact, as one of the most industrialised and urbanised states in the country, Maharashtra should lead India's climate action.

Maharashtra has prepared its State Action Plan on Climate change (SAPCC). Through the newly established District and City Climate Action Cells, Maharashtra aims to strengthen local climate action to achieve the objectives laid down in the SAPCC. As cities continue to grow, they are also increasingly impacted by climate change, calling for planned climate action urgently.

So far, four cities in the state, namely, Mumbai, Solapur, Nashik and Chhatrapati Sambhaji Nagar have released their climate action plans. I am proud to announce that Mira Bhayandar becomes the fifth AMRUT city in the state to release its climate action plan. Climate planning requires special skills and expertise. My special thanks to the Aga Khan Agency for Habitat (AKAH) for partnering with Mira Bhayandar Municipal Corporation (MBMC) in formulating the climate action plan. Collaboration with Mahatma Phule Renewable Energy, Infrastructure and Technology Ltd (MAHAPREIT) and the National Institute for Urban Affairs (NIUA) was crucial in the planning process.

The newly created Mira Bhayandar Climate Action Plan (CAP) is aligned with important government schemes and policies. While addressing the unique challenges faced as a coastal city and as a part of the densely populated Mumbai Metropolitan Region (MMR), it also adheres to the general framework and a common standard laid down by the SAPCC. The plan deals with the city's vulnerabilities to heatwaves, flooding, coastal erosion and vehicular emissions. It also deals with decarbonisation strategies for the energy and buildings sectors. Emphasis has been laid on nature-based solutions such as cool roofing and biodiversity conservation.

I extend my heartfelt appreciation to the administrative leadership of the Mira Bhayandar Municipal Corporation and the Aga Khan Agency for Habitat for their unwavering commitment to combating climate change by formulating the ambitious city climate action plan.

The release of the Mira Bhayandar Climate Action Plan marks a milestone for the city, encouraging other AMRUT cities to emulate its example and attain the ambitious target of achieving net zero emissions by 2050. As Mira Bhayandar walks towards the goal of climate resilience, I urge other cities of Maharashtra to tread the path towards a sustainable future.

Acknowledgements

Government of Maharashtra:

Mr. Praveen Pardeshi (IAS), Chief Executive Officer, Maharashtra Institution for Transformation (MITRA)
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Photo by: Vikrant Harankhede

VISION

Create a Resilient and Sustainable Urban Environment by Implementing Comprehensive Climate Action Strategies by 2047

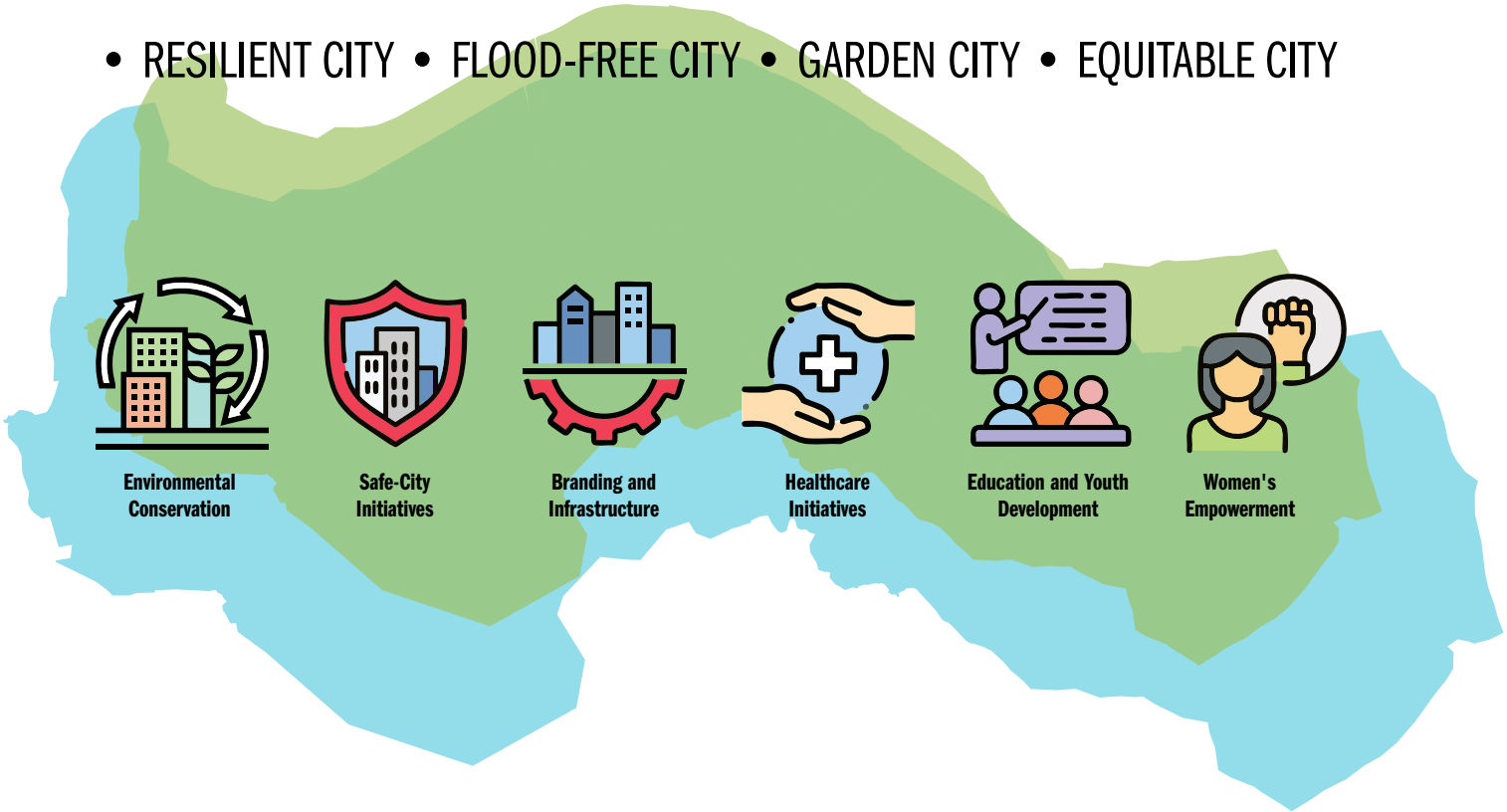
Mira Bhayandar envisages transforming itself into a sustainable, inclusive, and highly liveable urban centre by 2047, in alignment with the national vision of ViksitBharat@2047. Through innovations in governance, efficiency in public services, and citizen-centric development, it aims to enhance the quality of life of all its residents while setting benchmarks for urban excellence.

The Mira Bhayandar Municipal Corporation Climate Action Plan (MBMCCAP) is an extensive approach that aligns with the 2047 vision for Viksit Mira Bhayandar. Its assessments and recommendations correspond with the Maharashtra state's ambitious objective of attaining net-zero targets as outlined in the National Action Plan on Climate Change (NAPCC).

The Mira Bhayandar administration is currently focussing on six thematic areas, as illustrated below. The MBMCCAP enables augmentation of these efforts to create a futuristic city that stands on pillars of sustainability, resilience, and climate justice.

The MBMCCAP stands strong in its belief that without the people and communities at its core, no climate action plan is complete. In every one of its priority areas, creative mitigation and adaptation measures have been planned, maintaining space for sectoral experts, non-government organisations, citizens groups, and the voices and aspirations of the common people.

Mira Bhayandar is a unique combination of urban energy and abundant biodiversity. From a climate disaster perspective, it serves as a potential model for similar urban ecosystems in the country. The MBMCCAP aspires to establish a net-zero, climate-resilient, flood-free garden city where the systems, businesses, institutions, communities, and individuals can adapt, and thrive despite the climatic stresses they experience, one that India and the world can learn from and emulate.



LIST OF FIGURES

LIST OF ABBREVIATIONS

A

AEML:	Adani Electricity Mumbai Limited
AKAHI:	Aga Khan Agency for Habitat India
AMRUT:	Atal Mission for Rejuvenation and Urban Transformation

B

BARC:	Bhabha Atomic Research Centre
BEE:	Bureau of Energy Efficiency
BLDC:	Brushless DC Motors
BRTS:	Bus Rapid Transit System
BWG:	Bulk Waste Generator

C

CAC:	Climate Action Cell
CAP:	Climate Action Plan
CAPEX:	Capital Expenditure
CBG:	Compressed Biogas
C&D:	Construction and Demolition
CEW:	Council on Energy, Environment, and Water
CMCC:	Coimbatore City Municipal Corporation
CNG:	Compressed Natural Gas
CRZ:	Coastal Regulation Zone
CSCAF:	Climate Smart Cities Assessment Framework
CSR:	Corporate Social Responsibility

D

DBFOT:	Design, Build, Finance, Operate, and Transfer
DCS:	District Cooling Systems
DMA:	District Metered Areas
DPR:	Detailed Project Report
DISCOMS:	Distribution Companies

E

ECS:	Equivalent Car Spaces
EDGE:	Excellence in Design for Greater Efficiencies
EESL:	Efficiency Services Limited
EIA:	Environment Impact Assessment
EMSR:	Elevated Storage Reservoirs
ENV:	Environment Status Reports
EPR:	Extended Producer Responsibility
ESR:	Elevated Storage Reservoirs

F

FAME:	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FSI:	Floor Space Index

G

GHG:	Greenhouse Gas
GIS:	Geographic Information System
GWH:	Gigawatt-Hour

H

Ha:	Hectare
HEPA:	High-Efficiency Particulate Arresting Filter
HMWSSB:	Hyderabad Metropolitan Water Supply and Sewerage Board
HPMV:	High-Pressure Mercury Vapour
HVAC:	Heating, Ventilation, and Air Conditioning
HPSV:	High-Pressure Sodium Vapour

I

ICAP:	India Cooling Action Plan
IDF:	Intensity-Duration Frequency
IGBC:	Indian Green Building Council
IMD:	Indian Meteorological Department
IoT:	Internet of Things
IPT:	Intermediate Public Transport
IWRM:	Integrated Water Resource Management

J

JJM(U):	Jal Jeevan Mission (Urban)

K

Kl:	Kilolitre
KW:	Kilowatt
KWh:	Kilowatt-Hour
KWp:	Kilowatt-Peak
KVA:	Kilovolt Ampere

L

LED:	Light Emitting Diode
LPCD:	Litres per capita per day
LPS:	Land Use Surface Cover

LULC: Land Use Land Cover
LST: Land Surface Temperature

M

MBMC: Mira Bhayandar Municipal Corporation
MEDA: Maharashtra Energy Development Agency
MH: Maharashtra
MCGM: Municipal Corporation of Greater Mumbai
MLD: Megalitres per day
MLDC: Material Recovery Facility
MMRC: Mumbai Metropolitan Region
MMR: Mumbai Metropolitan Region
MoHUA: Ministry of Housing and Urban Affairs
MoJS: Ministry of Jal Shakti
MRDF: Material Recovery Facility
MSAPCC: Maharashtra State Action Plan for Climate Change
MSEDCL: Maharashtra State Electricity Distribution Company Limited
MSNA: Maharashtra Sujal and Nirmal Abhiyan
mtCo2e: Million Tonnes Carbon Dioxide Equivalent

N

NABP: National Biodiversity Action Plan
NAP: National Afforestation Programme
NBAP: National Biodiversity Action Plan
NBP: National Biodiversity Plan
NBMMP: National Biogas and Manure Management Programme
NCAAP: National Clean Air Programme
NCRMP: The National Cyclone Risk Mitigation Project
NEMMP: National Electric Mobility Mission Plan
NGO: Non-Governmental Organization
NGC: National Green Corps
NH: National Highway
NHP: National Hydrology Project
NMT: Non-Motorized Transport
NMSH: National Mission on Sustainable Habitat
NPDM: National Policy on Disaster Management
NRW: Non-Revenue Water
NUTP: National Urban Transport Plan
NZEB: Net Zero Energy Buildings

O

O&M: Operation & Maintenance
ODF: Open Defecation Free
OD: Origin-Destination

P

PACE: Property Assessed Clean Energy
PAYG: Pay-As-You-Go
PBR: People's Biodiversity Register
PM: Particulate Matter
PNG: Piped Natural Gas
PPP: Public-Private Partnership
PWD: Public Works Department

R

RRR: Reduce Reuse and Recycle
RTS: Rooftop Solar
RTO: Regional Transport Office
RWH: Rainwater Harvesting

S

SBM (U): Swachh Bharat Mission (Urban)
SCM: Smart Cities Mission
SCADA: Supervisory Control and Data Acquisition
SDG: Sustainable Development Goals
SGNP: Sanjay Gandhi National Park
SPV: Solar Photovoltaic
STP: Sewage Treatment Plant
SWD: Storm Water Drainage
SUDS: Sustainable Urban Drainage Systems

T

TTP: Tertiary Treatment Plant
TPD: Tonnes Per Day

U

UAE: United Arab Emirates
UFI: Urban Field Variance Index
UNEP: United Nations Environment Programme
URDPFI: Urban and Regional Development Plans Formulation and Implementation
UHI: Urban Heat Island
UJALA: Unnat Jyoti by Affordable LED for All
UTFVI: Urban Thermal Field Variance Index

W

W: Watt
WHO World Health Organization

Photo by: Vikrant Harankhede

CONTENT

EXECUTIVE SUMMARY

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Context Setting

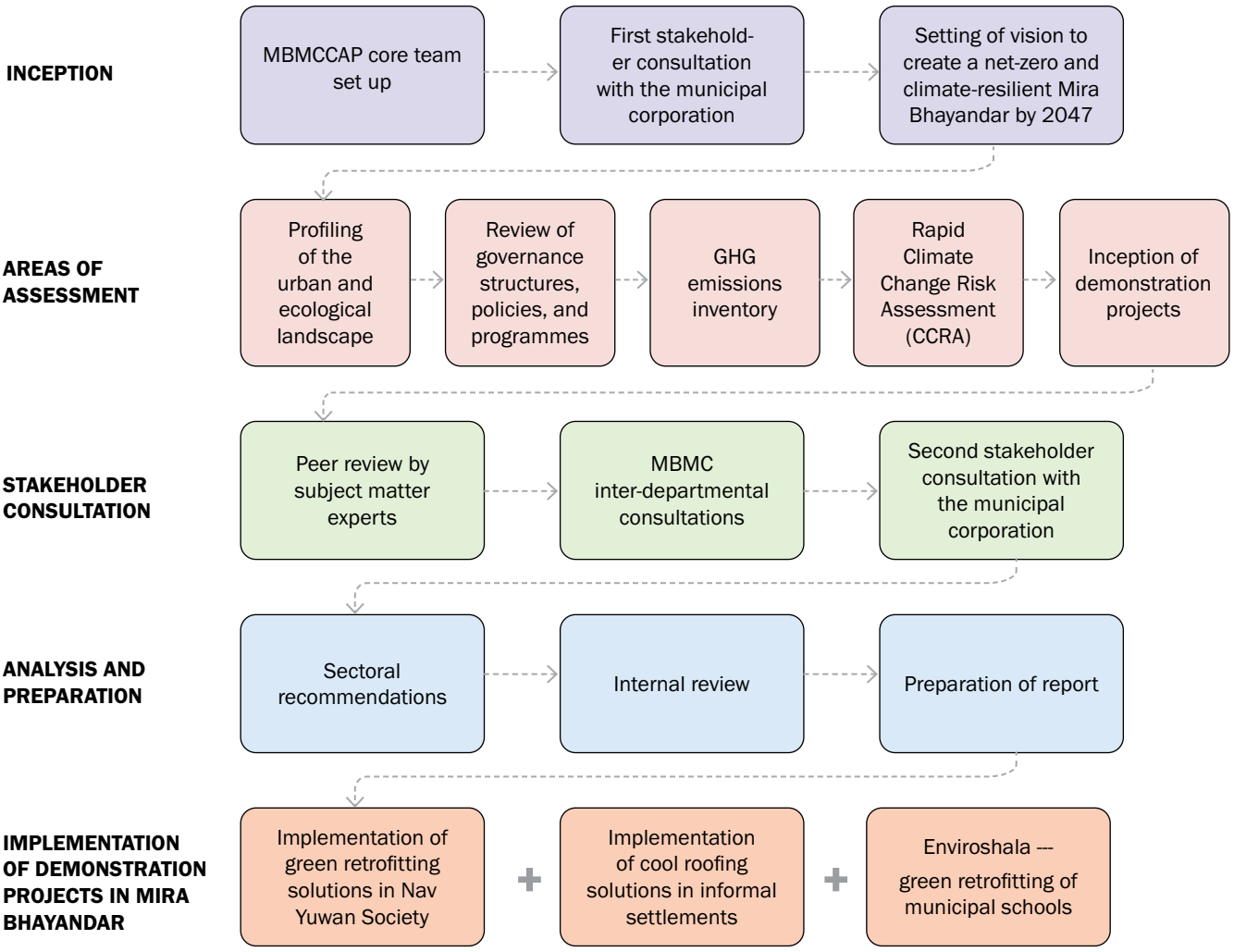
Globally, Greenhouse Gas (GHG) emissions have reached alarming levels, with approximately 53.82 billion tonnes of CO_2e emitted in 2023. The rise of anthropogenic activities, mainly from fossil fuels, industry, and agriculture, are the leading causes of these emissions. India has committed to reducing the emissions intensity of its GDP by 45% by 2030 and achieving net-zero emissions by 2070, as outlined in its updated 2022 commitment to the Nationally Determined Contributions (NDCs) under the Paris Agreement.

In keeping with the ambitious target, the Maharashtra State Climate Action Plan has directed AMRUT cities to create climate action plans and achieve Net-Zero targets by 2050. Mira Bhayandar, a key urban centre in the Mumbai Metropolitan Region (MMR) and one of the 42 cities in Maharashtra under the Central government's ambitious Atal Mission for Rejuvenation and Urban Transformation (AMRUT) scheme, has taken an ambitious step towards addressing the dual challenges of urbanisation and climate change. The city, nestled between the Vasai Creek to its north, the Sanjay Gandhi National Park (SGNP) to its east, and the Arabian Sea to the west, spans an area of 79.40 square kilometres (7,940 hectares), and has a population of 8.09 lakh as per the 2011 Census.

The Aga Khan Agency for Habitat (AKAH) India has partnered with the Mira Bhayandar Municipal Corporation (MBMC) as a knowledge partner to develop the Mira Bhayandar Climate Action Plan (MBMCCAP). Mahatma Phule Renewable Energy & Infrastructure Technology Limited (MAHAPREIT) and the National Institute of Urban Affairs (NIUA) played a pivotal role in shaping the plan, serving as advisory and technical partners to AKAH India. In March 2024, the first stakeholder consultation meeting facilitated vision-setting and identified key priority areas for action. By implementing the Climate Action Plan, Mira Bhayandar is not only contributing to India's climate targets but also setting an example for other cities to follow in their efforts toward sustainability and resilience.

While India is the third-largest emitter of GHGs, its per capita emissions are relatively low compared to developed nations, standing at about 2.9 tonnes of CO_2e per year, compared to the global average of 6.7 tonnes of CO_2e.

Mira Bhayandar Climate Action Planning Process

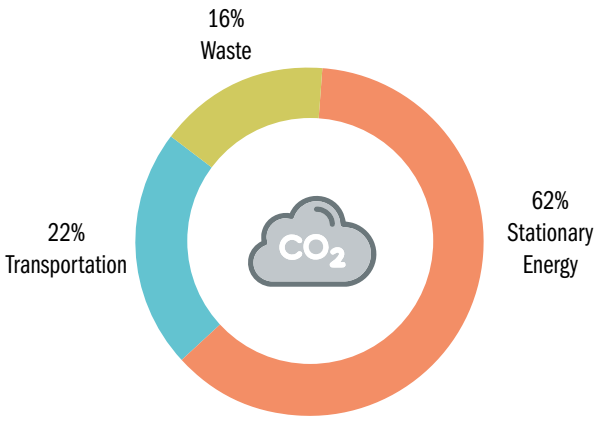


Baseline Assessment

GHG Emissions Inventory Of Mira Bhayandar

The BASIC approach calculations reveal that in 2023, Mira Bhayandar GHG emissions were **1.34 million tonnes of CO_2e or 1.12 tonnes of CO_2e per person,** an increase from 0.89 million tonnes of CO_2e in 2020. The stationary energy sector contributes to 0.83 million tonnes of CO_2e and accounts for 62% of the total emissions. **The findings show that the energy sector accounted for 62% of total emissions. Residential electricity use is a significant contributor, responsible for 40.5% of emissions.**

The transport sector contributes to 0.27 million tonnes of CO_2e and accounts for **22% of the total emissions**. **The waste sector** contributes to 0.22 million tonnes of CO_2e which accounts for **16% of the total emissions** in the city.



GHG emissions of the city

Photo credit: www.freepik.com

Rapid Climate Change Risk Assessment

The Rapid Climate Change Risk Assessment (CCRA) of Mira Bhayandar meets the minimum requirements for evidence-based decision making, providing a qualitative assessment of risk. It has been conducted in four parts *(table below).*

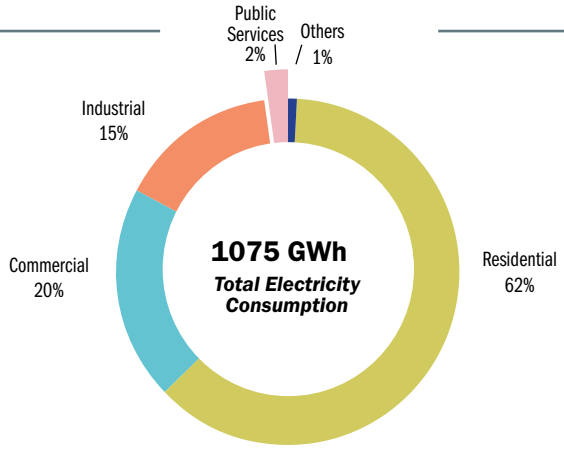
CLIMATIC HAZARDS			
URBAN HEAT	**URBAN FLOODING**	**COASTAL RISKS**	**AIR POLLUTION**
The built-up area in the city has increased by 50.05% between 2005 to 2022 and the vegetation cover was reduced to 13.6%. This resulted in the annual temperature rise by 0.46 degree celsius	The city is facing major urban flooding challenges due to waterlogging. This is caused due to an undulated and clogged drainage system as well as a poor discharging capacity of accumulated water during peak rainfall	The coastline of Mira Bhayandar has eroded by 0.5 km in the past 15 years (2008 to 2023). The climate-induced coastal risks not only threaten the livelihoods and food security of the vulnerable communities but also displace them, leading to social instability	The city has 1 ambient air quality monitoring station under the National Air Quality Monitoring Programme. The air pollution data reveals that the city's PM2.5 and PM10 levels exceed the WHO's air quality standards by 14 and 9 times, respectively
EXPOSURE		**WARD-LEVEL VULNERABILITY ANALYSIS** AREAS TO BE MOST AFFECTED DUE TO: • **Population Density:** Wards 3, 4, 5, 6, 7, 20, and 22 • **Building Density:** Wards 2, 3, 4, 5, 6 and 7 • **Susceptibility of Informal Settlements:** Wards 1, 2, 11, 13, 15, and 16	
VULNERABILITY		**WARD-LEVEL VULNERABILITY ANALYSIS** AT-RISK AREAS AND AT-RISK POPULATIONS TO BE AFFECTED: • **Access to Healthcare:** Ward 23 • **Access to Education:** Wards 10 and 22 • **Access to Gardens and Public Parks:** Wards 2,4, 5, 9, 11 and 12 • **Access to Public Transport:** Wards 4, 6, 13, 21, and 24 • **Access to Disaster Shelters:** Wards 3, 5, 6, 9, 20, and 22	
RISK ANALYSIS		**WARD-LEVEL RISK ANALYSIS** ASSESSMENT OF HAZARDS, EXPOSURE, AND VULNERABILITY OF AREAS AND POPULATIONS: • **Very high risk:** Wards 4 and 5 • **High risk:** Wards 6, 17, 20, and 22 • **Moderate Risk:** Wards 2, 7, 8, 9, 10, 15, 18, and 19	

Key Recommendations for Priority Sectors

Energy and Buildings | Water Supply Managemment | Urban Flooding | Urban Greening and Biodiversity | Mobility and Air Quality | Waste Management

Energy and Buildings

Mira Bhayandar consumed approximately 1075 GWh of electricity in 2023, and this consumption is fuelled by rapid urbanisation, population growth, and expansion of economic activities. A steady rise in energy requirements has been seen over the years across residential, commercial, industrial, and public services. Currently, there are 3,40,000 residential metered connections, and the consumer base is increasing by 4% on a yearly basis (2% increase in per capita consumption annually). The average annual consumption per household is 1,967 kWh, which indicates that a major share of the households is dependent on electrical appliances.



Electricity consumption by different sectors (2023)

164 kWh
Monthly Average Consumption Per Household

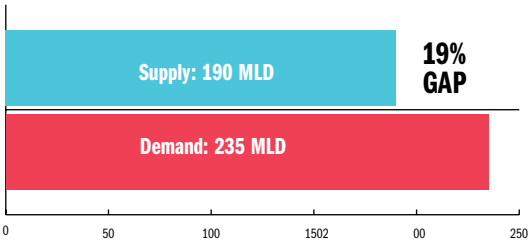
1,967 kWh
Average Annual Consumption Per Household

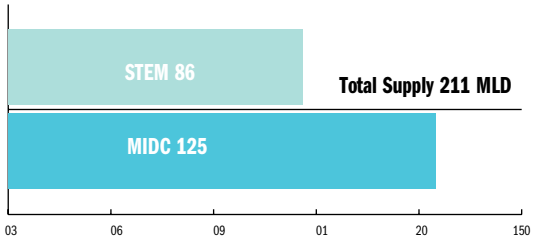
3,40,000
Residential Metered Connections

51,000
Commercial Metered Connections

Recommendations	Action	Timeline
Green Retrofitting of Buildings	The city can mandate retrofitting in non-residential buildings. The process typically includes upgrading HVAC systems, installing energy-efficient lights such as LEDs and BLDC fans, installing motion sensors for electricals in common toilets and common areas, and improving insulation and incorporating water-saving technologies like low-flow fixtures and water-efficient irrigation systems	Mid-term (2040)
Cooling Solutions in Informal Settlements	Collaborate with Corporate Social Responsibility (CSR) programmes, NGOs, and relevant organisations to implement cool roofs and other sustainability measures in informal settlements. Additionally, facilitate skill development by training locals in cool-roof installations and maintenance, and conduct workshops and awareness drives to educate residents and gather support	Short Term (2030)
Solar Initiatives	The administration should encourage adoption of Rooftop Solar Systems (RTS) city-wide. Moreover, expand renewable energy capacity by installing the innovative and self-sustaining solar tree structures in public parks, alongside roads, or in open spaces	Short to Mid-term (2030-2040)

Water Supply Management





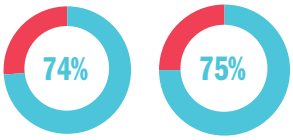
8 functional STPs (110.5 MLD)

5 MLD tertiary plants exist

Underutilised Treatment Plants

Water is supplied with seasonal inconsistencies for

2-3 Hours Daily



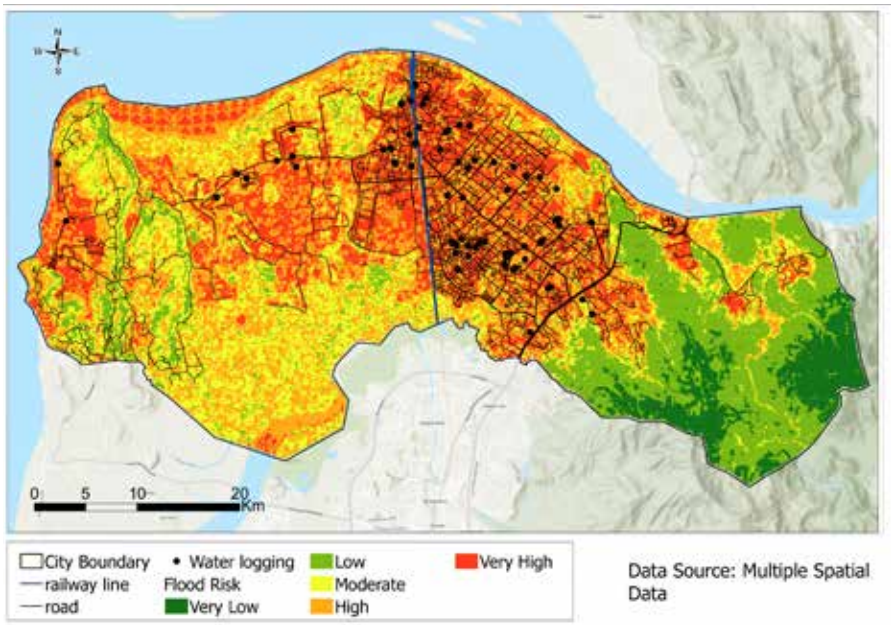
Water Supply Coverage for Households

Metered Connections

Recommendations	Action	Timeline
Eco Sewage Treatment Plants	Construct Eco STPs, which will use natural, low-energy biological processes for treating wastewater, particularly for informal settlements and areas lacking robust infrastructure	Short-term (2030)
Zonal Distribution Systems	Establish zonal distribution and bulk metering systems to ensure targetted interventions that directly address water loss and support equitable water supply	Short-term (2030)
Non-Revenue Water Reduction Strategy	Develop and implement a comprehensive NRW Reduction Strategy through a public-private partnership model to maximise resource utilisation and enhance service reliability	Mid-term (2040)

Urban Flooding

There are a total of **72 waterlogging points** in the city, with **wards 13, 20, 23, 10, and 4 at higher risk** of urban flooding than the rest. The city's stormwater **drainage network system is aged and covers only 50.24%** of the total road network. Many parts of the system have lower discharge capacity, which hinders efficient handling of the runoff during peak rainfall. On an average, Mira Bhayandar has experienced 3 very heavy events, 7 heavy events, 26 moderate events, and 40 light events. The years 2005, 2010, and 2019 have received the peak rainfall.



Map of High-Risk waterlogging zones in Mira Bhayandar

5 HIGH RISK WARDS

3 VERY HEAVY EVENTS

7 HEAVY EVENTS

40 LIGHT EVENTS

Peak Rainfall
2005, 2010, & 2019

Recommendations	Action	Timeline
Upgrade of Drainage Infrastructure and Implement Nature-Based Solutions	Invest in the expansion and modernisation of the city's drainage systems, especially in the 'high' and 'very high' risk wards – 4, 10, 13, 20, 23. This includes increasing the capacity of existing drains, constructing new drainage channels, and ensuring regular maintenance to prevent blockages	Mid-term (2040)
Enforce Urban Planning Regulations	Enforce strict zoning regulations to prevent development in flood-prone areas, and integrate Sustainable Urban Drainage Systems (SuDS) into urban planning so that new developments are designed to manage water sustainably	Short-term (2030)
Establish Early Warning Systems	Introduce real-time flood monitoring and early alert mechanisms and employ flood forecasting models to prepare for impending rainfall and flooding	Mid-term (2040)

Greening and Biodiversity

With the rapid expansion of the **built-up area from 5.52% in 2005 to 11.28% in 2022,** there has been a significant loss of vegetation cover which stands at 13.6% within the urban agglomeration. There are 79 gardens and public parks in the city and **almost 28% of the population (buffer area: 400 metres) have physical access to these green public spaces.** Within the main built-up area, **the city has only 77 hectares of green space, with an average of 0.7 square metres per person.** This is much lower than the 10 square metres per person that the URDPFI 2014 guidelines specify.

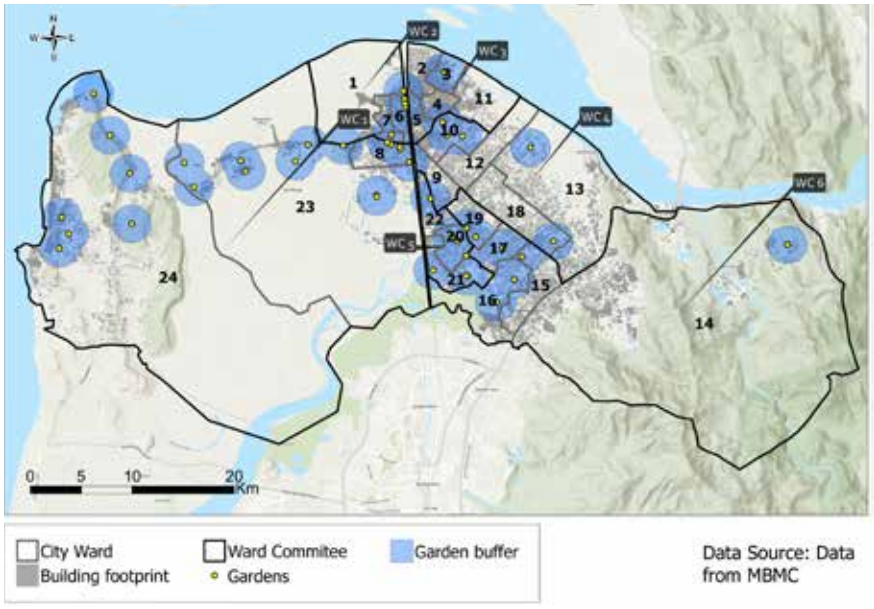
79
Parks and Playgrounds

120+
Waterbodies consisting of lakes and wetlands

21%
Sanjay Gandhi National Park

15%
Mangroves

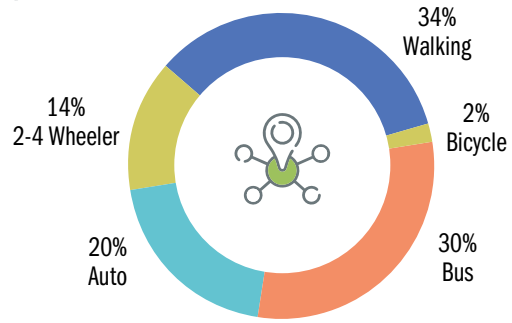
23.8 km
Shoreline



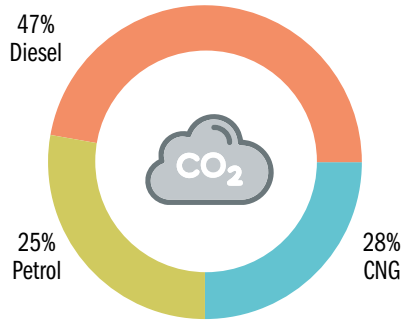
Map of Access to Green Public Spaces in Mira Bhayandar

Recommendations	Action	Timeline
Promote and Conserve Green Spaces	Promote community-led development of greenery in spaces between road dividers, upcoming metro lines, and any new construction to mitigate the urban heat island effect	Mid-term (2040)
Establish Ward-Level Biodiversity Management Committees (BMC)	Mandate to involve the local stakeholders, such as wildlife conservationists and rescuers in the BMC, who can bring in valuable insights on species-specific needs, habitat conservation, and rescue efforts, particularly for marine and urban wildlife. A standing committee member should serve as the chairman of the central BMC to ensure alignment with municipal priorities and effective governance	Short-term (2030)
Biodiversity Booklet	Develop an informative booklet based on the findings of the People's Biodiversity Register (PBR) and distribute it in both MBMC and private school libraries. The register can act as a guide to Local Biodiversity Action Plan (LBSAP)	Short-term (2030)

Mobility and Air Quality



Modal split of vehicles in Mira Bhayandar



5% increase in emissions between 2015 and 2023

Total transportation emissions in 2023

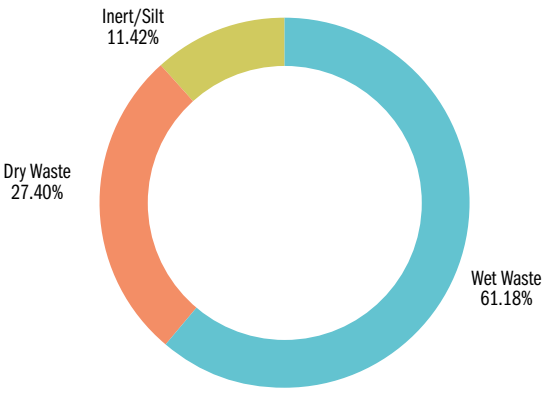
The emissions from the transport sector comprises of 47% Diesel, 28% CNG and 25% Petrol. A significant 20% of the city's population are pedestrians. Only 5% of people use bicycles. However, nearly 60% of the roads have no dedicated footpaths for pedestrians, particularly in densely populated neighbourhoods.

1
Ambient air monitoring station

Mira Bhayandar, a non-attainment city, has already implemented a City Clean Air Action Plan. At present, it has one ambient air quality monitoring station installed under the National Air Quality Monitoring Programme. The city's PM2.5 and PM10 levels exceed the WHO's air quality standards by 14 and 9 times, respectively.

Recommendations	Action	Timeline
Establish Comprehensive Emissions Inventory	Develop an air pollution emissions inventory to identify major pollution sources, establish a baseline for air-quality management, and support the development of targeted mitigation strategies	Mid Term (2040)
Complete Street Concept	Integrate all modes of transportation, including walking, cycling, and public transport, with a focus on safety, efficiency, and environmental health	Short-term (2030)
Variable Parking Mechanism	Implementation of time-based Variable Parking Mechanism / Zonal parking pricing on the different parking zones identified based on traffic density, land use and availability of public transport. High-density areas will have higher parking charges whereas peripheral zones would have lower rates	Short-term (2030)

Waste Management



The city has 10 Sewage Treatment Plants (STP), 8 of which are operational. They collectively treat 110.5 MLD which includes the tertiary treatment plant which has a 5 MLD capacity. Although, the total installed capacity of the 10 STPs is 128 MLD, there exists a gap of 17.5 MLD in the existing treatment capacity.

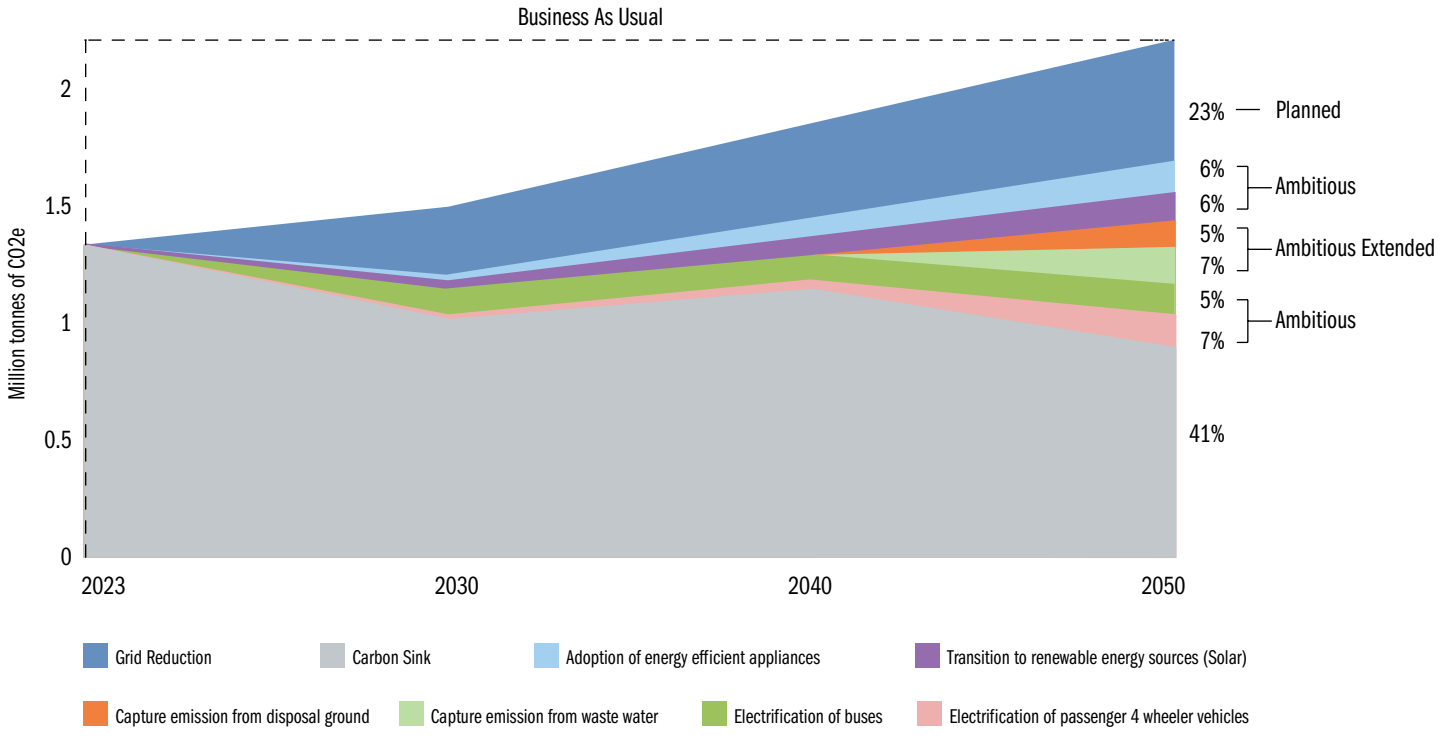
Current Scenario Of Wastewater Treatment Capacity

Recommendations	Action	Timeline
Construction and Demolition Waste	Construction and demolition (C&D) waste accounts for nearly half the solid waste generated globally each year. This type of waste includes materials such as concrete, wood, metals, glass, and plastics, which are produced during the construction, renovation, and demolition of buildings and infrastructure. Currently, Mira Bhayandar lacks a comprehensive strategy to manage this waste	Mid-term (2040)
Comprehensive Wastewater Management and Sustainable Sludge Treatment Strategy	Ensure 100% coverage within the city limits with a fully closed and underground sewer collection network and transition all domestic wastewater treatment plants to aerobic systems either by constructing new or upgrading existing anaerobic STPs	Mid-term (2040)
Waste Collection And Management		
Furniture Waste	Establish specific monthly collection days for registered bulky furniture waste, ensuring items are segregated for reuse, recycling, or processing into biochar and compost to decrease landfill pressure	Short-term (2030)
Poultry Waste	Establish designated collection points at poultry markets and shops with a daily collection schedule, using specialised vehicles to process collected waste through composting for organic fertiliser and anaerobic digestion for biogas production	Short-term (2030)

Summary of Mitigation Actions

In order to meet the internationally agreed-upon goal of net-zero emissions by 2050, there are a number of key priority actions and recommendations broken down by sector that could help lower greenhouse gas emissions.

Owing to limitations in methodology and data, the MBMCCAP has only enumerated the mitigation potential of 7 recommendations. The city can support the ongoing Grid Reduction efforts at the national level by enhancing its local energy mix and reducing 23% of emissions by 2050. This comes under the Planned Scenario. By adopting rooftop solar infrastructure across residential, commercial, and industrial buildings, solarising municipal infrastructure like streetlights and facilities, and promoting energy-efficient appliances such as BLDC fans and BEE star-rated devices, the city can reduce emissions by 24% by 2050 under the Ambitious Scenario. Furthermore, under the Extended Ambitious Scenario, the city can achieve an additional 12% reduction in emissions from the waste sector.



Mitigation Actions Under the MBMCCAP

Implementation of Demonstration Projects to Mitigate Urban Heat Island Effect in Mira Bhayandar

GREEN RETROFITTING

1. Nav Yuwan Housing Society

The findings show that the energy sector accounted for 62% of total emissions. Residential electricity use is a significant contributor, responsible for 40.5% of emissions. To address this, the Aga Khan Agency for Habitat (AKAH) has implemented energy-efficient retrofitting solutions substantially reducing by over 60% emissions. As a pilot initiative, these solutions have been successfully deployed at Nav Yuwan Housing Society, delivering tangible outcomes, and serving as a replicable model to drastically bring down emissions in India and the world. The project has received IFC Edge Advanced Certification which serves as a credible recognition and is the first existing society to receive the IFC EDGE certification in Asia.

IMPLEMENTATION

The Nav Yuwan CHS project focussed on a multi-pronged approach:

Energy Efficiency:

BLDC Fans: Installed in all 280 households, resulting in up to a 41% reduction in electricity consumption for cooling

LED Lighting: Replaced traditional incandescent bulbs across all units, significantly lowering energy demand for lighting

Solar PV System: A 44 KWp solar PV system was installed to power common areas, reducing reliance on grid electricity by 8-10%

Water Conservation:

Low-Flow Fixtures: Installed in bathrooms and kitchens across the 280 households to minimise water usage

Water-Saving Practices: Promoted water-efficient habits among the 1,120 residents (assuming an average of 4 residents per household), such as the use of bucket baths, which can save up to 35% of water

Community Engagement:

Workshops and Training: Conducted workshops on sustainable living practices to empower the 1,120 residents to make informed choices

Kitchen Gardening: This training has offered residents, specially senior citizens, gentle exercise, stress relief, and a sense of purpose. Growing one's own food improves nutrition intake as it reduces reliance on processed options. The gardens generate compost, which minimises waste, and benefits the environment

Results & Impact

THE NAV YUWAN CHS PROJECT ACHIEVED SIGNIFICANT POSITIVE OUTCOMES

Energy Savings 41% overall: Substantially reduced energy consumption across all 280 households, leading to lower electricity bills for residents

Water Savings 35% overall: Achieved a significant reduction in water consumption across households, contributing to water resource conservation

Environmental Impact: Reduced carbon emissions associated with energy consumption across 280 households, mitigating the impact of climate change

Social Benefits: Improved resident comfort and wellbeing through enhanced indoor air quality and reduced energy costs for all 1,120 residents. Fostered a sense of community through shared sustainability goals and initiatives

MUNICIPAL SCHOOLS

In addition to residential projects, AKAH is retrofitting 3 selected schools located in heat-stressed zones to enhance their sustainability and resilience. As part of this initiative, 159 BLDC fans, 35 motion sensor lights and 60 dual-flush cisterns were installed to achieve a target of minimum 20% improvement in energy and water efficiency. Among the key measures implemented is the use of BLDC fans, which has the potential to reduce electricity consumption by 53% as compared to traditional fans, significantly cutting energy use. Furthermore, 47% water efficiency can be achieved with the installation of dual-flush cisterns.




Cooling Solutions In Informal Settlements




In informal settlements, AKAH is addressing thermal comfort challenges by introducing cooling solutions such as Solar Reflective Index (SRI) paints, alufoil, and wood wool panels with ventilation cores, which is being implemented in 105 household units. These measures are expected to lower indoor temperatures by 3–4°C and reduce rooftop surface temperatures by approximately 20°C, delivering immediate and perceptible relief to residents

[Chapter-1]

CITY PROFILE

A critical satellite city in the Mumbai Metropolitan Region, Mira Bhayandar is emerging as a comprehensive model of economic growth, ecological conservation, and climate justice.

Mira Bhayandar is a major urban centre in the Mumbai Metropolitan Region (MMR)[1]. It is identified as a satellite city due to its proximity to Greater Mumbai[2], comparatively lower cost of living, and ongoing transformation into a smart city under the central government's Atal Mission for Rejuvenation and Urban Transformation (AMRUT). It is one of the 500 cities in the country and among the 42 cities in Maharashtra that AMRUT is enabling to achieve a circular economy of water, equitable access to basic resources, development of non-motorised transport, and net-zero waste and emissions.

Nestled between the Vasai Creek to its north, the Sanjay Gandhi National Park (SGNP) to its east, and the Arabian Sea to the west, the ecologically rich satellite city spans an area of 79.40 square kilometres (7,940 hectares), and has a population of 8.09 lakh as per the 2011 Census. It boasts of a vibrant economy that is fuelled by small-scale industries, agriculture, fishing, and sand and salt farming.

1 The Mumbai Metropolitan Region (MMR), spread over 6,328 square kilometres, comprises Mumbai and all its satellite cities. It encompasses 9 municipal corporations (Greater Mumbai, Thane, Kalyan-Dombivali, Navi Mumbai, Ulhasnagar, Bhiwandi Nizamapur, Vasai Virar, Mira Bhayandar, and Panvel) and 9 municipal councils (Ambarnath, Kulgaon Badlapur, Matheran, Karjat, Khopoli, Pen, Uran, Alibaug, and Palghar), along with more than 1,000 villages in the Thane, Raigad and Palghar districts. Mumbai is the apex city of MMR.

2 Greater Mumbai is the term used to describe the island city of Mumbai and its suburbs.

8.09 lakh

Population
(as per the 2011 Census)

79.40 sq km

Area
(as per the 2011 Census)

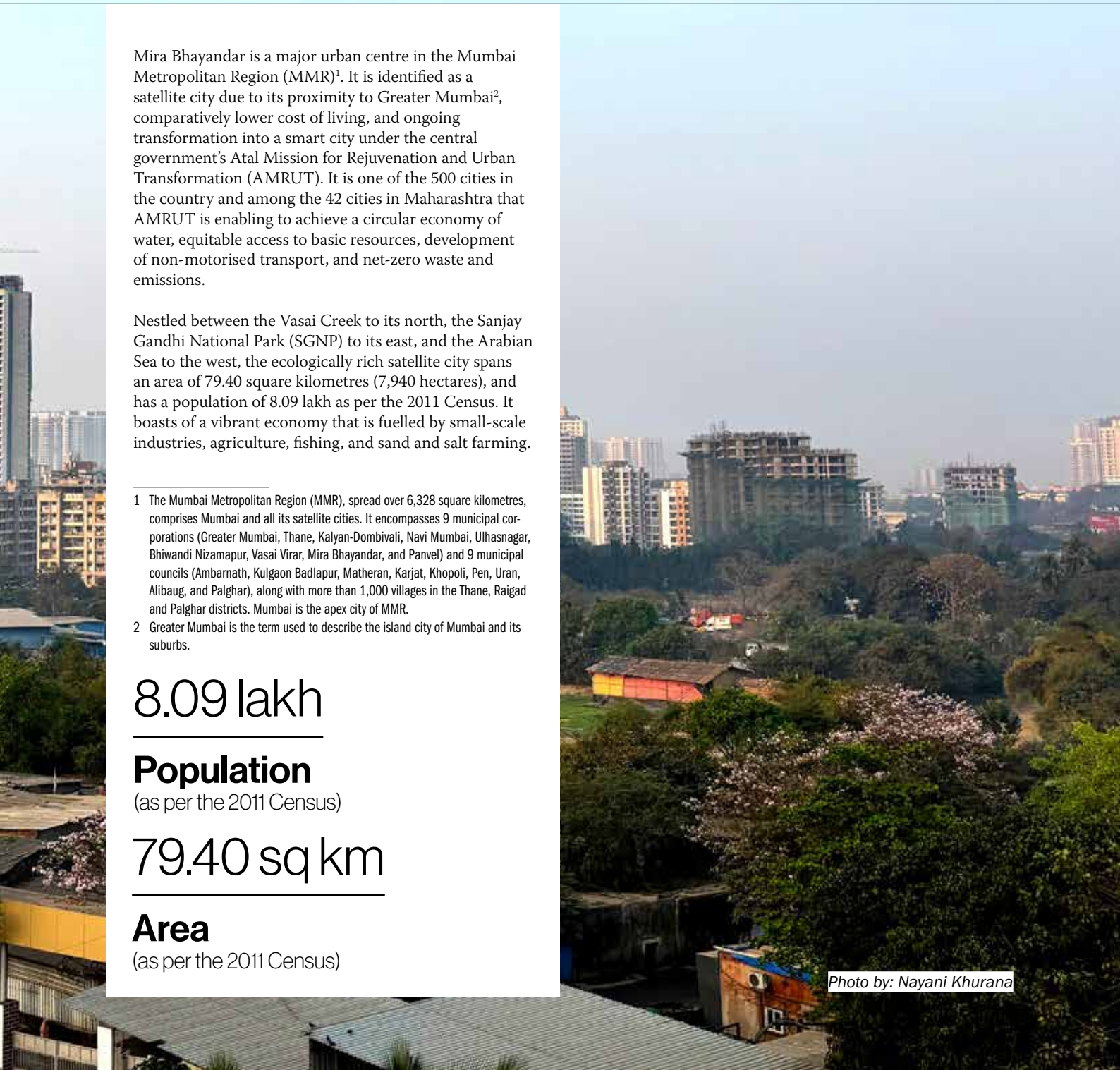


Photo by: Nayani Khurana

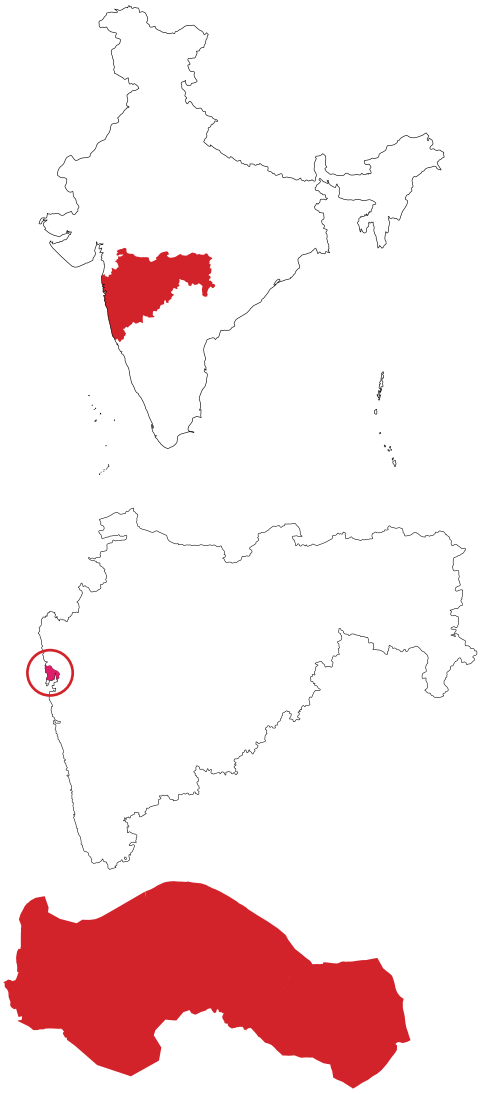


Figure 1.1: Location of Mira Bhayandar in the state of Maharashtra, India

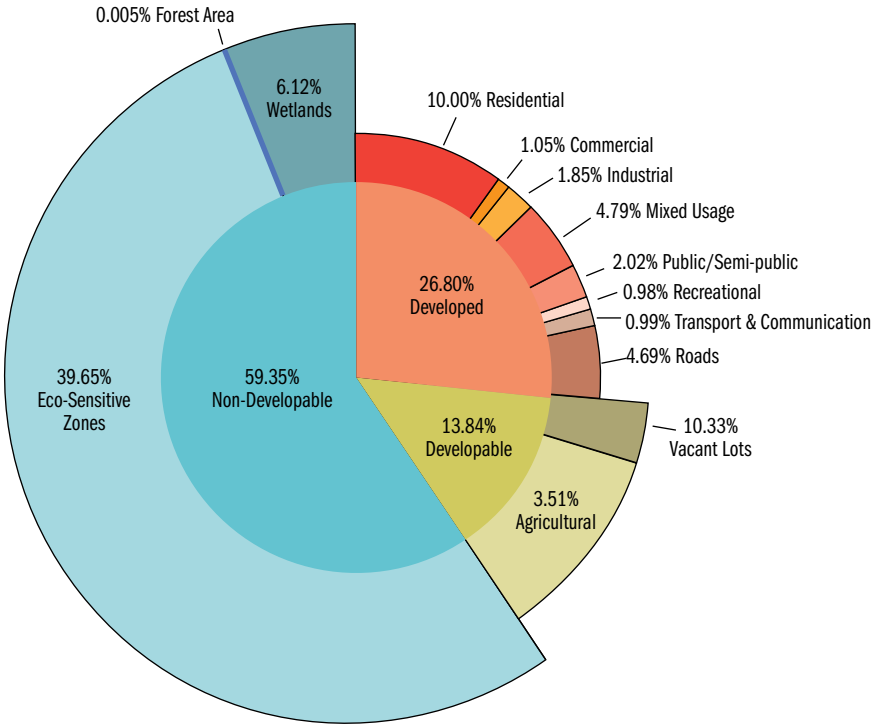


Figure 1.2: Distribution of developable, non-developable and developed area in Mira Bhayandar

Geographically, Mira Bhayandar lies between 14º42'N to 20º20'N latitude and 0º25'E to 73º44'E longitude at an average mean sea level of 3 metres.

1.1 URBAN LANDSCAPE

1.1.1 City Administration

On June 12, 1985, the Mira Bhayandar Municipality was formed by the amalgamation of five gram panchayats — Bhayandar, Navghar, Kashi, Mira, and Ghodbunder. On January 23, 1990, four more gram panchayats — Chena, Rai-Murdhe, Dongri-Uttan, Varsova — were incorporated. In 2002, the municipality was elevated to become the Mira Bhayandar Municipal Corporation (MBMC) to meet the increasing requirements of a burgeoning population.

The MBMC comprises 24 electoral wards to which representatives are elected every five years. It oversees all essential services, such as water supply, sewerage treatment and disposal, the construction of roads and bridges, primary education, healthcare, and the development and maintenance of primary infrastructure. It also provides certain discretionary services, including transportation and slum improvement.

The MBMC budget for the previous fiscal year, 2023-2024, was ₹2,174 crore.

1.1.2 Development Pattern

The Draft Revised Development Plan of MBMC (2017-2037) shows that the total developed area of the city is 1,736 hectares (26.80%), the developable area is 896 hectares (13.84%), and 3,845 hectares (59.35%) is non-developable.

In the developed area, residential infrastructure occupies 647.62 hectares (10%), commercial infrastructure occupies 67.99 hectares (1.05%), industry occupies 120.02 hectares (1.85%), and 310.07 hectares (4.79%) is under mixed usage. The public and semi-public areas comprising educational institutes, healthcare delivery facilities, and government properties are approximately 130.85 hectares (2.02%); recreational land use in gardens, parks, playgrounds, and swimming pools is 63.78 hectares (0.98%); transport and communication facilities constitute around 63.83 hectares (0.99%); and roads cover 304.17 hectares (4.69%).

In the developable area, agricultural lands occupy 227.68 (3.51%) hectares, while vacant lots occupy 669.14 hectares (10.33%).

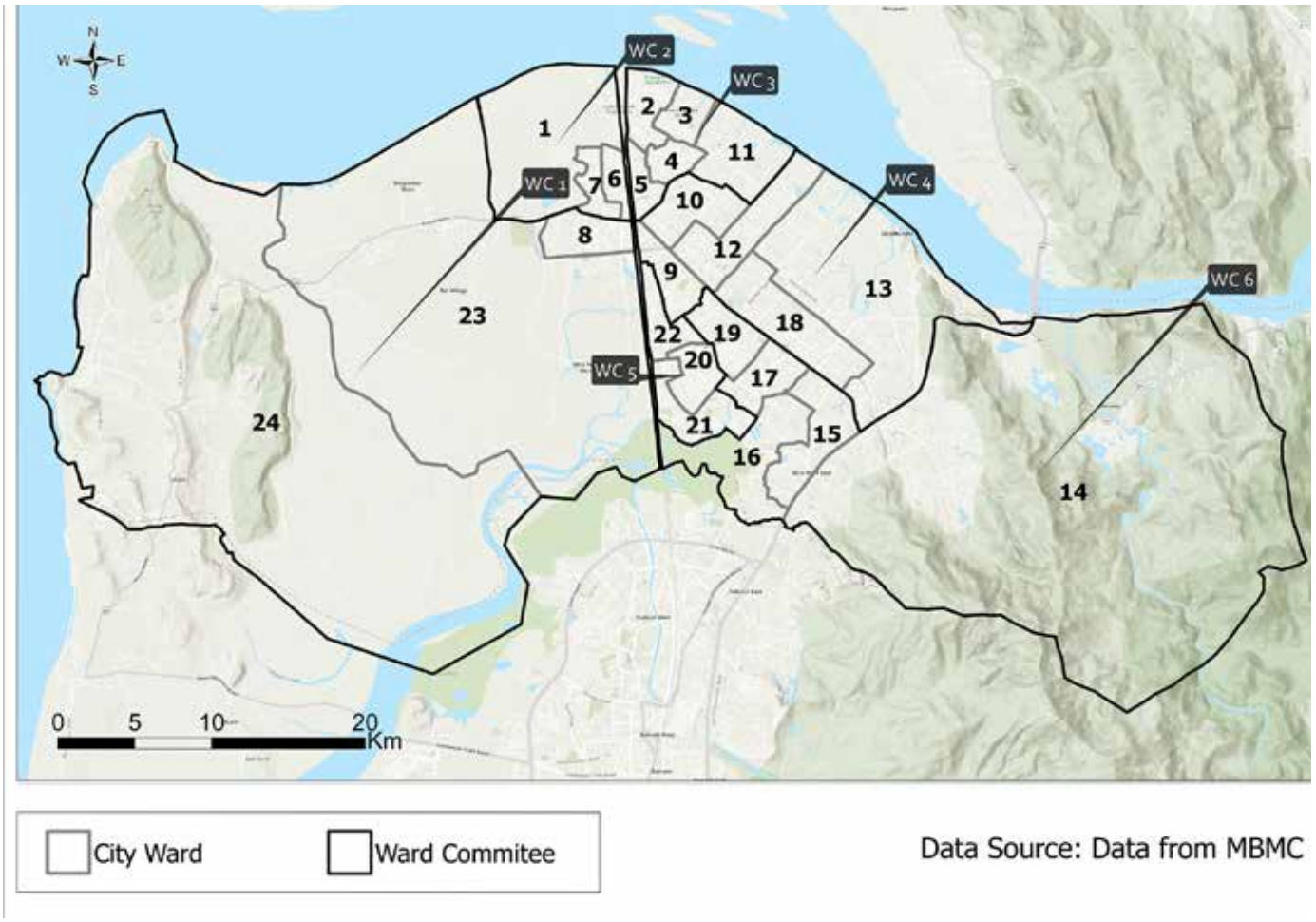


Figure 1.3: Political map of Mira Bhayandar

The non-developable area comprises 396.82 hectares (6.12%) of wetlands, 2,568.66 hectares (39.65%) of eco-sensitive zones, and 0.311 hectares (0.005%) of forest area.

The MBMC is surrounded by adjoining planning authorities — Thane Municipal Corporation, Vasai Virar Municipal Corporation, Municipal Corporation of Greater Mumbai, and Navi Mumbai Municipal Corporation — and therefore, has no scope for expansion on its south, west, and east side.

1.1.3 Economy

Mira Bhayandar is a hub for the small-scale industries with the manufacturing and machine spare parts industries dotting the areas of Saraswati Mansarovar Complex, Kashimira and Bhayandar East. Most of the units came up in an unauthorised manner and developed haphazardly into an industrial slum that caters to the big industries in Greater Mumbai.

The introduction of the industrial location policy has led to a steady decline in industrial activity, but it has also marked a paradigmatic shift from agriculture to industries to the service sector. The city has been able to retain some of its traditional occupations such as agriculture, sand and salt farming, and fishing.

1.1.4 Demography

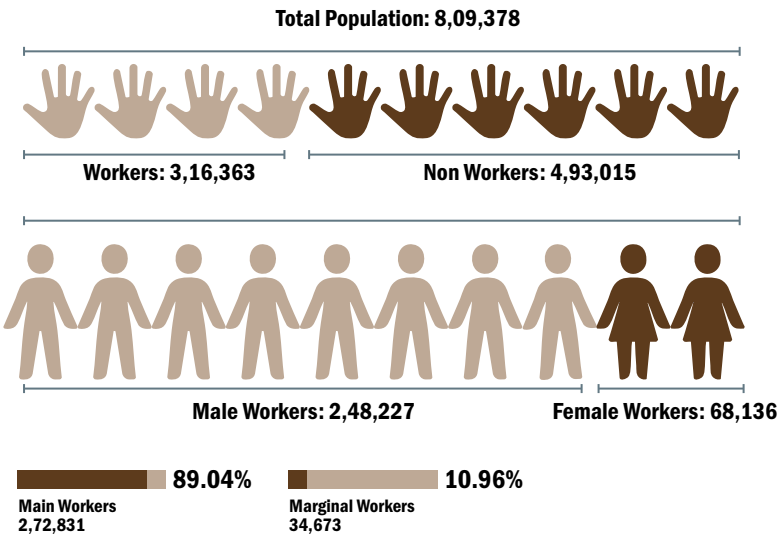
The MBMC has a population of 8,09,378, of which 4,29,260 are male and 3,80,118 are female, as per the Census of India 2011.

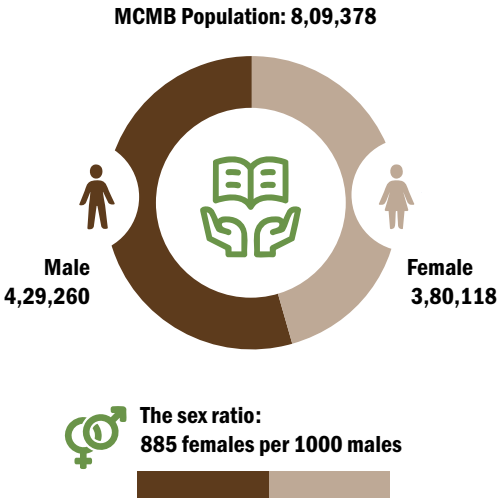
The literacy rate of the city is 81.01%, which is higher than Greater Mumbai (81%) and the national average (74%) and close to the Maharashtra average (82.34%). The female literacy rate is 45.69%, and the male literacy rate is 54.31%. When compared to the Census of India 2001, the numbers indicate a slight increase in female literacy and a drop in the male literacy rate.

The sex ratio of Mira Bhayandar is 885 females per 1,000 males, which is higher than Mumbai (858) but lower than both the Maharashtra average (925) and the national average (940).

In fact, when compared to the Census of India 2001, the child sex ratio for the population below six years has also marginally

MIRA BHAYANDAR WORKFORCE
CENSUS OF INDIA 2011





The introduction of the industrial location policy has led to a steady decline in industrial activity, but it has also marked a paradigmatic shift from agriculture to industries to the service sector.

Mira-Bhayandar Workforce
Census of India 2011

Population	**8,09,378**
Total Workforce	**3,16,363 (39%)**
Male Workers	2,48,227 (78.46%)
Female Workers	68,136 (21.53%)
Main Workers	2,72,831 (89.04%)
Marginal Workers	34,673 (10.96%)

declined from 900 to 898.

1.1.5 Pattern of Urbanisation

The majority of the population is clustered around the west side of the Bhayandar railway station and Mira Road, where the gross population density is 1,131 persons per hectare. The area around Khari Gaothan on the east side of Bhayandar station is also a well-developed residential area that shows a gross density of 1,129 persons per hectare. The areas along the west side of the coastline and adjoining forests show the lowest density.

The socio-economically vulnerable populations live in the extremes — along the railway tracks, in the peripheries of the forests, near water creeks, and in low-lying areas prone to tidal flooding.

1.1.6 Occupational Pattern

According to the Census of India 2011, 39% of the population — 3,16,363 people — are workers, while the remaining population of 4,93,015 are classified as non-workers.

People engaged in regular work for at least six months are considered main workers, while those engaged for less than six months are considered marginal workers. In MBMC, 89.04% of the total workers are main workers, while 10.96% are marginal workers.

The percentage of the total working population showed a promising increase from 30.10% in 1981 to 39% in 2011.

However, there has been a drop in the number of main workers from 96.26% in 2001 to 89.04% in 2011, implying a decrease in long-term employment opportunities.

1.1.7 Connectivity

Mira Bhayandar is a critical city because of its easy connectivity to Greater Mumbai via the Western Railway stations of Mira Road and Bhayandar, from approximately 1,00,000 people commute daily for jobs and other activities.

The Western Express Highway links Mira Road with the entire length of the western suburbs of Greater Mumbai, and carries heavy goods traffic.

The National Highway 48 is a major link road connecting the Mumbai-Ahmedabad Road (NH-8) part of the Golden

Photo credit: Youth Conclave Students | SPA Bhopal

Photo by: Abolee Muranjan

Quadrilateral[1] near Ghodbunder to the Mumbai-Agra Road (NH-3) near Kapurbawadi. This link passes through the MBMC area and carries heavy commercial traffic.

Apart from the railway and the road network, the city has the Mira Bhayandar Municipal Transport (MBMT) services operating across 20 routes as a feeder system for daily commuters to Greater Mumbai. Local travel is also dependent on two-wheelers (38%), followed by auto-rickshaws (34%).

Mira Bhayandar is a critical city because of its easy connectivity to Greater Mumbai via the Western Railway stations of Mira Road and Bhayandar, from approximately 1,00,000 people commute daily for jobs and other activities

1 The Golden Quadrilateral is a network of four national highways in India that connect the four major metro cities of Delhi, Mumbai, Chennai, and Kolkata. One of the most important road projects in India, it has a significant role in the country's economy.

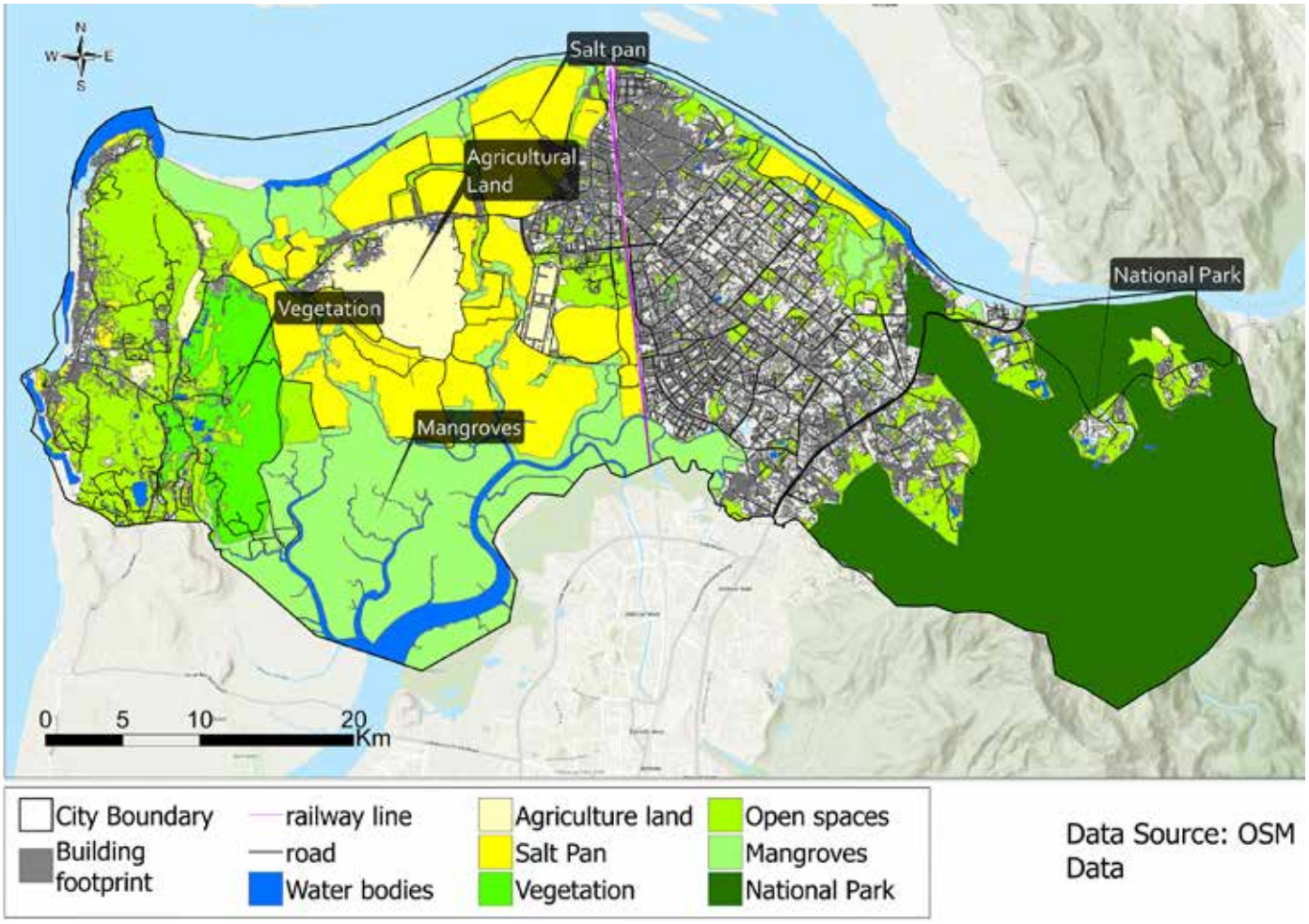


Figure 1.4: Ecological map of Mira Bhayandar

1.2 ECOLOGICAL LANDSCAPE

Geographically, Mira Bhayandar lies between 14°42'N to 20°20'N latitude and 0°25'E to 73°44'E longitude at an average mean sea level of 3 metres. It is located in the northern part of the Konkan region to the west of the Sahyadri mountain range, and is bound by the Thane Municipal Corporation Sanjay Gandhi National Park (SGNP) to the east, the Vasai Virar Municipal Corporation to the north, the Greater Mumbai Municipal Corporation to the south, and the Arabian Sea to the west.

The city is situated on plain-level land. The Vasai creek surrounds it from east to north followed by the Arabian Sea at the west. Uttan, Ghodbunder, and the eastern part of the city are hilly. The plain terrain forms a wide area of waterlogged and marshy land to the west of Mira Road. Geologically, the city falls in the Deccan lava terrain.

Mira Bhayandar has a well-functioning coastal ecosystem and natural drainage system, encompassing rivers, streams, forest areas, and wetlands, which contribute to the overall flora, fauna, and biodiversity. The rich mangrove forests occupy 396.82 hectares (6.12%) and form a natural barrier against tidal surges on the east, controlling urban flooding and acting as productive carbon sinks.

2,566.71 Ha
Sanjay Gandhi National Park (SGNP)

1,300
Species of flowering plants

43
Species of reptiles

45
Species of mammals

300
Species of birds

The SGNP spreads across 2,566.71 hectares (39.62%) and is home to 300 species of birds, 45 species of mammals, 45 species of reptiles, 150 species of butterflies, and over a staggering 1,300 species of flowering plants.

1.2.1 Climatology

The city experiences an equable coastal climate, characterised by hot and humid summers between March and May, with maximum temperatures around 37°C and minimum around 22°C. The monsoon season extends from July to late September, bringing light to moderate rainfall primarily from the southwest monsoon, though occasional precipitation occurs during the winter and pre-monsoon periods. Winters are mild, with maximum temperatures reaching 33°C and minimum temperatures dropping to 16°C. The overall temperature variation throughout the year is relatively narrow, averaging a difference of 6.8°C.

Photo Credit: AKAH

The dense urbanisation, coupled with reduced vegetation and water surfaces and anthropogenic activities, has contributed to the urban heat island effect. The increased ambient temperature in the city during day and night times, particularly during summer months, has a profound effect on the socio-economic well-being of the population, especially the outdoor workers, slum dwellers, women, children, and elderly.

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1.2.2 Conservation Mechanisms

The ecological richness of Mira Bhayandar is protected by multiple legal provisions on ecological justice.

According to a verdict passed by the Supreme Court of India, dated June 3, 2022, all protected forests, national parks, and nature reserves in the country must have mandatory buffer zones or ecologically sensitive zones at least one kilometre from their designated boundaries. In adherence, the area extending from 100 metres to 4 kilometres from the boundary of SGNP is notified as an eco-sensitive zone, and a few of the villages of Mira Bhayandar — Kashi, Mira, Chene, Ghodbunder, and Versave fall in it.

The Coastal Zone Management Plan (CZMP), 2019, which regulates and manages developmental and human activities in coastal areas, is underway in Mira Bhayandar as notified by G.S.R. 37 (E) dated January 18, 2019, by the Ministry of Environment, Forest and Climate Change, Government of India.

The area between the Vasai Creek to the north and Versave village to the east is proposed to be in the Coastal Regulation Zone (CRZ)-I. This excludes the existing development, which will be included in CRZ-II along with the villages adhering to the coastline. Under CRZ-I, construction is prohibited up to 200 metres from the high-tide line. Certain activities like agriculture, horticulture, and forestry may receive permission. However, in the more sensitive CRZ-II zone, where traditional hamlets, mangroves, coral reefs and sand dunes lie, no development activities are permitted.

In August 2023, the Maharashtra Coastal Zone Management Authority (CZMA) reduced the limit from 100 metres to 50 metres from the high-tide level for creeks and rivers.

This change is expected to boost tourism activity and facilitate the regularisation of old houses and establishment of common facilities for local residents. Fishermen will be permitted to use the land for traditional activities such as fish drying, net repairing, and boat maintenance. The new regulations will make it easier to develop facilities like shacks, toilets, and common seating areas for tourists, who are attracted to Mira Bhayandar's beaches, forts, monuments, religious places, and natural history.

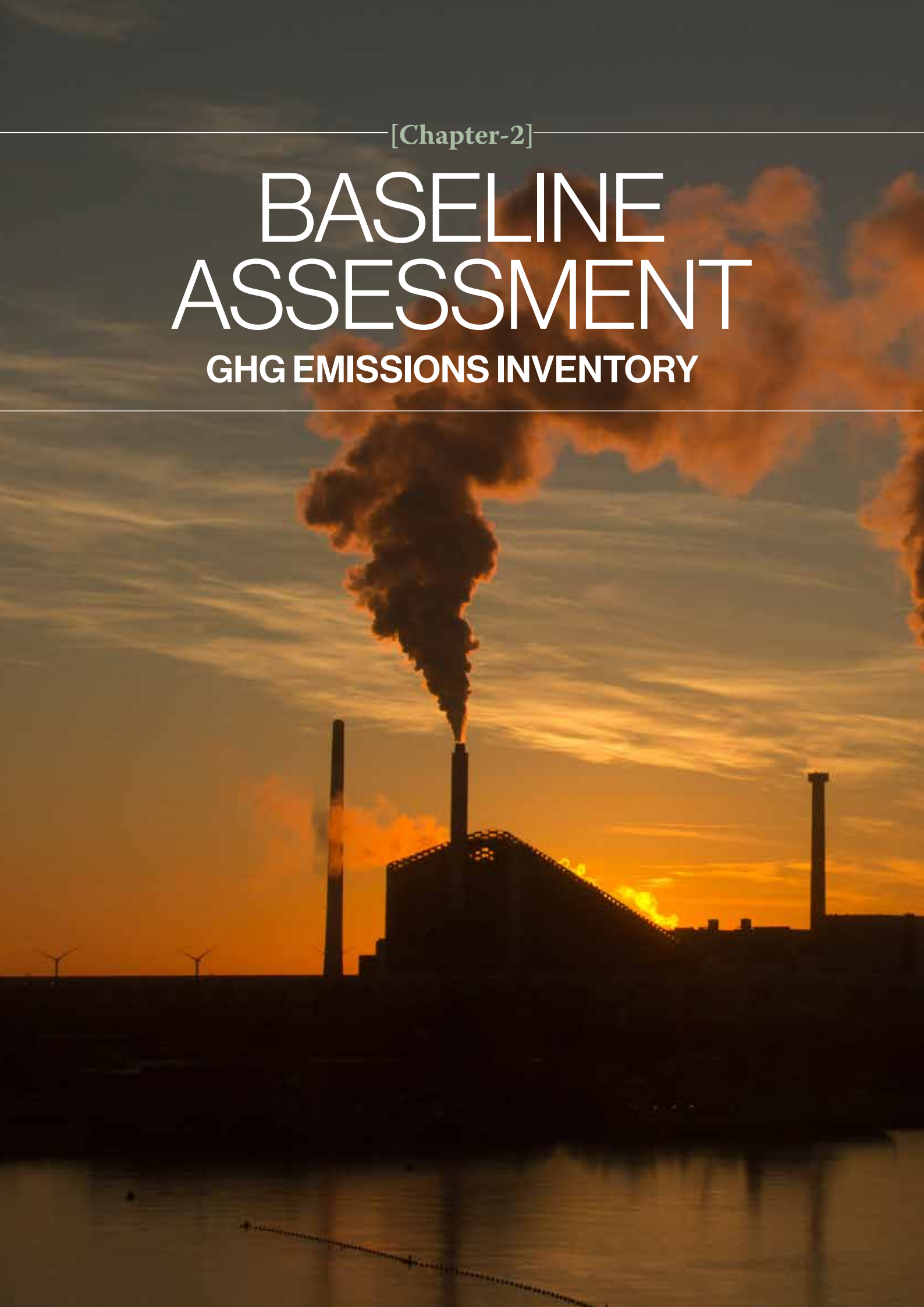
Sources:

1. *Comprehensive Mobility Plan, 2014*
2. *Draft Revised Development Plan Mira Bhayandar (1997-2037)*
3. *Mira Bhayandar Environment Status Report 2022-2023*
   Bhayandar Population Census 2011-2024
4. *Supreme Court of India verdict details: https://api.sci.gov.in/supremecourt/1995/2997/2997_1995_8_1501_43924_Judgement_26-Apr-2023.pdf*
5. *Minutes of the 168th meeting of the Maharashtra Coastal Zone Management Authority (MCZMA) details: https://mczma.gov.in/sites/default/files/168%20MoM.pdf*

[Chapter-2]

BASELINE ASSESSMENT

GHG EMISSIONS INVENTORY



The global greenhouse gas protocol equips Mira Bhayandar with the standards and tools it needs to measure GHG emissions. This helps the city to build effective emissions reduction strategies, set measurable and more ambitious emission reduction goals, and track their progress more accurately.

Greenhouse Gas (GHG) inventories are a list of emission sources and the associated emissions quantified using standardised methods. The BASIC approach to a GHG inventory is to collect, process, and analyse emission data to track and quantify GHG emissions from various sources.

Process for GHG Emissions Inventory

The GHG inventory development comprises four processes:

01

Review accounting standards and methods, determine organisational and operational boundaries, and choose a base year

02

Collect data and quantify GHG emissions

03

Develop a GHG Inventory Management Plan to formalise data collection procedures

04

Set a GHG emission reduction target, and track and report progress

Photo credit: www.freepic.com

2.1 GHG Inventory Development Process

Scope and Plan Inventory

1. Review GHG accounting standards and methods for organisational reporting
2. Determine organisational and operational boundaries
3. Choose a base year
4. Consider third-party verification

Collect Data and Quantify GHG Emissions

1. Identify data requirements and preferred methods for data collection
2. Develop data collection procedures, tools, and guidance materials
3. Compile and review facility data (e.g., electricity, natural gas)
4. Estimate missing data to fill gaps
5. Choose emissions factors
6. Calculate emissions
7. Conduct verification

Develop a GHG Inventory Management Plan

Formalise data collection procedures and document processes relevant to the following:

1. Organisation information
2. Boundary conditions
3. Emissions quantification
4. Data management
5. Base year
6. Management tools
7. Auditing and verification

Set a GHG Emission Reduction Target, and Track and Report Progress

Formalise data collection procedures and document processes relevant to the following:

1. Finalise data
2. Complete third-party verification (optional)
3. Report data as needed
4. Prepare to set a publicly reported GHG target and track progress
5. Conduct audit and verification

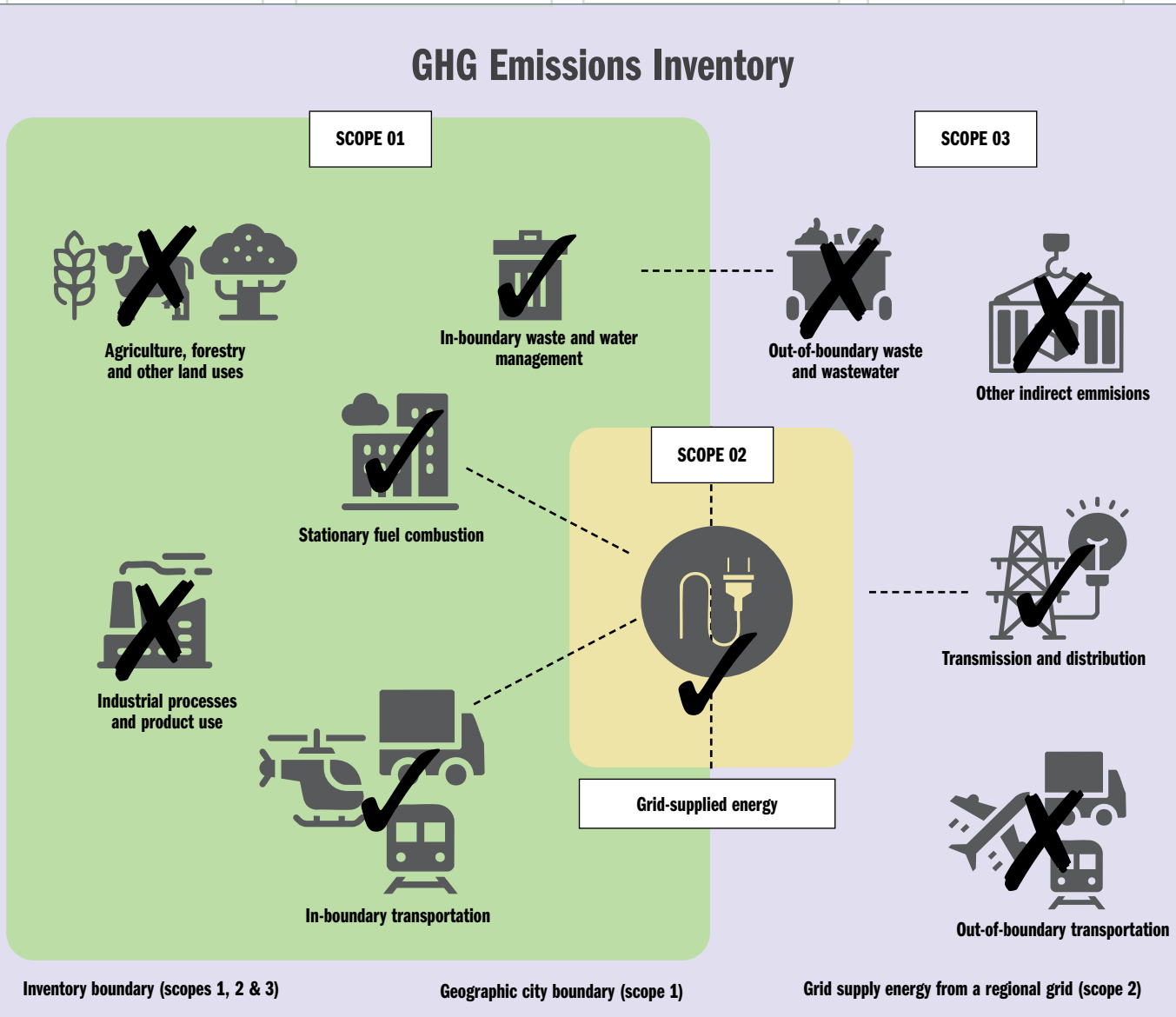


Figure 2.1: GHG Emissions Inventory

BASIC Reporting

1. Emissions from stationary energy
2. Emissions from transportation
3. Emissions from waste

BASIC+ Reporting

1. Emissions from all BASIC sources
2. Emissions from Agriculture, Forestry and Other Land Uses (AFOLU)
3. Emissions from Industrial Processes and Product Use (IPPU)
4. Emissions from transboundary transportation

2.2 Methodology for GHG Emissions Inventory

The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) provides cities with the standards and tools they need to understand their total emissions and biggest emissions sources, set measurable and ambitious emission reduction goals, plan effective reduction strategies, and track their progress. This is a globally recognised standard consistent with guidelines of the IPCC — the Intergovernmental Panel on Climate Change of the United Nations that assesses the science related to climate change.

The GPC delivers sector-based emissions inventories *(Figure 2.1)*. This means that these inventories measure emissions produced within the city boundary (known as 'scope 1' or 'territorial' emissions, shown in the graphic below) and those from the use of grid-supplied energy ('scope 2' emissions). These inventories do not include the emissions embedded in the goods and services consumed in the city but which are imported from outside ('scope 3' emissions).

2.3 GHG Emissions Inventory for Mira Bhayandar

BASIC Reporting

The GPC framework allows cities that are creating a GHG emissions inventory for the first time to use the BASIC approach.

Accordingly, in Mira Bhayandar, under Scope 1, data collection and calculation have applied to waste, wastewater, stationary fuel combustion, and transportation sectors within the city's administrative boundary. AFOLU calculations have not been accounted for because only 3.5% of its land cover is in agricultural use and 3.4% is fallow land; they do not create significant GHG emissions. IPPU has not been considered because the majority of manufacturing units in Mira Bhayandar are small-scale. Only a few heavy polluting units exist, and their emissions data is unavailable.

Under Scope 2, data collection and calculation have applied to emissions from grid-supplied energy within the city's administrative boundary.

Under Scope 3, the data takes into consideration the transmission and distribution sector. The other categories of Scope 3 emissions — out-of-boundary waste, wastewater, transportation and other indirect emissions — occur outside the city and therefore outside the purview of consideration. .

The BASIC approach calculations reveal that in 2023, Mira Bhayandar GHG emissions were 1.34 million tonnes of CO_2e (carbon dioxide equivalent) or 1.12 tonnes of CO_2e per person, an increase from 0.89 million tonnes of CO_2e in 2020. The emissions inventory includes the three primary GHGs — carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) — and fluorinated gases (sulfur hexafluoride or SF_6 and nitrogen trifluoride or NF_3). Around 62% of the city's total emissions are from stationary energy, followed by 22% from the transportation sector and 16% from the waste sector (*Figure 2.2)*.

2.3.1 Stationary Energy

The stationary energy sector contributes to 0.83 million tonnes of CO_2e and accounts for 62% of the total emissions. This sector covers residential buildings, commercial and institutional buildings, and construction and manufacturing industries *(Figure 2.3).*

The residential buildings account for 0.54 million tonnes of CO_2e which is 65% of the total stationary energy. The commercial and institutional buildings account for 0.17 million tonnes of CO_2e which is 20%. The construction and manufacturing industries contribute 0.12 million tonnes of CO_2e which is 14.86%. Agriculture, forestry and fishing contribute 0.0.000185 million tonnes of CO_2e which is 0.14%.

The transport sector contributes to 0.27 million tonnes of CO_2e and accounts for 22% of the total emissions.

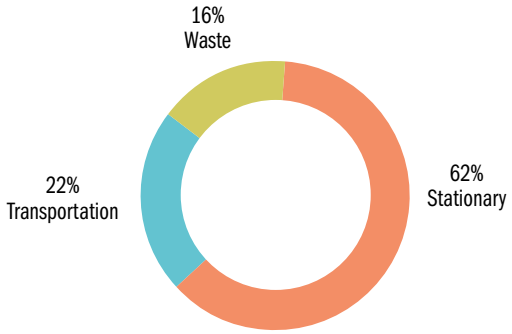


Figure 2.2: Emissions breakup of different sectors

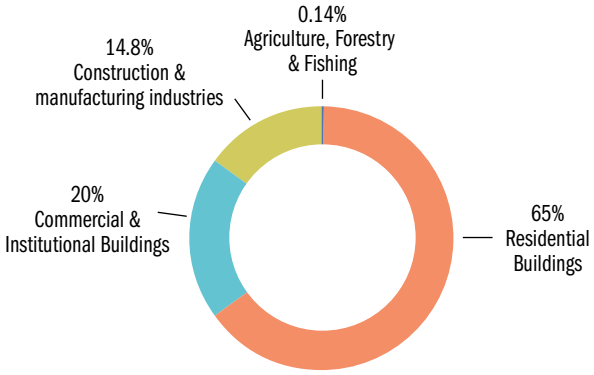


Figure 2.3: Emissions contribution of different sectors under Stationary Energy

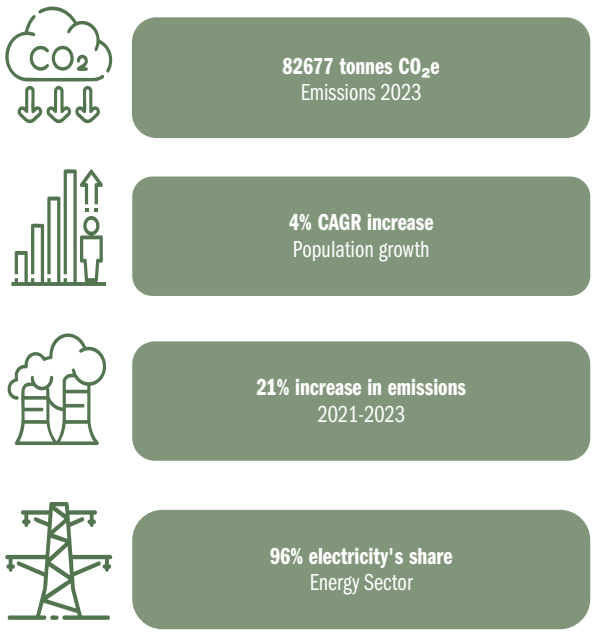


Figure 2.4: Stationary Energy Profile of Mira Bhayandar

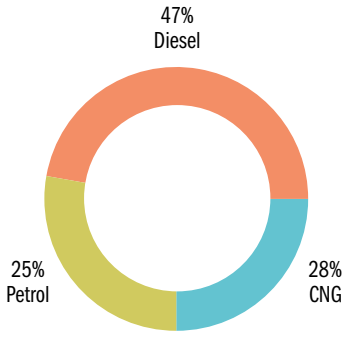


Figure 2.5: Breakup of emissions from fossil fuel in 2023

Figure 2.6: Breakup of Emissions from Waste

The on-road transport includes two-wheelers, autorickshaws, cars/ taxis. Buses, trucks and others that are heavily dependent on diesel contribute 46.67% of the total emissions. The number of electric vehicles is minimal at this stage and there is a need to transition to low-carbon based eco-friendly vehicles.

2.3.2 Transport

Transport falls under Scope 1 of the emissions covering stationary fuel combustion and in-boundary transportation. The emissions have been mainly from fuels such as CNG, petrol and diesel *(Figure 2.5).* The on-road transport includes two-wheelers, autorickshaws, cars/taxis. Buses, trucks and others that are heavily dependent on diesel contribute 46.67% of the total emissions. The number of electric vehicles is minimal at this stage and there is a need to transition to low-carbon based eco-friendly vehicles. The vehicles dependent on CNG fuel are intermediate public transport, namely three-wheelers and taxis, which contribute 26.68% of the total transport sector emissions from the transportation sector.

2.3.3 Waste

The waste sector contributes to 0.22 million tonnes of CO_2e which accounts for 16% of the total emissions in the city. The emissions are calculated from two sectors — solid waste disposal and wastewater. The solid waste disposal contributes to 1.12 million tonnes CO_2e million tonnes of CO_2e (52% of the total emissions from waste) and the wastewater contributes to 1.06 million tonnes of CO_2e (48% of the total emissions from waste) *(Figure 2.6).*

Sources:

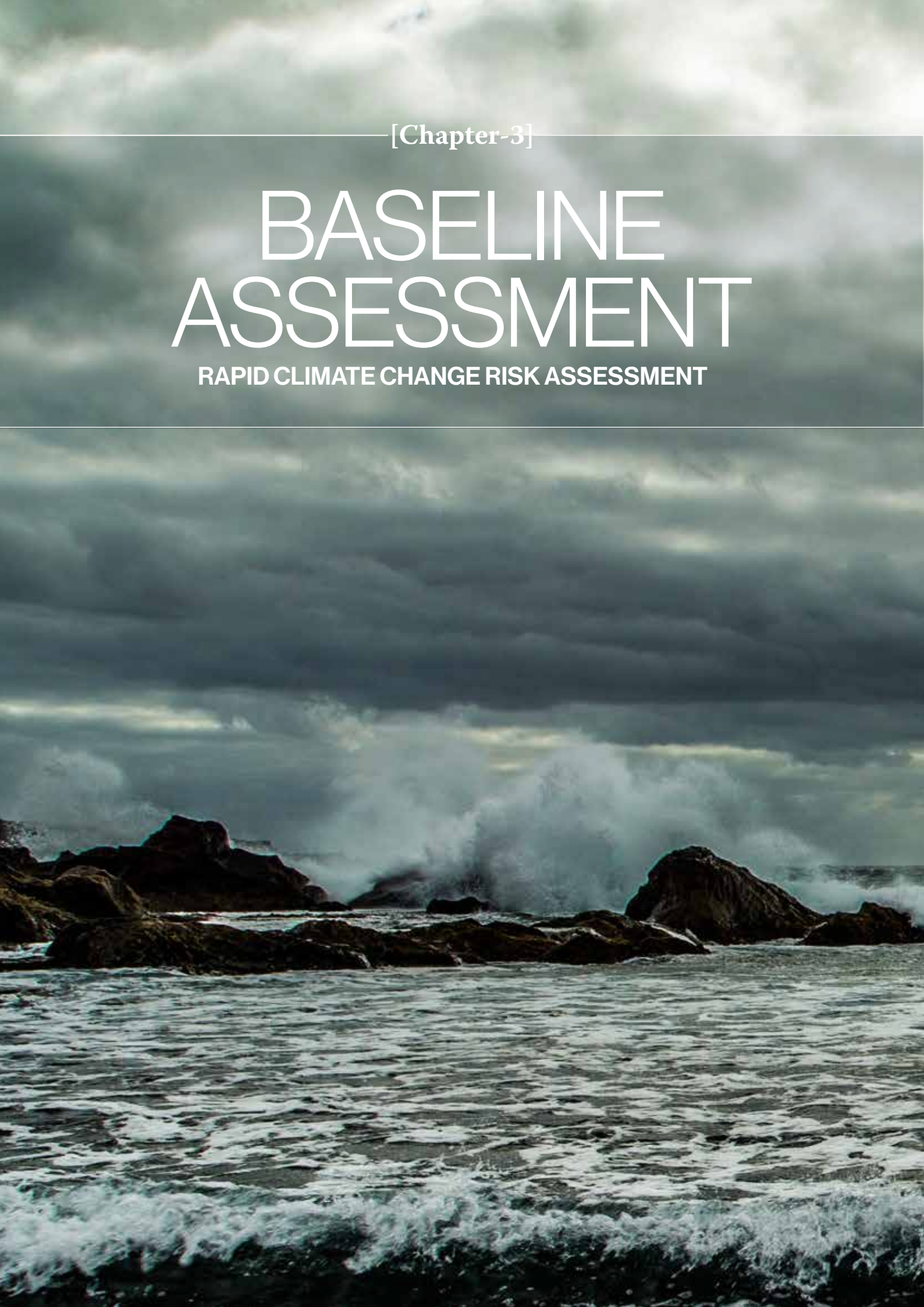
1. *The Intergovernmental Panel on Climate Change (IPCC)*
2. *The Task Force on National Greenhouse Gas Inventories (TFI)*
3. *TFI — IPCC*
4. *www.ipcc.ch*
5. *Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC Protocol)*
6. *United States Environmental Protection Agency*

Photo credit: www.freepic.com

[Chapter-3]

BASELINE ASSESSMENT

RAPID CLIMATE CHANGE RISK ASSESSMENT



Given that almost three-quarters of cities are already experiencing the effects of climate change, a city's climate action strategy must include a deep understanding of the risks. A Rapid Climate Change Risk Assessment creates a concrete baseline to understand the threats and formulate actions that build resilience for the people, the economy, and the environment.

The rapid Climate Change Risk Assessment (CCRA) of Mira Bhayandar meets the minimum requirements for evidence-based decision making, providing a qualitative assessment of risk. It has been conducted in four parts.

01

CLIMATIC HAZARDS

A qualitative overview of relevant climate hazards at the city level, including historical trends and projections.

02

EXPOSURE

A ward by ward assessment of the extent to which people, infrastructure, services, livelihoods, and assets in the city are exposed to climatic risks.

03

VULNERABILITY

Evaluation of scenarios of at-risk areas and at-risk populations at the ward level.

04

RISK ANALYSIS

Assessment of hazards, exposure, and vulnerability of areas and populations at the ward level.

Photo credit: www.freepik.com

Rapid Climate Change Risk Assessment

The findings of the Rapid CCRA of Mira Bhayandar has been expressed in four categories

Urban Heat | Urban Flooding | Coastal Risks | Air Pollution

3.1 CLIMATE HAZARDS

3.1.1 Urban Heat

Mira Bhayandar has been affected by the Urban Heat Island (UHI) effect due to high population concentration, densely packed buildings made of low-albedo materials like concrete and asphalt, loss of natural surfaces and green cover, and greenhouse gas emissions from anthropogenic activities that trap heat in the atmosphere. An analysis of the Land Use Land Cover (LULC) in Mira Bhayandar was conducted to evaluate the spatial distribution and temporal changes in land use patterns associated with diverse socio-economic activities. The city has developed exponentially with a rapid increase in built-up area from 5.52% in 2005 to 11.28% in 2022, indicating a 50.05% increase in 17 years *(Figure 3.1).*

The vegetation within the main built-up area has drastically reduced to 13.6% in 2022, even though the vegetation cover at the city level has increased to 25% owing to the presence of the Sanjay Gandhi National Park (SGNP) and mangroves and creeks, which act as major carbon sinks for the city. The Land Surface Temperature (LST) *(Figure 3.2)* indicates the major heat islands. On the other hand, the areas lying outside, namely the dense forest cover of SGNP in the east and the mangroves and creeks adjoining the Arabian Sea in the west, have a comparatively cooler temperature between 35°C to 30°C.

The label in *(Figure 3.2)* illustrates the growth of a built-up area and the excessive use of building construction or roofing materials, which have a low albedo (low reflectivity capacity) and trap more heat in the area. The albedo data was analysed by computing different bands of the Enhanced Thematic Mapper Plus sensor on the Landsat 7 satellite over the years 2000 to 2023, and it was found to have reduced to 0.1, whereas the annual temperature increased by 0.46 degree Celsius. This indicates that albedo has an inverse correlation with LST concerning roofing materials. Changes in the roofing material to higher albedo materials can play an important role and are one of the game changers in mitigating UHI in heat-stressed zones.

The housing typology in Mira Bhayandar contributes significantly to the UHI effect. Heat-retaining materials such as asbestos or corrugated metal sheets make up 69% of roofs across the city, while concrete makes up 29%, and clay, which offers better thermal regulation, makes up just 2%. In high-density wards, namely 3, 4, 5, 6, 7, 20, and 22, buildings are packed closely together, further trapping heat. Slum settlements within these areas are highly cluttered with minimal space for ventilation. There is limited access to open, green spaces and water bodies which further exacerbates the heat stress. The heat-absorbing asbestos sheets intensify the indoor temperature, adversely affecting the health of household members and necessitating

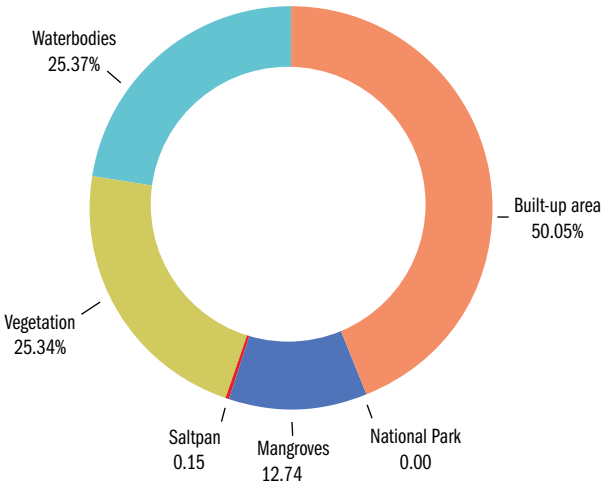


Figure 3.1 : Percentage change in LULC Categorisation between 2000-2022

13.6% (2005-2022)
Vegetation cover reduced

50.05% (2005-2022)
Increase in built - up area

0.46°C (2000 - 2023)
Annual rise in temperature

The barren lands and salt pans, which span across 12.3 square kilometres in the west, and the main built-up area recorded a temperature in the 37°C to 47°C range, which releases a substantial amount of heat that leads to higher temperatures during daytime and nighttime.

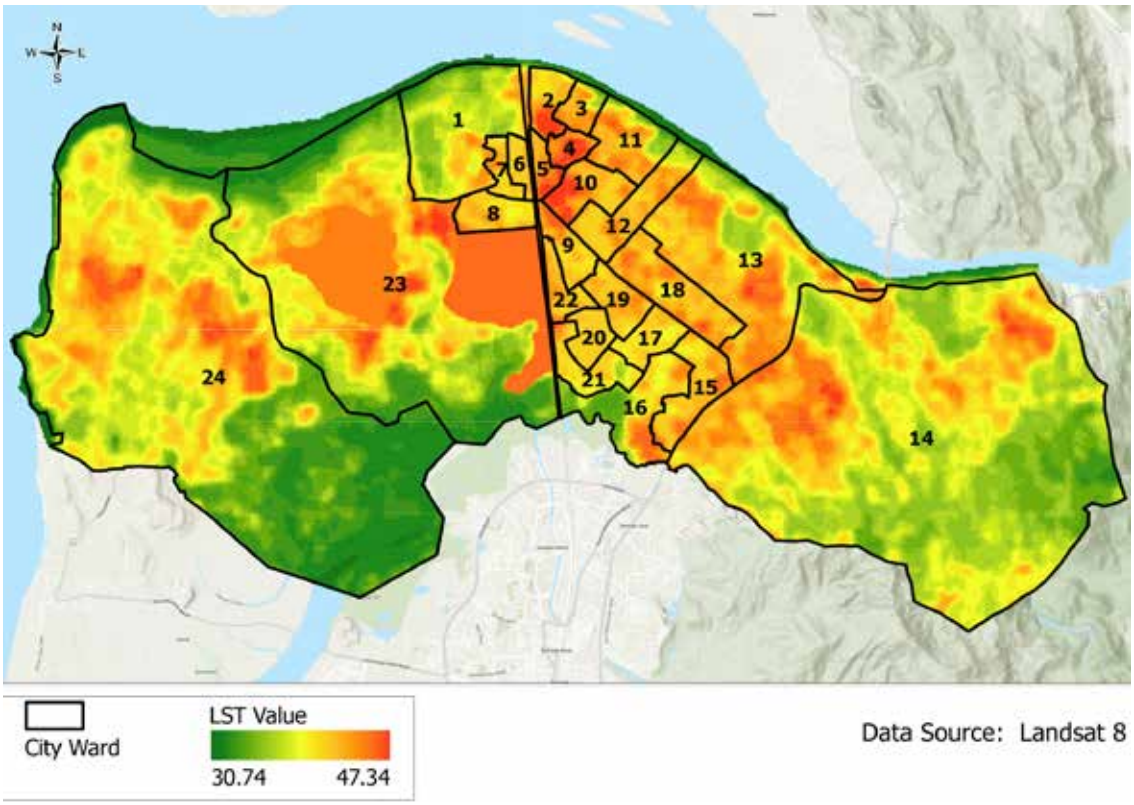


Figure 3.2: Land Surface Temperature for Mira Bhayandar City

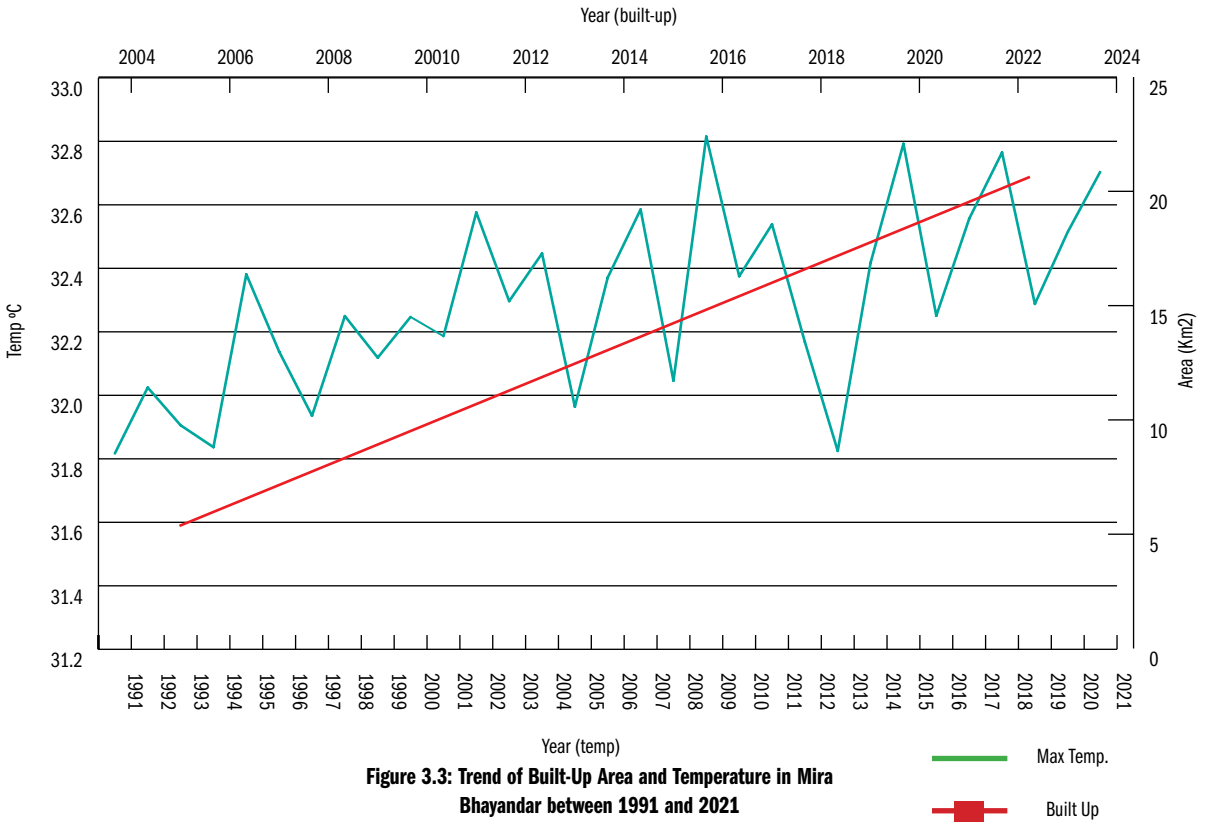


Figure 3.3: Trend of Built-Up Area and Temperature in Mira Bhayandar between 1991 and 2021

Photo credit: Youth Conclave Students | SPA Bhopal

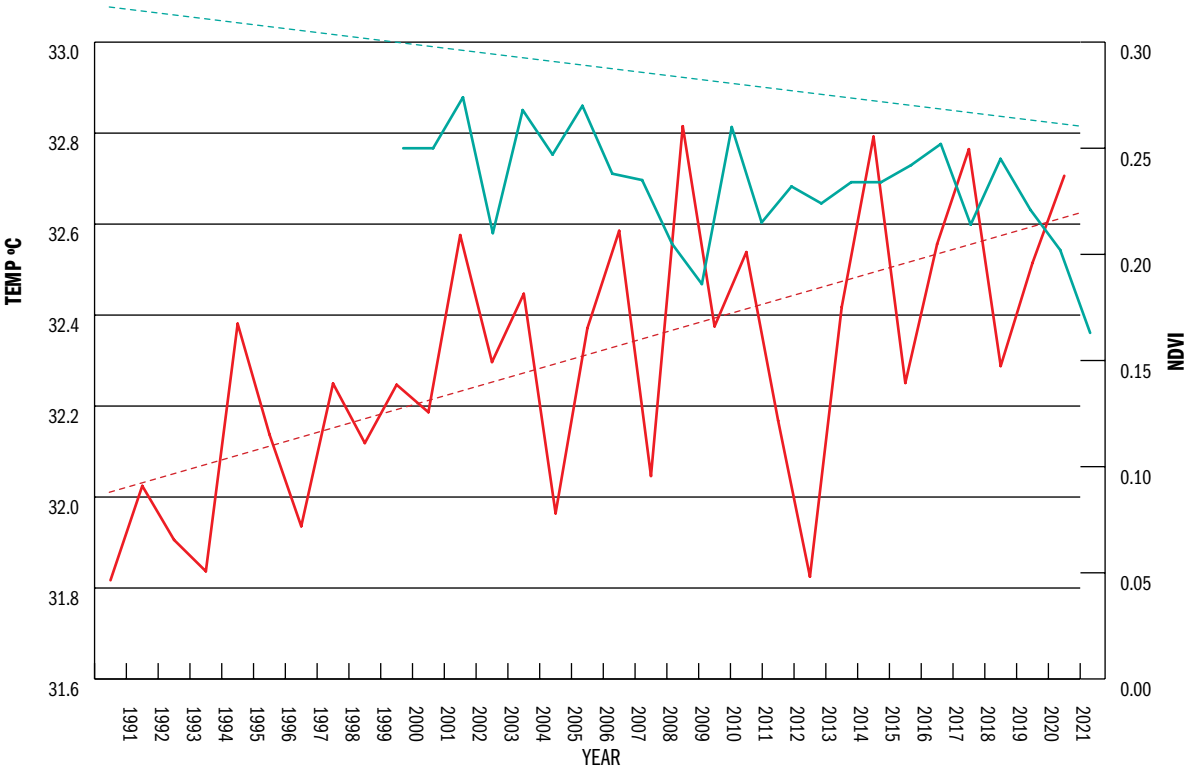


Figure 3.4: Trend of Vegetation and Temperature in Mira Bhayandar between 1991 and 2021

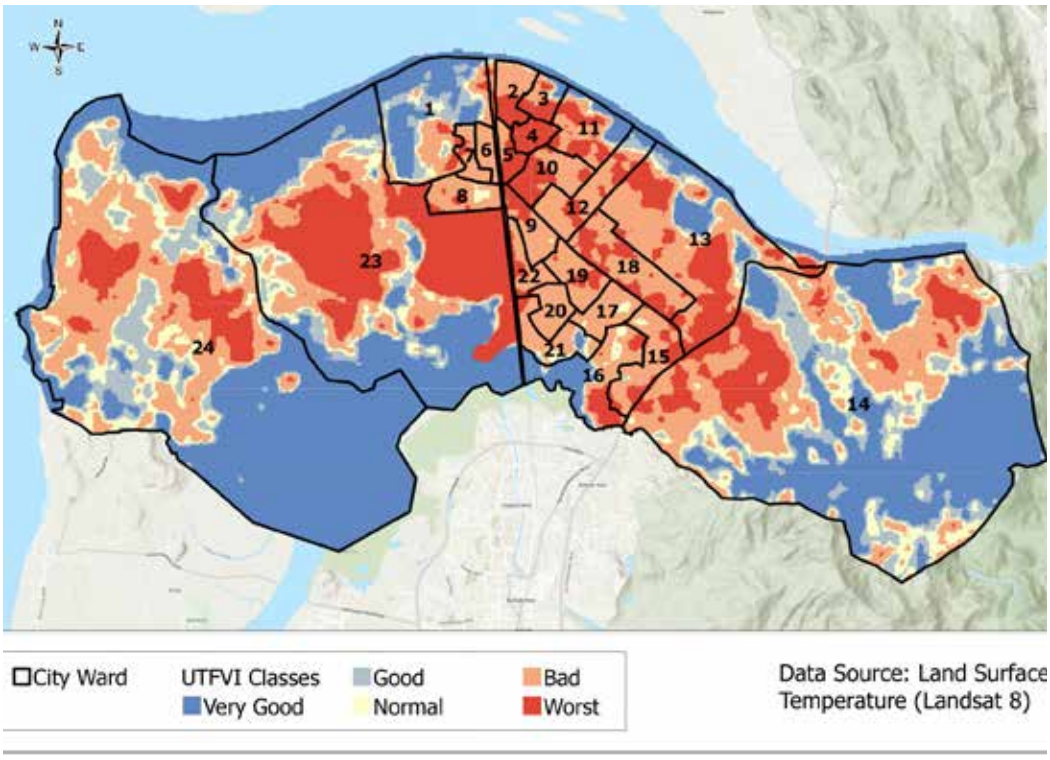


Figure 3.5: Urban Thermal Field Variance Index for Mira Bhayandar

them to incur additional costs for cooling solutions or hospital visits. It also affects their productivity during working hours.

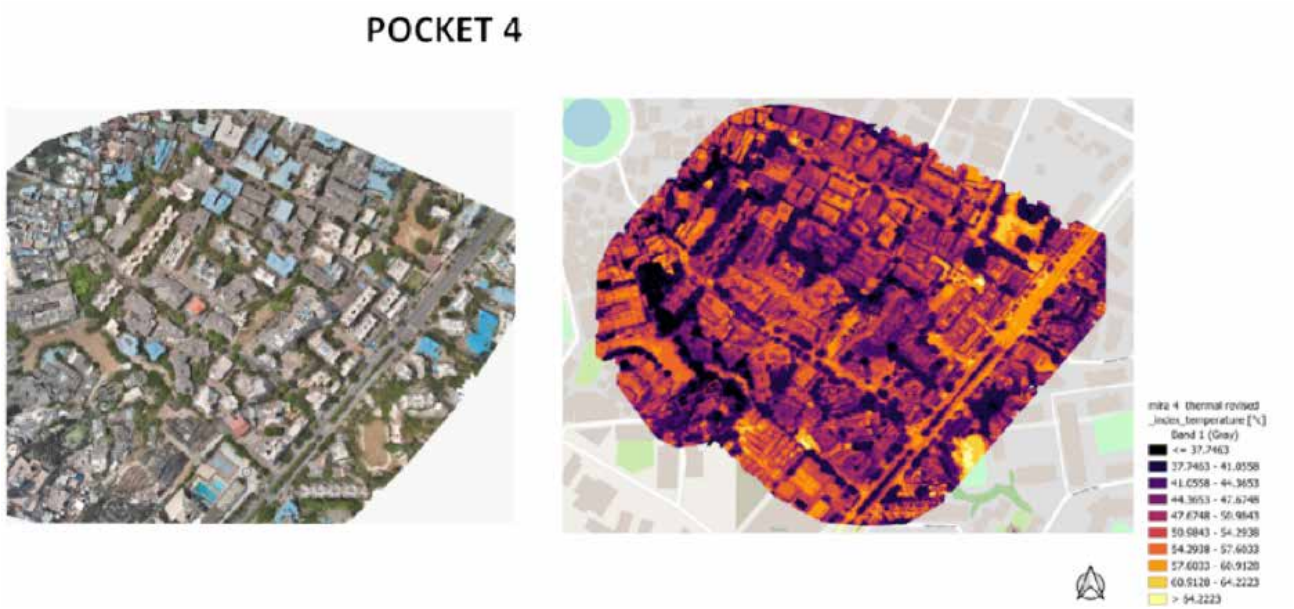
Figure 3.4 illustrate the inverse relationship between LST and Normalised Difference Vegetation Index (NDVI), which indicates the vegetation cover in the built-up area. *Figure 3.5* further clarifies the findings by demonstrating that the areas with the highest temperatures also have the poorest ecological conditions (green cover and water surfaces), leading to higher UHI and vice versa.

MBMC BUILDING – MBMC BUILDING

BP ROAD – LOW RISE HIGH DENSITY

SHIV SHAKTI ROAD – INFORMAL SETTLEMENT

NAVGHAR ROAD – HIGH RISE LOW DENSITY



	NAVGHAR ROAD	SHIV SHAKTI ROAD		BP ROAD	TALAV ROAD
Orientation	NW-SE	NW -SE		NW -SE	SW-NE
Typology of Buildings	Mix Residential + Com-mercial	Mix-Residential + Com-mercial		Mix-Residen-tial + Commer-cial	Mix-Residen-tial + Commer-cial
Green Cover	37%	50%		0%	10%
Type of Vegetation Cover	Moderate to Broad Canopy	Moderate to Broad Canopy		NA	Low to Moderate Canopy
Vehicular	Medium-High	Low – Medium		Medium - High	Low-Medium
Width of Street	12	12	24	12	9
Average building height	15	15	6	15	10
Ratio H/W	1.25	1.25	0.25	1.25	1.11

The analysis of Mean Radiant Temperature (MRT) across various zones in Mira Bhayandar reveals significant thermal stress during midday hours. Informal Settlement (Pocket 3) exhibit the highest MRT values. It also experiences highest Potential Air Temperature (PAT) values, contributing to extreme heat stress. In contrast, high-rise areas such as Navghar Road show better thermal performance.

Among all four pockets, Informal Settlements experiences extreme Physiological Equivalent Temperature (PET) values throughout the day due to high surface heat absorption and limited cooling infrastructure. Midday PET values exceed 50°C, reinforcing the vulnerability of these areas to extreme heat events. MBMC Building (Pocket 1) experiences diurnal variation and BP Road (Low Rise High Density) demonstrates high PET values, particularly during midday hours. In contrast, Navghar Road (High Rise Low Density) shows better thermal performance compared to other zones, likely due to improved ventilation and reduced ground-level heat retention.

3.1.2 Urban Flooding

The city mainly experiences light to moderate rainfall, as observed in the decadal data in which the frequency of rainfall between 1991 and 2021 was analysed. On an average, Mira Bhayandar has experienced 3 very heavy events, 7 heavy events, 26 moderate events, and 40 light events. The years 2005, 2010, and 2019 have received the peak rainfall. However, the city does not face flooding challenges caused due to heavy rainfall, storm surges, dam overflow, or riverine flooding. It gets waterlogged primarily due to an undulated and clogged drainage system, as well as a poor discharging capacity of accumulated water during peak rainfall.

The maps above illustrates the flood risk distribution across Mira Bhayandar, providing a clear indication of areas that are more physically exposed and susceptible to flooding. The analysis reveals that the 'very high risk' category covers 25% (20 square kilometres) of the total area, while the 'high risk' category covers 40% (31.8 square kilometres). Additionally, 22% of the city area falls under 'moderate risk', 21% under 'low risk', and 6.4% under 'very low risk'. This data highlights that a substantial portion of the city's area is in the 'high' to 'very high risk' category' *(Figure 3.6).* These areas are characterised by low-lying topography, which naturally makes them more prone to water accumulation during heavy rainfall. Furthermore, these regions often lack sufficient vegetation cover, which is critical for absorbing rainwater and reducing surface runoff. The dense urban development in the form of buildings and concretisation of roads in these zones significantly limits water infiltration into the ground and causes waterlogging. There are a total of 72 waterlogging points, with wards 4, 10, 13, 20, and 23 at higher risk of urban flooding than the rest.

The city's stormwater drainage network system is aged and covers only 50.24% of the total road network *(Figure 3.7).* Many parts of the system have lower discharge capacity, which hinders efficient handling of the runoff during peak rainfall. Excess water accumulates on the roads and seeps into shops and houses, disrupting daily life and resulting in damages and losses to businesses, properties, and livelihoods. Submerged roads also hinder the transportation of goods and services, and stagnant water poses health risks as it can spread waterborne diseases. The flowing runoff brings debris that clogs the drainage lines. This creates a cyclical issue, which makes the lines increasingly ineffective over time. These conditions contribute to the weakening of the road surface, necessitating frequent repairs and increasing maintenance costs.

The drainage network covers only 50.24% of the total road network, and many parts of the system have lower discharge capacity, which hinders efficient handling of the runoff during peak rainfall. Many parts of the system have lower discharge capacity, which hinders efficient handling of the runoff during peak rainfall

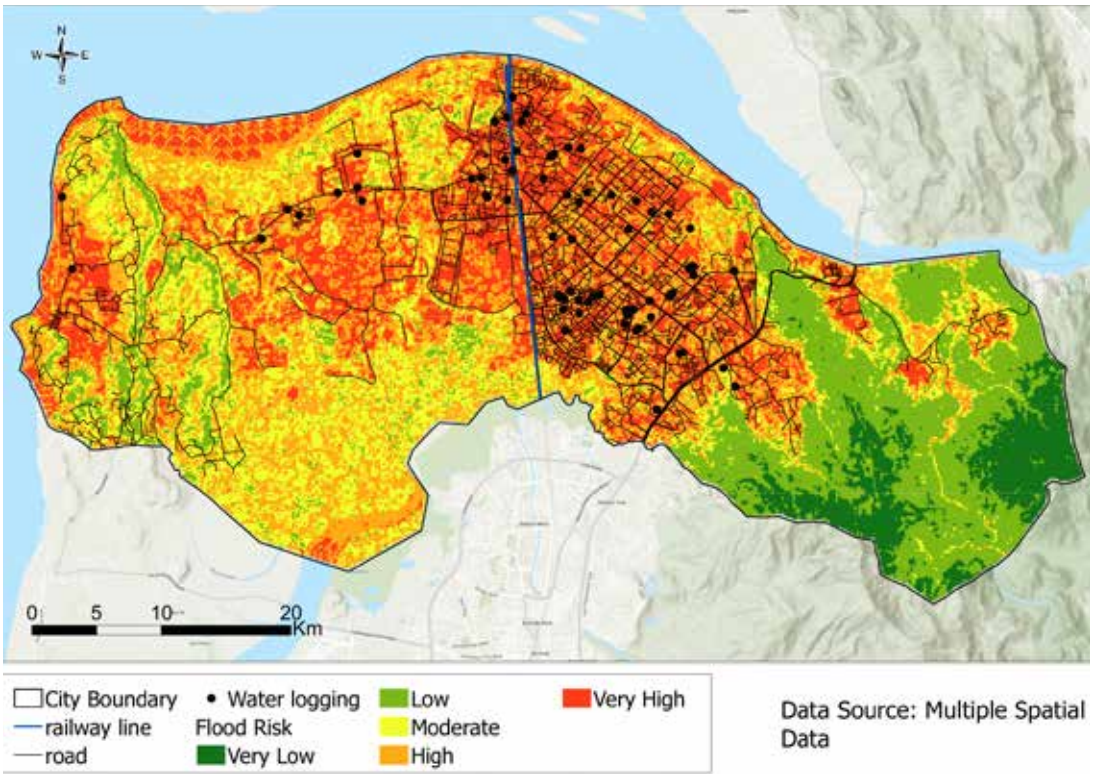


Figure 3.6 :Map of Vulnerable waterlogging points and high-risk areas in Mira Bhayandar

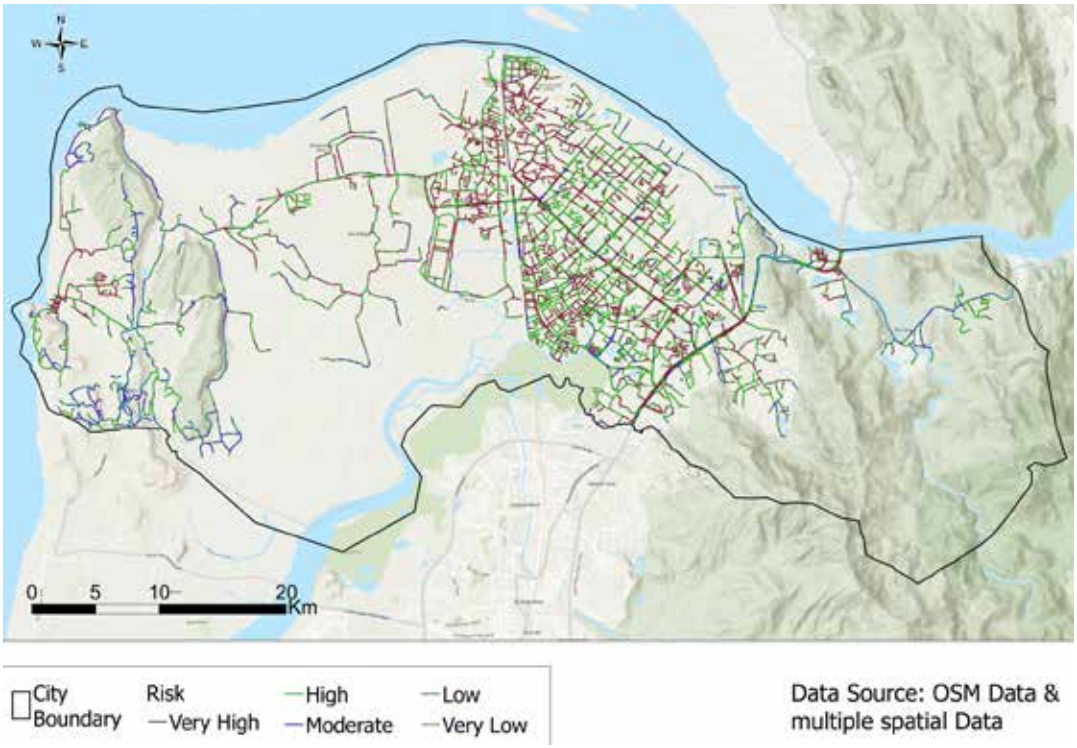


Figure 3.7: Map Showing the Susceptibility of Roads to Waterlogging in Mira Bhayandar

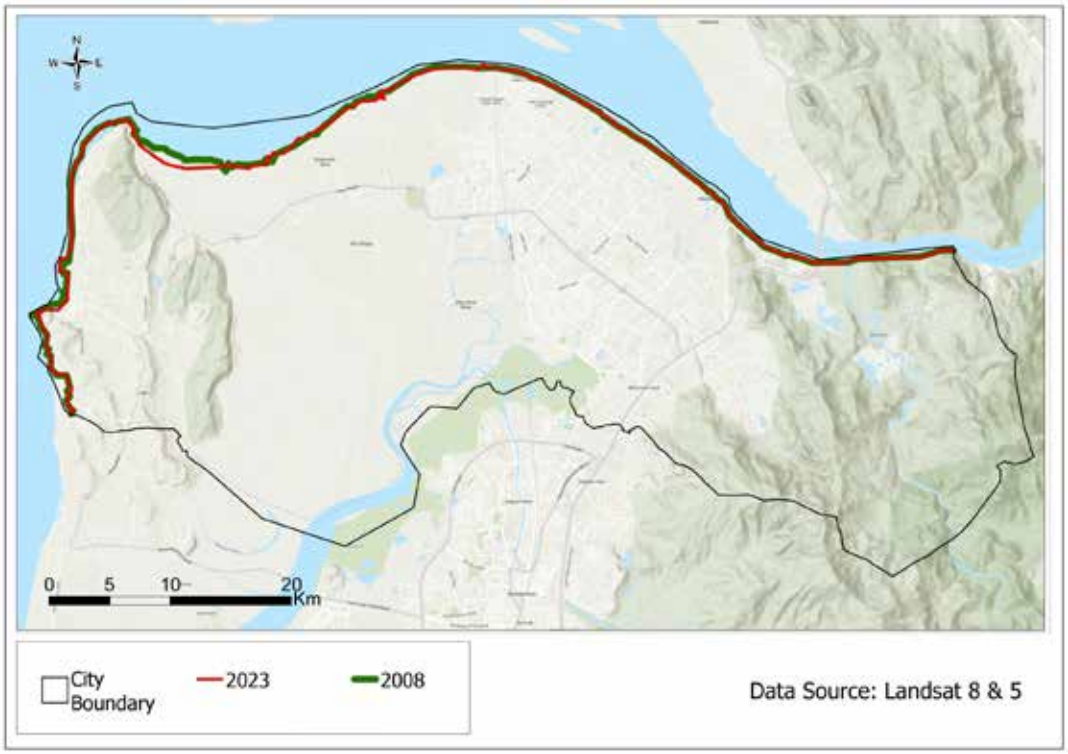


Figure 3.8 : Map of Coastal Change in Mira Bhayandar Observed Between 2008 and 2023

3.1.3 Coastal Risk

The coastline of Mira Bhayandar has eroded by 0.5 km in the past 15 years (2008 to 2023) *(Figure 3.8)*. This is attributed to soil erosion and other natural processes at the mouth of the Vasai Creek to the north.

On the western side, the coastline has experienced both accretion and erosion, influenced by natural and anthropogenic processes. The climate-induced coastal risks not only threaten the livelihoods and food security of the vulnerable communities but also displace them, leading to social instability. Approximately 30,000–40,000 fishermen reside near the western coastline and are dependent on the sea for their livelihood. The decrease in the coastline has profound socio-economic ramifications for the community, who now have to venture far out into the sea to catch fish in the riparian zone. Mira Bhayandar is well protected by mangroves in the upper north and southwest. They act as a natural barricade to storm surges and do not allow seawater to enter the city. Between 2000 and 2022, there has been an increase of 2.82 square kilometres in the mangroves lining the upper north and southwest coast, compared to a decrease of 1.66 square kilometres to the north along the Vasai Creek *(Figure 3.9)*. The upper north and southwest coasts remain completely

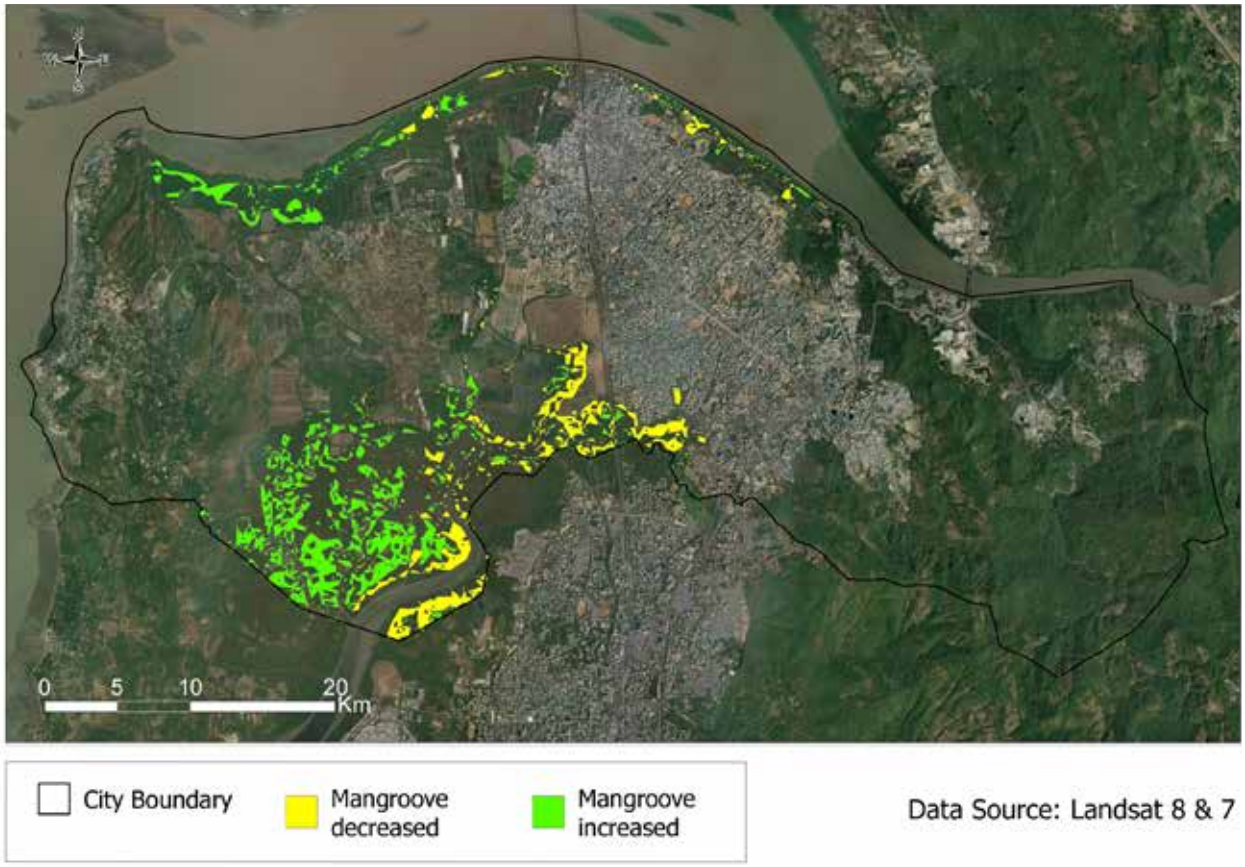


Figure 3.9: Map of Change in Mangrove Density in Mira Bhayandar between 2000 and 2022

unaffected by urbanisation, which has led to an increase in the density of mangroves. Additionally, the city administration has been actively carrying out extensive mangrove plantation activities, encompassing over 15 varieties of species.

3.1.4 Air Pollution Risks

Mira Bhayandar, a non-attainment city, has already implemented a City Clean Air Action Plan. At present, it has one ambient air quality monitoring station installed under the National Air Quality Monitoring Programme. The Maharashtra Pollution Control Board data on the city's air pollution between 2022 and 2024 covers major air pollutants like PM2.5, PM10, SOx, NOx, and ozone. The data reveals that the average PM2.5 and PM10 in the city exceed the threshold levels, amounting to 70.12 µg/m^3 and 140.71 µg/m^3, respectively. The city's PM2.5 and PM10 levels also exceed the World Health Organisation's air quality standards by 14 and 9 times, respectively. Unpaved roads, construction activities, and vehicular exhausts are the major sources of dust pollution. Another major source of air pollution is National Highway 48, which passes through the city's centre and accounts for 37% of daily trips.

Long-term exposure to air pollution can cause health issues such as respiratory and cardiovascular diseases, lung damage, and increased risk of cancer. It severely affects children, women, and the elderly.

There are evident data gaps and a need to monitor air quality over a substantial period of time to gain a clear understanding of the sources and contributing factors to air pollution, based on which the city administration can strategise to mitigate it.

AIR POLLUTANTS	CITY'S AVERAGE ANNUAL EMISSIONS	WHO STANDARDS
Particulate Matter (PM) 2.5	70.12 µg/m^3	5 µg/m^3
Particulate Matter (PM) 10	140.71 µg/m^3	15 µg/m^3
Nitrogen Dioxide (NO2)	25.81 µg/m^3	10 µg/m^3
Carbon Monoxide (CO)	0.62 µg/m^3	4 µg/m^3 (24-hour mean)
Sulphur Dioxide (SO2)	6.8 µg/m^3	40 µg/m^3 (24-hour mean)

3.2 Exposure Analysis

Population Density | **Building Density** | **Informal Settlements**

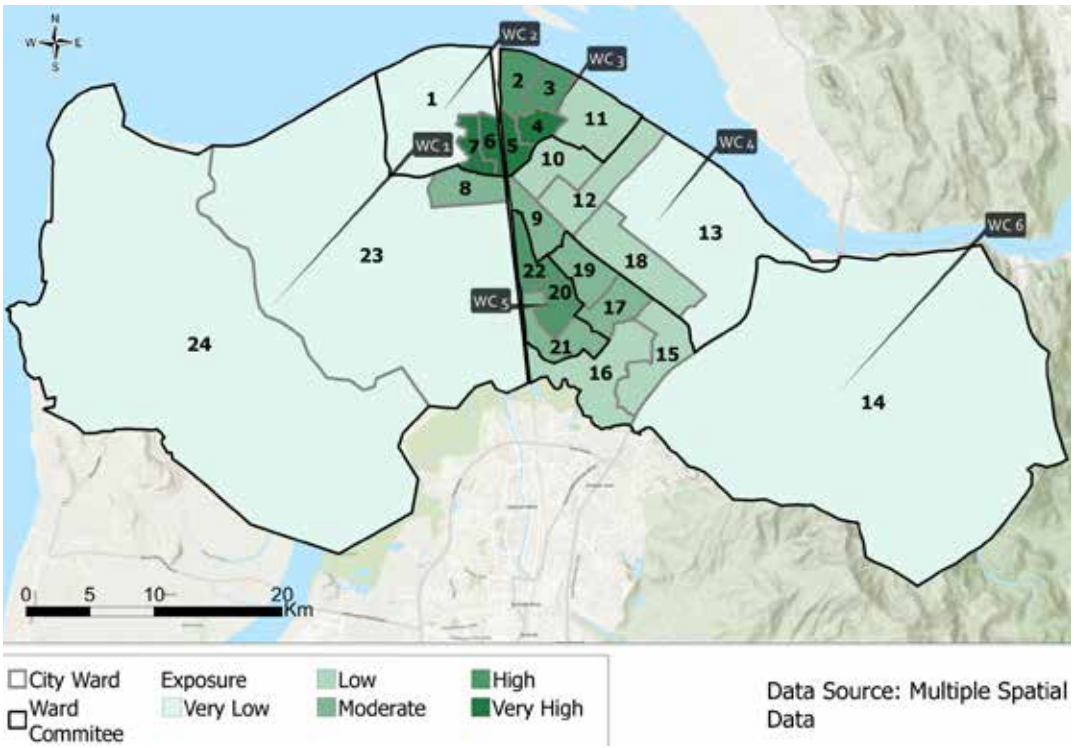


Figure 3.10: Ward-level Exposure Analysis Map of Mira Bhayandar

INDICATORS	RATIONALE	ANALYSIS
Population Density	Population density often reflects socio-economic disparities. The inequities shape resilience and overall well-being because they affect access to resources, infrastructure, and essential health services	The interplay between population density and vulnerability is complex and multi-faceted. High population density often correlates with increased risk due to greater exposure to hazards and underlying socio-economic inequalities **Exposed Wards**: 3, 4, 5, 6, 7, 20, and 22
Building Density	High building density often correlates with inadequate infrastructure and slower response management, making it difficult to meet the needs of residents. This can lead to delays in emergency response, increased pressure on resources, and greater vulnerability to risks and disruptions	There are 430 dangerous buildings across the city. In dense environments, the proximity of structures is often coupled with inadequate infrastructure and limited emergency response capabilities, exposing the population to hazards such as earthquakes, floods, and fires. The situation exacerbates in informal settlements, where evacuation routes are congested and insufficient, and building codes are poorly enforced. This results in structures that are more vulnerable to collapse or damage **Exposed wards:** 2, 3, 4, 5, 6 and 7
Informal Settlements	The poor living condition and high population density in informal settlements is closely linked to limited economic capacity and resources, which lowers the capacity of the slum community to tackle the adverse effects of the hazards	Approximately 7.2% of the population resides in 36 slums in Mira Bhayandar which are mostly located in geographically vulnerable and risky locations such as near water bodies, adjoining forest lands, and low-lying flood-prone areas. Their spatial location within the city exposes them to hazards, and their own adaptive capacity is very limited, which makes them more vulnerable **Exposed Wards:** 1, 2, 11, 13, 15, and 16

3.3 Vulnerability Analysis

Access to Public Transport | Access to Education | Access to Healthcare | Access to Green Spaces | Access to Disaster Shelters

Access to green public spaces is an inverse indicator: the greater the access, the lower the vulnerability, as these spaces provide opportunities for physical activity, mental well-being, and a buffer against environmental stresses

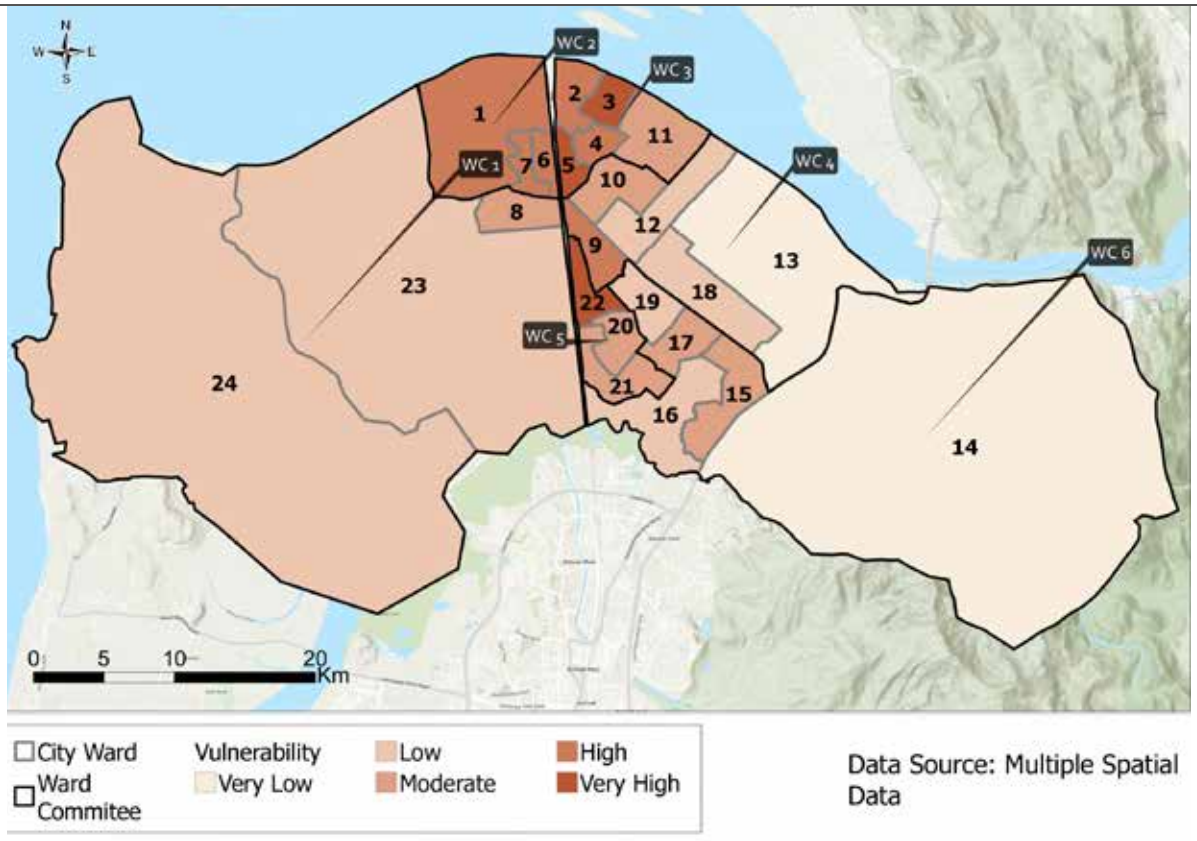


Figure 3.11: Ward-level Vulnerability Analysis Map of Mira Bhayandar

INDICATORS	RATIONALE	ANALYSIS
Access to Public Transport • **Metro line:** 33.1 kilometres (Proposed) • **Bus Stations:** 93 • **Routes:** 29 • **Train Stations:** 2 • **Road Network:** 112 kilometres	Access to public transport improves mobility and enables quicker responses to emergencies, ultimately decreasing vulnerability in times of crisis	Around 60% of the population in Mira Bhayandar lives within 500 metres walking distance of bus routes. The majority of the population is dependent on public transport, such as buses and railways, bound for Mumbai for jobs **Vulnerable Wards:** 6, 24, 4, 21, and 13
Access to Education	Access to education directly relates to the ability of people to receive information and make informed decisions. It strengthens their capacity to respond to climate risks effectively	Around 70% of the population in Mira Bhayandar have access to educational institutes within walking distance of 750 metres The physical access to educational institutes has a positive relation to the vulnerability. It indicates that the youth and the citizens are in a better position to perceive the hazards, build their adaptive capacities, and deal with the climatic threats **Vulnerable Wards:** 22 and 10
Access to Healthcare • **Hospitals:** 177 • **Beds:** 3,366 • **Bed-to-population ratio**: 4.15 • **Coverage:** 50.5% of total area	Access to healthcare is an inverse indicator: the greater the access, the lower the vulnerability It enables people to receive timely treatment and preventive care, which reduces the impact of health risks	More than 60% of the population in Mira Bhayandar lives within a 1.25 kilometres walking distance. The city has a bed-to-population ratio of 4.15, which is significantly higher than the WHO stipulation of 2.9. This shows access to healthcare services is high, which lowers the population's vulnerability to hazardous events **Vulnerable Ward:** 23
Access to Green Public Spaces	Access to green public spaces is an inverse indicator: the greater the access, the lower the vulnerability, as these spaces provide opportunities for physical activity, mental well-being, and a buffer against environmental stresses	There are 79 gardens and public parks. With a buffer of 400 meters, almost 28% of the population have physical access to these green public spaces. The areas where the slum population resides have very few open or green public spaces, which makes them more vulnerable to hazards Not only do these spaces hold significance from a recreational perspective, but they also serve as secure temporary shelters during disasters, serving as gathering places for communities after evacuation and serving as hubs for response and recovery initiatives. Additionally, the green cover absorbs extra surface runoff during heavy rainfall **Vulnerable Wards:** 4, 12, 5, 2, 11, and 9
Access to Disasters Shelters	Access to disaster shelters is an inverse indicator: the greater the access, the lower the vulnerability. It ensures safer refuge during emergencies and protects communities from the impacts of disasters	The proximity to disaster shelters in case of climatic hazards helps reduce vulnerability and draw vulnerable populations to safe locations. Currently there are 66 disaster shelters within the city limits. In the event of disasters, the administration converts schools into disaster shelters and rents out hotels and private flats as per the need of the situation **Vulnerable Wards:** 6, 22, 5, 20, 3, and 9

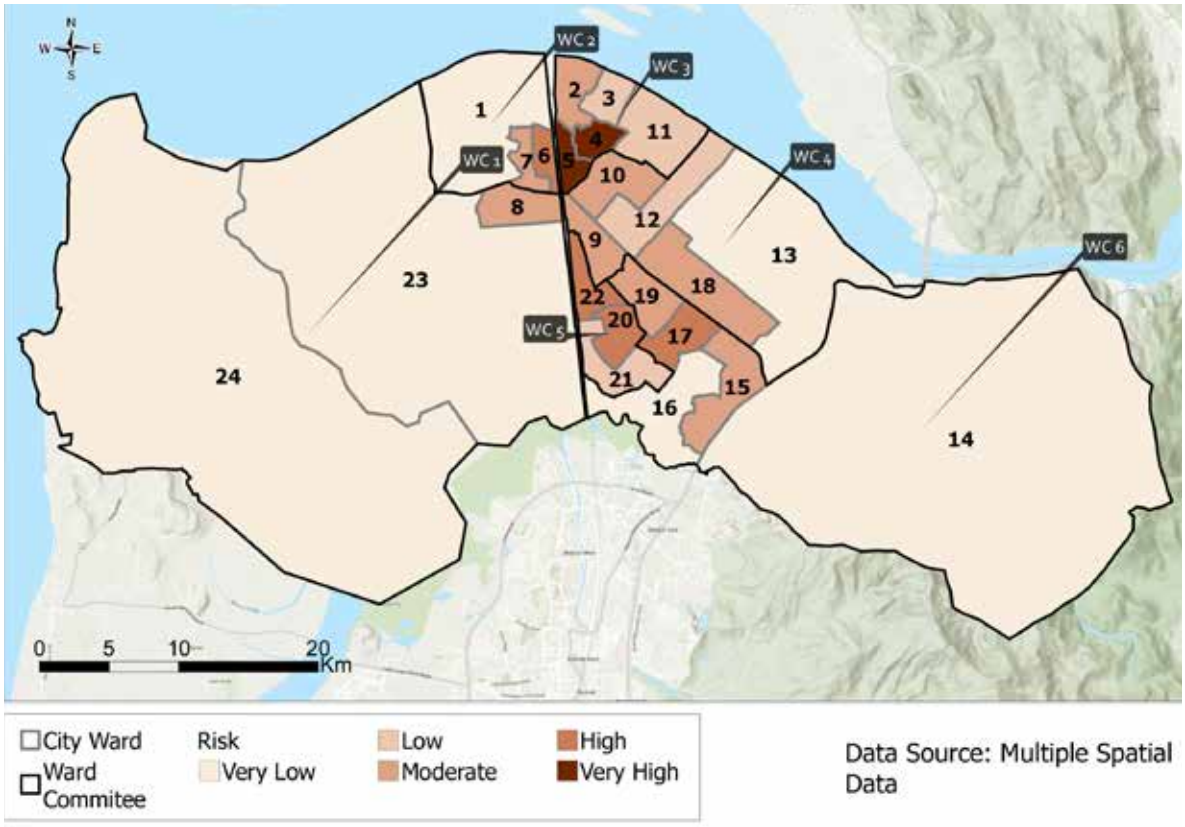


Figure 3.12: Ward-level Risk Analysis Map of Mira Bhayandar

3.4 Summary of Risk Analysis for Mira Bhayandar

According to the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, risk is defined as "the potential for adverse effects or harm to occur as a result of the interaction between hazards, exposure, and vulnerability. It is a measure of the likelihood and impact of an event causing damage to people, property, or the environment."

The risk framework for any city, as per the Global Disaster Preparedness Centre, can be calculated as follows:

$$\text{Risk} = \frac{\text{Hazard x Exposure x Vulnerability}}{\text{Capacity}}$$

Mira Bhayandar, due to its unique geography, is physically susceptible to coastal risks. The hot and humid climate contributes to the UHI effect, urban flooding, and air pollution. These hazards are exacerbated by the proliferation of anthropogenic activities, including unplanned development, high building density, poor drainage systems, and inadequate green spaces, which further increase temperatures and urban flooding risks during the monsoons.

The exposure analysis for Mira Bhayandar was calculated at the ward level using three indicators: building density, population density, and informal settlements. The greater the presence of people, livelihoods, services, infrastructure, and socio-cultural-economic assets, the more vulnerable they are to damage, losses, or harm.

Wards 3, 4, 5, 6, 7, 20, and 22 are densely populated *(Figure 3.10),* and wards 2, 3, 4, 5, 6, and 7 have higher building densities *(Figure 3.10)*. It makes the residing population more susceptible to climatic risks. Wards 1, 2, 11, 13, 15, and 16 have the highest slum populations, which makes them more exposed to hazards and more susceptible to harm due to their limited capacity to cope or respond to the hazard. The vulnerability assessment highlights gaps in access to essential services such as schools, hospitals, gardens, and public transport across the 24 wards.

Hazards are perceived differently by different segments of the population depending on their physical location, housing structure, access to basic services and public infrastructure, and socio-economic factors such as gender, age, class, caste, and livelihoods. These factors determine the predisposition of individuals or communities to face adverse effects or their internal ability to cope and adapt to any hazard. Individuals or communities with limited access to these services or infrastructure are less resilient to climate hazards. Thus, by combining the potential hazards, exposure, and vulnerability, the risk analysis as shown in *(Figure 3.12)* reveals that wards 4 and 5 are at "very high risk," followed by wards 6, 17, 20, and 22, which fall under the "high risk" category, wards 2, 7, 8, 9, 10, 15, 18, and 19 are in the "moderate risk" category, while other wards fall into the "low" and "very low" risk categories.

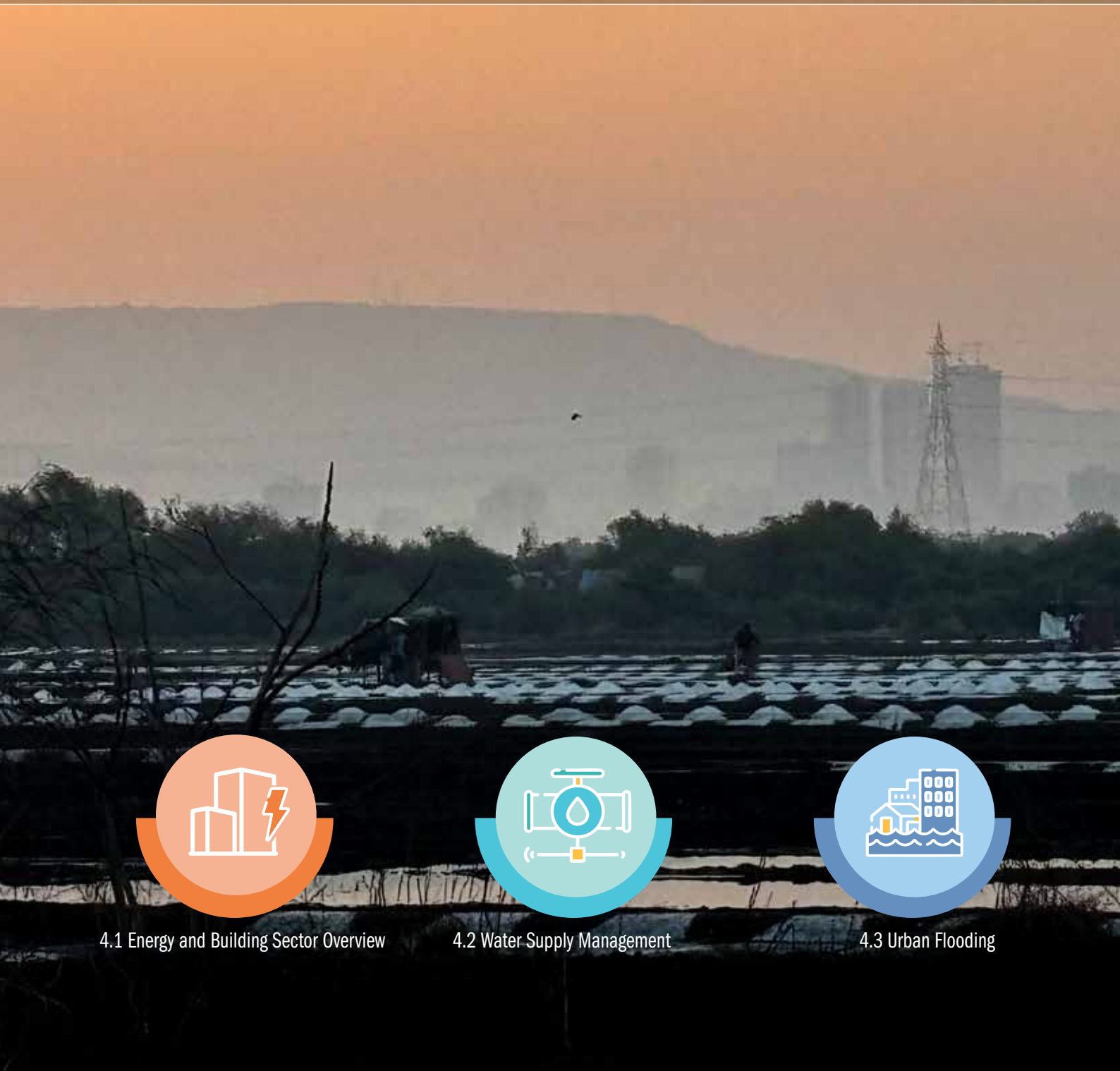
Sources:

1. *City Air Action Plan for Control of Air Pollution in Mira-Bhaindar: One of the Non-Attainment Cities of Maharashtra*
2. *IPCC Sixth Report*
3. *Disaster Risk Equation*
4. *Thane Heat Action Plan*
5. *C40 Knowledge Hub*

Photo Credit: AKAH

[Chapter-4]

SECTORAL ANALYSIS AND RECOMMENDATIONS

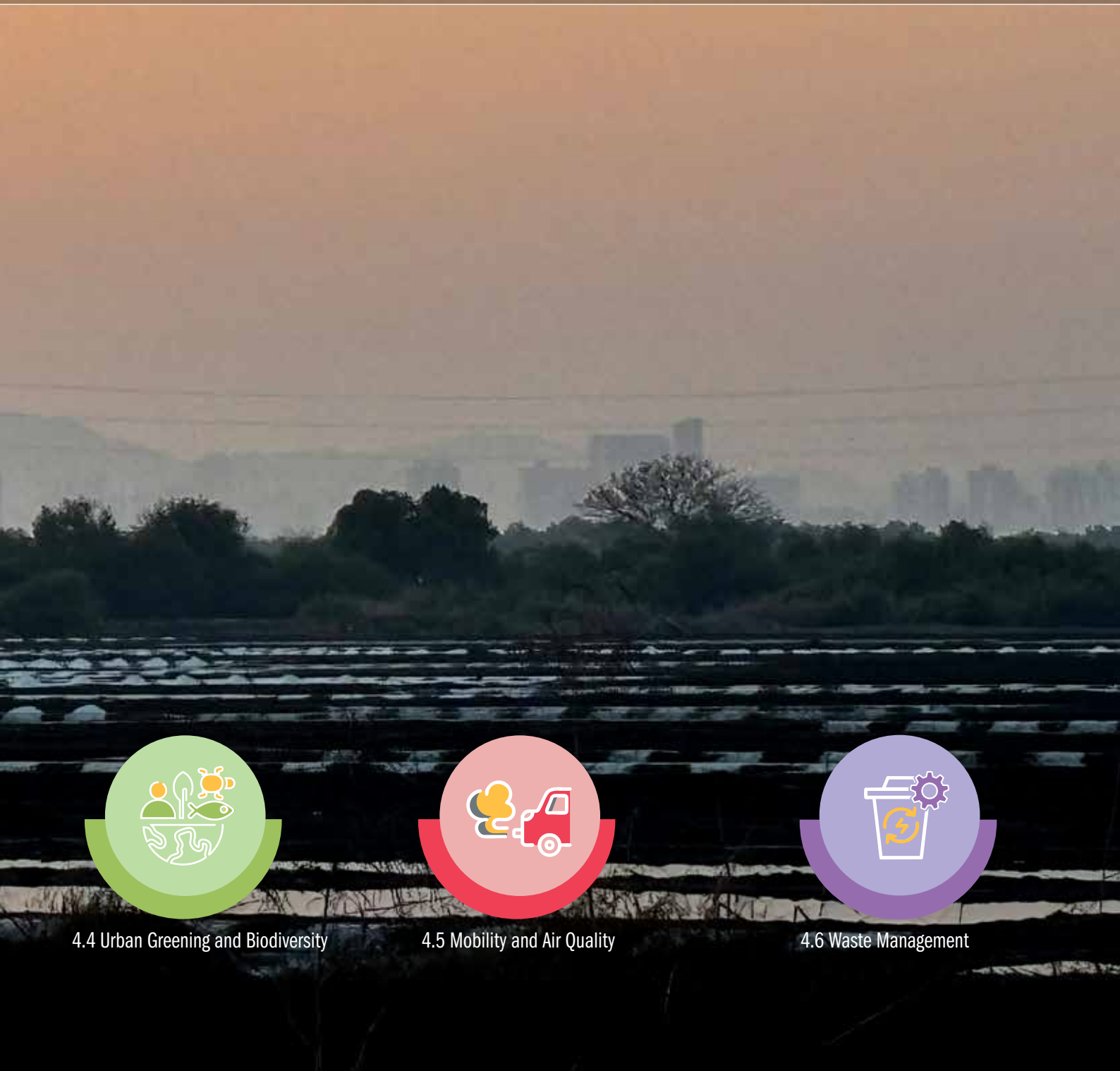


4.1 Energy and Building Sector Overview

4.2 Water Supply Management

4.3 Urban Flooding

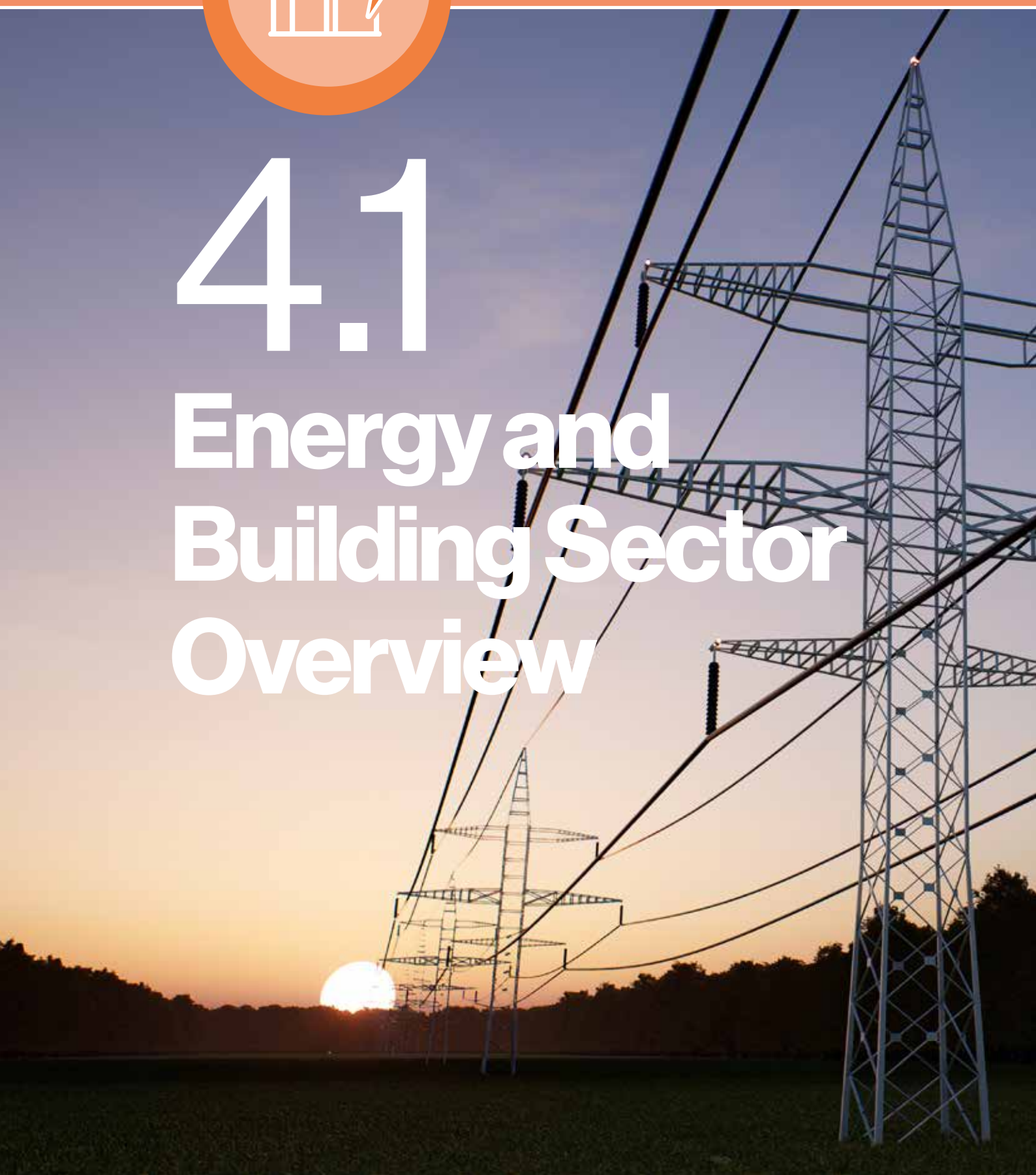
The Paris Agreement mandates that all countries submit Nationally Determined Contributions (NDC) by 2025, which are climate action plans that seek to reduce emissions and adapt to climate change. The legally binding international agreement mandates that the NDCs encompass all sectors and emissions. The Intergovernmental Panel on Climate Change reports mention that sectoral solutions can achieve a reduction in annual global emissions by 22 gigatonnes, or 22 billion tonnes of CO_2 equivalent, to limit the global temperature rise to the requisite 1.5 degrees centigrade. Cities worldwide base their climate action plans on this framework, and conduct comprehensive sectoral analysis.



4.4 Urban Greening and Biodiversity

4.5 Mobility and Air Quality

4.6 Waste Management



4.1 Energy and Building Sector Overview

Mira Bhayandar can significantly reduce greenhouse gas emissions and improve energy efficiency by adopting rooftop solar systems to meet 43% of the city's energy demand through renewables. Green retrofitting in residential and commercial buildings such as installing energy-efficient fans, motion-sensor lighting, and rooftop solar, and can further lower electricity consumption and carbon footprints.

Photo credit: www.freepik.com

4.1.1 Electricity Consumption Profile

The residential sector dominates the usage with 62% of the total electricity consumption *(Figure 4.1.1)*. Currently, there are 3,40,000 residential metered connections, and the consumer base is increasing by 4% on a yearly basis (2% increase in per capita consumption annually). The average annual consumption per household is 1,967 kWh, and the monthly average consumption per household is 164 kWh, which indicates that a major share of the households is dependent on electrical appliances. The total contribution of the residential sector to the emissions is 0.51 million CO_2e, accounting for 41% of the total emissions, and the demand is expected to grow further.

The commercial sector consumes 20% of the total electricity and has shown the highest growth rate among all sectors, with electricity consumption increasing sharply from 127.85 GWh in 2021 to 217.85 GWh in 2023. The economy has transitioned from industrial to commercial and service-based, which places a significant burden on energy resources.

The city has 6,896 small-scale industries / manufacturing units, which accounts for 15% of the total electricity consumption, a steady rise from 113.05 GWh in 2021 to 162.30 GWh in 2023.

Among the public services, government buildings and the municipality consumes 2% of the total electricity, and street lighting consumes 1% of the total electricity. In agriculture, electricity consumption is minimal, with the usage increasing slightly from 2.1 GWh in 2021 to 2.6 GWh in 2023.

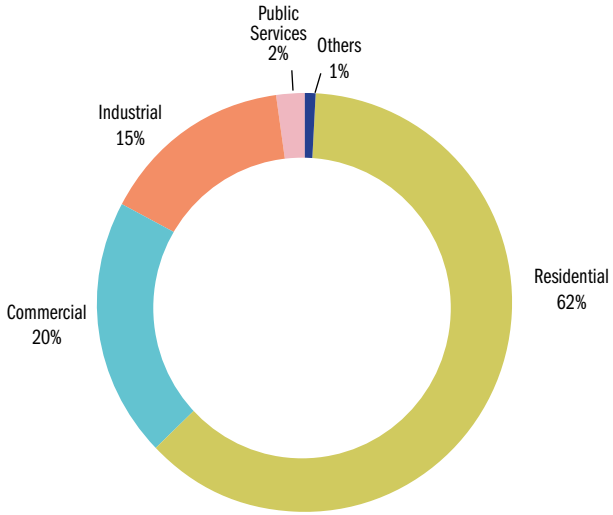


Figure 4.1.1 : Sectoral emissions from electricity in 2023

4.1.2 Renewable Energy

The adoption of rooftop solar (RTS) systems *(Figure 4.1.2)* in Mira Bhayandar is significantly low. Figure 16 reveals that only 2% of the city's electricity consumption is being supplied by solar panels, with the monthly average of solar energy generation being only between 76 kWh and 168 kWh. However, there is immense potential for renewable energy generation given its geographical and climatic conditions. Approximately 43% of the city's electricity demand can be met through renewable energy sources. This could bring down the energy sector's contribution to the total emissions by half — from the current 62% to 32.86%.

Residents can avail the benefits of the PM Surya Ghar Muft Bijli Yojana, a national government scheme under which households will receive a subsidy of up to 40% of the cost to install solar panels on their rooftops. Additionally, the Mira Bhayandar Municipal Corporation (MBMC) offers a 5% property tax rebate to housing societies using RTS systems, solar water heaters, and other renewable energy measures.

1075 GWh

of electricity consumed approximately, in 2023

3,40,000

residential metered connections currently

51,000

commercial metered connections currently

62%

of the total electricity in the city consumed by the residential sector

The MBMC has a total installed solar capacity of 115 kW across its institutional buildings. It has already installed 600 solar street lights in remote wards, with another 30 to 40 installations underway. It is also planning to solarise all schools to promote renewable energy adoption at the institutional level. The solar photovoltaic (SPV) panels in Mira Bhayandar have the potential to generate approximately 1,600 kWh/kWp annually *(Figure 4.1.3)*. The heatmap *(Figure 4.1.4)* shows the Direct Normal Irradiance (DNI)[1] patterns for Mira Bhayandar throughout the year. The summer months from March to May observe the highest DNI values, shown in red, indicating peak solar intensity. Monsoon months like July and August observe lower DNI values, shown in green and blue, due to reduced solar radiation. This highlights the opportunity for the city to leverage its potential to meet its growing energy demands and reduce its carbon footprint.

[1]Direct Normal Irradiance (DNI) indicates the amount of sunlight energy that reaches a surface that is always facing the sun directly. It is measured in watts per square meter (W/m^2) and is highest on clear, sunny days.

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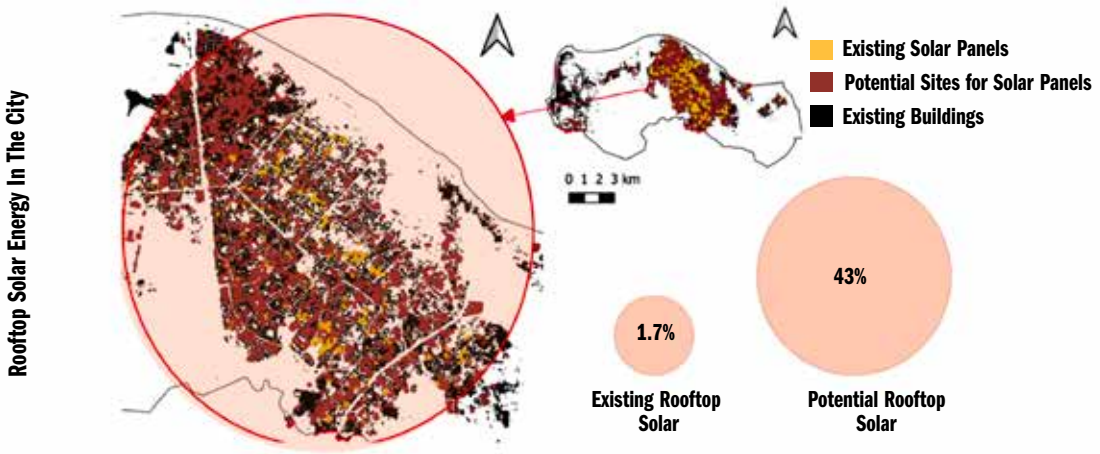


Figure 4.1.2: Existing rooftop solar (RTS) systems and the potential for scaling

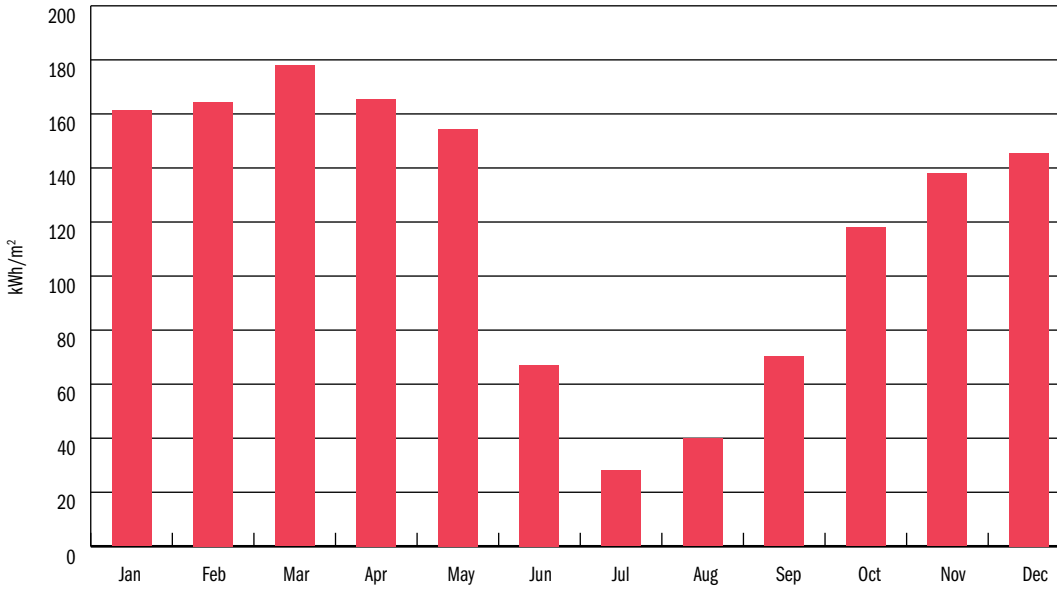


Figure 4.1.3: Monthly average output of photovoltaic power

Direct normal irradiation [Wh/m²]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0 - 1												
1 - 2												
2 - 3												
3 - 4												
4 - 5												
5 - 6					1							
6 - 7		3	20	65	97	36	7	5	19	28	10	1
7 - 8	172	215	245	277	240	99	30	44	110	194	218	178
8 - 9	406	454	438	424	357	166	63	81	180	321	402	394
9 - 10	537	588	565	546	481	217	96	121	230	412	517	514
10 - 11	623	674	655	630	569	266	118	161	278	478	590	592
11 - 12	672	729	701	665	607	288	134	189	313	513	624	632
12 - 13	687	751	715	670	613	295	133	190	335	523	617	632
13 - 14	661	727	698	649	593	291	122	179	313	490	571	599
14 - 15	599	663	638	591	534	243	92	144	256	406	497	529
15 - 16	498	567	539	493	437	185	67	104	189	301	381	418
16 - 17	320	423	396	361	318	122	38	63	119	149	178	209
17 - 18	37	87	136	154	147	55	17	25	23	4	1	2
18 - 19				1	3	1	1					
19 - 20												
20 - 21												
21 - 22												
22 - 23												
23 - 24												
Sum	5,211	5,881	5,743	5,525	4,997	2,264	918	1,305	2,367	3,819	4,606	4,699

Figure 4.1.4: Average hourly profiles of DNI

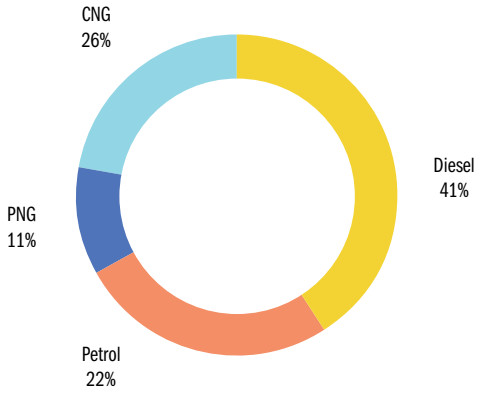


Figure 4.1.5: Emission scenario of PNG, petrol, diesel and CNG in Mira Bhayandar

Projections based on the base year, 2023 (Figure 6), show that by 2050, GHG emissions from diesel are anticipated to grow by nearly 3 times and petrol by approximately 2.3 times. CNG emissions are projected to increase over tenfold. This substantial increase underscores the urgent need for investment in zero tailpipe emission vehicles.

4.1.3 Fossil Fuel Consumption

In 2022-2023, in the distribution of GHG emissions *(Figure 4.1.5)* in Mira Bhayandar from different fossil fuels, diesel was established as the largest contributor, accounting for 41%. Petrol contributed 22%, compressed natural gas (CNG) contributed 26%, while piped natural gas (PNG) was responsible for 11%.

Projections based on the base year, 2023 *(Figure 4.1.6)*, show that by 2050, GHG emissions from diesel are anticipated to grow by nearly 3 times and petrol by approximately 2.3 times. CNG emissions are projected to increase over tenfold. This substantial increase underscores the urgent need for investment in zero tailpipe emission vehicles. The MBMC has procured 42 buses that run on electricity under the National Clean Air Programme (NCAP), which shows its commitment to its green goals.

4.1.4 Energy Efficient Street Lighting

Mira Bhayandar has made significant strides in modernising its street lighting system. In 2022-2023, the city installed a mix of energy-efficient streetlights, including 7036 LED (90W) units and 301 LED (135W) units. However, traditional lighting systems such as High-Pressure Sodium Vapor (HPSV) lamps (4,320 units) and other older technologies like Metal Halide (MH) and High-Pressure Mercury Vapor (HPMV) continue to be mainly used. The MBMC has taken a commendable step by introducing solar streetlights in 27 settlements. Out of the planned 630 solar streetlights, around 600 units have already been installed. The city is planning to have 100% LED streetlights in the near future.

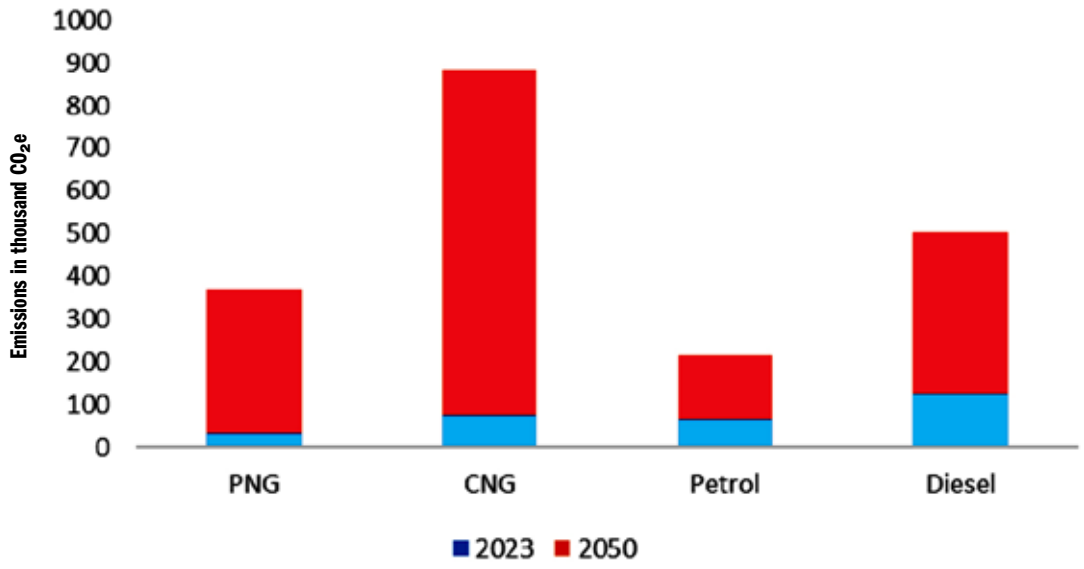


Figure 4.1.6: Projections of emissions by different fossil fuels in 2050

Photo by: Samruddhi Mittal

4.1.5 Key Priority Actions

4.1.5.1 Green Retrofitting

Achieve energy and water efficiency in existing non-residential buildings by mandating retrofitting.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Upgrading HVAC systems	Energy savings	Public works department	The National Building Code
Installing energy-efficient lights such as LEDs and BLDC fans	GHG reduction	Electrical works department	Energy Conservation Building Code (ECBC)
Installing motion sensors for electricals in common toilets and common areas		Revenue department	
Installing motion sensors for electricals in common toilets and common areas		Energy rating agencies	
Incorporating water-saving technologies like low-flow fixtures and water-efficient irrigation systems			

TARGET SDGS

CSCAF THEME
PROMOTION OF GREEN BUILDINGS.

ACTION TIMELINE
MID- TERM
(2040)

CASE STUDY: 4.1.5.1.1
GREEN BUILDING IN MIRA BHAYANDAR

The meditation centre in the Ramdev Park area is the only existing green building built by the MBMC. The Green Building certificate has been sanctioned to it by the Indian Green Building Council for incorporating energy-efficient appliances, renewable sources of energy such as solar, water conservation measures like rainwater harvesting, waste reduction measures, and other aspects of material sustainability.

At the society level, 174 motion-sensor lights have been installed in common areas (staircases, lift lobbies, and parking lots), and a 44-kWh RTS system has been installed. It is projected that the electricity bills will reduce by 65% with the installation of BLDC fans yielding major savings to household members.

CASE STUDY: 4.1.5.1.2
ASIA'S FIRST GREEN BUILDING CERTIFIED BY THE INTERNATIONAL FINANCE CORPORATION (IFC)

The Aga Khan Agency for Habitat (AKAH) has undertaken and implemented green retrofitting measures across 280 households and 10 buildings in the Nav Yuwan Housing Society in Mira Bhayandar. At the household level, 1,000 energy-efficient BLDC fans have been installed. At the society level, 174 motion-sensor lights have been installed in common areas (staircases, lift lobbies, and parking lots), and a 44-kWh RTS system has been installed. It is projected that the electricity bills will reduce by 65% with the installation of BLDC fans yielding major savings to household members. Furthermore, the RTS system is projected to generate 8% to 10% energy savings and cover 100% electricity needs of the common area.This is the first existing housing society to receive Excellence in Design for Greater Efficiencies (EDGE)-certification by the International Finance Corporation (IFC) in Asia.

4.1.5.2 Cooling Solutions in Informal Settlements

The slum population in Mira Bhayandar constitutes 7.2% of the total population, with 33,269 households residing in slums (Census of India, 2011). These areas are highly vulnerable to urban heat risks due to poor infrastructure, inadequate ventilation, and limited resources for thermal comfort. To address these challenges, implementing cooling solutions such as cool roofs can be highly effective. Made with reflective materials or coatings, cool roofs help reduce indoor temperatures, improve occupants' comfort, and lower energy consumption. The integration of advanced materials like aluminum foil or wood wool panels for thermal insulation can further enhance heat resistance in households. Natural ventilation solutions such as ventilators can strategically optimise airflow.

These methods, proven effective in Urban Heat Risk Reduction (UHRR) strategies, can significantly improve living conditions by making houses in slums more resilient to extreme heat while ensuring energy efficiency. A combination of these solutions can create a comprehensive framework for improving thermal comfort and enhancing the overall quality of life for vulnerable population.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES
Collaborate with Corporate Social Responsibility (CSR) programmes, NGOs, and relevant organisations to implement cool roofs and other sustainability measures in informal settlements	Reduced urban heat island (UHI) effect	Public works department
Facilitate skill development by training locals in cool-roof installations and maintenance	Lowered energy consumption	Electrical works department
Actively involve community members in decision-making and project implementation to ensure acceptance and long-term success	Increased livelihood opportunities	Revenue department
Conduct workshops and awareness drives to educate residents about the benefits of cool roofs in reducing heat stress and energy costs	Reduced cooling costs	Energy rating agencies
	Improved living conditions and comfort levels for vulnerable populations	

TARGET SDGS

CSCAF THEME
PROMOTION OF GREEN BUILDINGS

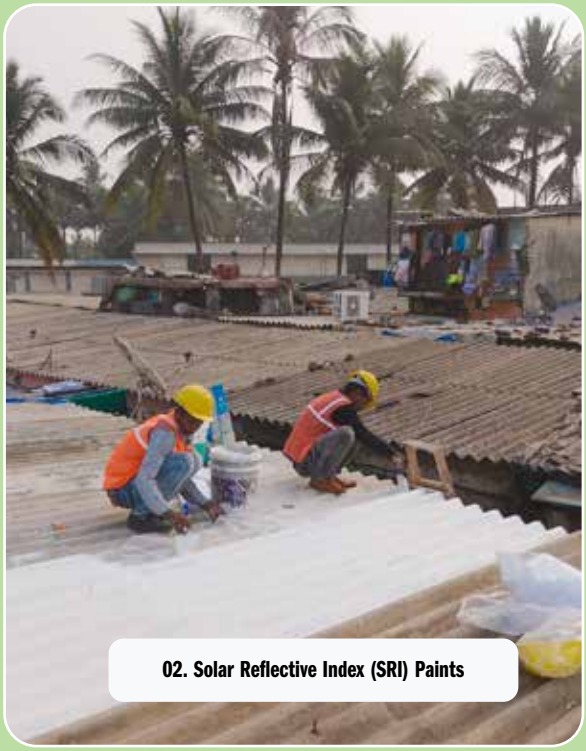
ACTION TIMELINE
MID-TERM
(2040)

CASE STUDY: 4.1.5.2
ONGOING COOLING SOLUTIONS IN INFORMAL SETTLEMENTS IN MIRA BHAYANDAR

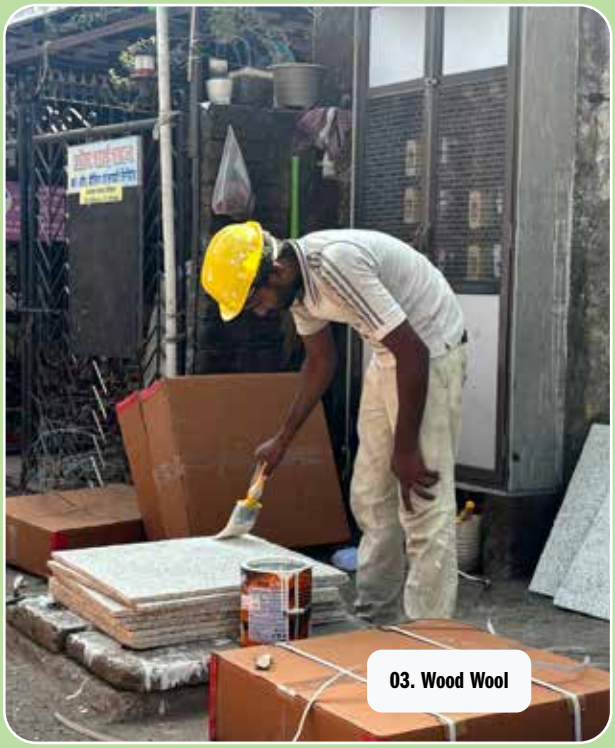
Aga Khan Agency for Habitat (AKAH) initiated a project to implement and provide cooling solutions in specific informal settlements in Mira Bhayandar. Three slum pockets were identified as hotspots after conducting a micro-urban heat island effect analysis with the help of drone mapping. The different cooling solutions were tailored to the specific needs of the community by considering factors such as cost, maintenance requirements, longevity, structural analysis, and the age of the existing structures (patra). 105 units were chosen for the installation of cooling solutions. In 46 units, SRI paint was applied to reduce internal temperatures by 3°C to 4°C and decrease the rooftop surface temperature by approximately 20°C. Aluminium foil was wrapped around asbestos roofs in 55 units, which achieved an internal temperature drop of approximately 3°C to 4°C. Wood wool was installed in 4 units in order to create a false ceiling for heat insulation. AKAH will monitor the effectiveness of the cooling solutions in all units during peak summer season (April-May). The findings will be used to advocate for policy change, ensuring that beyond selected community facilities, more people can benefit from the improvements. The broader vision is to incorporate these effective solutions into other housing projects. This approach enables the transfer of small-scale projects from one city or community to another, eventually contributing to larger goals on a broader scale.

In 46 units, SRI paint was applied to reduce internal temperatures by 3°C to 4°C and decrease the rooftop surface temperature by approximately 20°C. Aluminium foil was wrapped around asbestos roofs in 55 units, which achieved an internal temperature drop of approximately 3°C to 4°C. Wood wool was installed in 4 units in order to create a false ceiling for heat insulation.

01. Ventilation Core



02. Solar Reflective Index (SRI) Paints



03. Wood Wool

04. Alufoil

Photo Credit: AKAH

4.1.5.3 Solar Energy Initiatives

The administration should encourage adoption of Rooftop Solar Systems (RTS) city-wide. Moreover, expand renewable energy capacity by installing innovative and self-sustaining solar tree structures in public parks, alongside roads or in open spaces.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Adoption of RTS systems and solar trees accross the city	Reduced emissions	Public works department	The National Clean Air Programme (NCAP)
These trees generate clean energy without taking up much land, making them ideal for cities with limited space	Space efficiency	Electrical works department	
The innovative and self-sustaining solar tree structures can be placed in public parks, alongside roads, or in open spaces	Awareness and education	Revenue department	
	Economic savings	Garden department	

TARGET SDGS

CSCAF THEME
RENEWABLE ENERGY.

ACTION TIMELINE
SHORT TO MID TERM
(2030-2040)

Adoption of the Public-Private Partnership (PPP) model to create Rooftop Solar (RTS) system infrastructure will reduce the upfront cost of the corporation. Under this model, the corporation will provide support in the form of incentives (land access subsidies, tax breaks) to encourage private companies to install, operate, and maintain rooftop solar systems. At present, there is no subsidy being given by the MBMC for RTS systems.

4.1.6 Recommendations in the Energy and Building Sector

GREEN RETROFITTING OF SCHOOLS IN MIRA BHAYANDAR

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Replace conventional ceiling fans with Brushless Direct Current (BLDC) fans to reduce electricity consumption by up to 50% • Install motion sensor lighting in classrooms, hallways, and washrooms to minimise energy wastage when spaces are unoccupied • Replace conventional toilets with dual-flush systems to reduce water consumption. • Install rooftop solar panels to harness renewable energy to reduce dependency on grid electricity and lower operational costs • Create green roofs and vertical gardens to improve thermal insulation and reduce the urban heat island effect • Apply SRI paint to roofs and walls to reflect solar radiation and reduce indoor heat buildup • Use insulation materials with low U-value (thermal transmittances) for walls and roofs to minimise heat transfer and improve thermal comfort	• Electrical works department • Public works department • Town planning department • Education department	• National Building Code • Energy Conservation Building Code

Co-benefits: Energy-efficiency, savings in electricity bills, reduced carbon footprint.

DEVELOPMENT AND IMPLEMENTATION OF PPP MODEL

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Adoption of the Public-Private Partnership (PPP) model to create Rooftop Solar (RTS) system infrastructure will reduce the upfront cost of the corporation. Under this model, the corporation will provide support in the form of incentives (land access subsidies, tax breaks) to encourage private companies to install, operate, and maintain rooftop solar systems. At present, there is no subsidy being given by the MBMC for RTS systems **Recommended steps:** • Initiate with the public buildings like schools, hospitals, and government offices, and later expand to private residential and commercial buildings based on success metrics • Use pilot projects to evaluate performance and gather insights for larger-scale implementations • Educate residents and building owners about financial benefits and environmental impact to encourage participation	• Electrical works department • Revenue department	NA

Co-benefits: Reduced emissions, energy efficiency, job creation, and investment attraction.

ENERGY AUDIT IN INDUSTRIAL / COMMERCIAL BUILDINGS

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Mandate industrial and commercial energy audits to identify inefficiencies in electricity, water, and fossil fuel usage. Use audit results to define priority areas for upgrades • Integrate Property Assessed Clean Energy (PACE), a programme that finances energy efficiency upgrades for homes and businesses, into Mira Bhayandar's property tax framework. It will enable property owners to repay over 10–20 years via property taxes • Provide incentives like interest rate subsidies for early adopters • Offer higher benefits for industries implementing solar or water conservation projects • Train stakeholders (industries, businesses, municipal staff) on PACE processes, benefits, and procedures	• Revenue department • Public works department • Electrical works department • Energy rating agencies	• Tata Power's Smart Energy Management programme • Maharashtra Energy Development Agency's (MEDA) Save Energy Programme

Co-benefits: Energy savings, GHG reduction.

DEVELOPMENT OF CITY-LEVEL SOLAR POLICY

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
The city currently meets only 1.7% of its energy demands from RTS systems. However, the potential for renewable energy is 43%. The city needs a city-level solar policy that will mandate the uptake of rooftop solar provisions for buildings and introduce subsidy and incentive programmes in collaboration with MSEDCL **Recommended steps:** • Educate households about the benefits of RTS systems, such as the Maharashtra policy that offers a 40% subsidy for RTS installations up to 3KW and a 20% subsidy for installations from 3KW to 10KW • Promote the concept of solar cooperatives • Promote the use of solar infrastructure by providing subsidies for hybrid inverters under the PM Surya Ghar Muft Bijli Yojana • Explore the possibility of implementation of Pay-As-You-Go (PAYG) schemes to increase accessibility for residents	• Public works department • Electrical works department • Tata Power • Adani Power • MSEDCL	• PM Surya Ghar Muft Bijli Yojana • State Renewable Energy Policy 2020 • NCAP Phase-II Grid Connected Rooftop Solar Programme

Mitigation Action: Reduction by 6% – 123835 MtCO2e in 2050 as compared to 1340045 MtCO2e in 2023. (Ambitious Scenario)

Co-benefits: Cost savings, reduced emissions, green job generation, increased climate resilience, improved energy literacy.

Informal settlements are often highly vulnerable to urban heat risks due to poor infrastructure and inadequate ventilation. To address these challenges, implementing cooling solutions such as cool roofs, aluminum foil for thermal insulation, wood wool panels, and ventilators for natural ventilation — proven strategies in Urban Heat Risk Reduction — can significantly reduce indoor temperatures, improve comfort, and enhance energy efficiency.

INSTALLATION OF SMART METERS

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
The traditional meters can be replaced by the smart meters, which enable both utilities and consumers to track electricity consumption, identify high-usage periods, and adjust their consumption accordingly **Recommended steps:** • Collaborate with distribution companies (DISCOMS) to subsidise initial installation costs • Pilot smart meter installation in high-energy consumption areas or sectors to showcase their advantages • Conduct awareness campaigns to educate consumers on the benefits of smart meters	• Electrical works department • DISCOMS	Smart Meter National Programme (SMNP)

Co-benefits: Real-time monitoring, energy efficiency, accurate billing, demand forecasting, and consumer awareness.

EMBODIED CARBON REDUCTION MEASURES

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Embodied Carbon Reduction Measures Sustainable procurement of construction materials can reduce embodied carbon from the extraction, production, and transportation of materials. Approximately 50% of emissions come from cement and concrete. Construction projects can significantly reduce their carbon footprint by using alternatives like low-carbon cement, recycled steel, and reclaimed wood **Recommended steps:** • Enforce the use of sustainable materials in the construction of all new corporate projects through policies and procurement guidelines • Constructors and suppliers can receive financial or non-financial incentives for prioritising sustainable materials in their projects • Introduce a carbon pricing mechanism that imposes additional costs on the use of carbon-intensive construction materials in order to discourage their adoption • Mandate for large construction firms to conduct and report the Life Cycle Assessments that quantify the upfront carbon emissions (embodied carbon) of materials used in their projects	• Public works department • Town planning department • Revenue department	NA

Co-benefits: Carbon reduction, waste reduction, economic savings, and creation of local jobs.

Photo Credit: AKAH

DISTRICT COOLING IN COMMERCIAL BUILDINGS

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
It's ideal for cities to incorporate district cooling systems (DCS) during the planning phase to accommodate densely populated urban areas and prevent expensive retrofitting and design inconsistencies later on. The DCS infrastructure of Singapore is a model example **Recommended steps:** • Update building regulations to prioritise DCS, ensuring that construction aligns with sustainable cooling solutions. This guarantees the seamless integration of buildings with future DCS infrastructure. For example, the UAE mandates provisions for DCS in high-rise developments through adjusted by-laws • Mandate establishment of DCS in high-density areas to maximise efficiency and cost-effectiveness	• Urban planning department • Public works department • Electric works department	India Cooling Action Plan (up to 30% capital subsidies for installation, tax exemptions, and reduced GST rates)

Co-benefits: Reduced emissions, energy savings.

COOL ROOFING SOLUTIONS IN INFORMAL SETTLEMENTS

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Informal settlements are often highly vulnerable to urban heat risks due to poor infrastructure and inadequate ventilation. To address these challenges, implementing cooling solutions such as cool roofs, aluminum foil for thermal insulation, wood wool panels, and ventilators for natural ventilation – proven strategies in Urban Heat Risk Reduction (UHRR) – can significantly reduce indoor temperatures, improve comfort, and enhance energy efficiency **Recommended steps:** • Facilitate skill development by training locals in cool-roof installations and maintenance • Actively involve community members in decision-making and project implementation to ensure acceptance and long-term success • Before the implementation, conduct workshops and awareness drives to educate residents about the benefits of cool roofs in reducing heat stress and energy costs	• Corporate Social Responsibility (CSRs) programmes • NGOs	NA

Co-benefits: Reduced urban heat island effect; lower energy consumption, and creation of local jobs, reduced cooling costs, improved living conditions and comfort levels for vulnerable populations.

INSTALLATION OF ENERGY CONSUMPTION DASHBOARD

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Smart dashboards improve visibility for energy consumption and costs **Recommended steps:** • Install interactive energy consumption dashboards in public buildings such as schools, hospitals, and government offices • Equip residents with tools such as mobile apps and web portals that provide real-time insights into household energy usage • Highlight individual and community-level energy usage patterns on energy bills	NA	NA

Co-benefits: Reduced energy bills, reduced energy consumption, reduced emissions, increased awareness.

PHASE WISE RETROFITTING OF BUILDINGS

ACTION TIMELINE
SHORT TO MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
An energy efficiency retrofit is the removal of a building's existing equipment, whether that is HVAC, lighting, or any other, to install updated, energy-efficient equipment **Recommended steps:** • Creation of a detailed technical plan focusing on retrofitting interventions by building size: small (< 500 square feet), medium (500-2,000 square feet) and large (>2000 square feet), and operational characteristics • Public buildings, starting with municipal buildings, will be used as demonstration projects	• Public works department • Electric works department • Education department	NA

Co-benefits: Energy savings, reduced carbon footprint, improved air quality, resilient urban environment, reduced energy consumption.

PROMOTION OF BLDC FANS

ACTION TIMELINE
SHORT TO MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
The city is heavily dependent on fans for cooling mechanisms. The adoption of BLDC (Brushless DC) fans that consume about 28-35W at top speed, compared to 75W for conventional fans (as per a report by the Council on Energy, Environment, and Water – CEEW), can be promoted **Recommended steps:** • Partner with the central government's Energy Efficiency Services Limited (EESL) to provide subsidies or rebates for BLDC fans • Explore bulk procurement to lower retail prices, as demonstrated by the LED lamp programme under the UJALA scheme • Install BLDC fans in municipal buildings, schools, and public spaces to showcase their benefits and set an example for adoption • Offer financing options like on-bill financing to make these fans more accessible to low-income households	• Public works department • Electric works department	NA

Mitigation Action: 6% reduction in 2050 – 135394 MtCO2e as compared to 1340045 $MtCO_2e$ in 2023. (Ambitious Scenario)

Co-benefits: Increased energy efficiency of buildings, savings in electricity bills, reduced carbon footprint of buildings.

PROMOTION OF GREEN BUILDINGS

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
There is only one green building in Mira Bhayandar, indicating the need to scale sustainable building practices within the urban residential sector **Recommended steps:** • Incentivise housing societies to undertake green retrofitting under the green building certification system of Excellence in Design for Greater Efficiencies (EDGE) • Promote green buildings by offering additional floor space index (FSI) and reduced taxes for certified green projects under EDGE and the Indian Green Building Council (IGBC), etc • Participate in a green rating programme as a city to benchmark environmental performance and sustainable practices, akin to Pune, which won the IGBC Green City Award • Conduct targeted training and awareness programmes for real estate developers, architects, engineers, resident welfare associations, citizens, and construction firms	• Public works department • Town planning department • Revenue department • Local body tax department	• Maharashtra Green Building Policy

Co-benefits: Reduced energy consumption, reduced carbon footprint, and improved air quality, resilient urban environment.

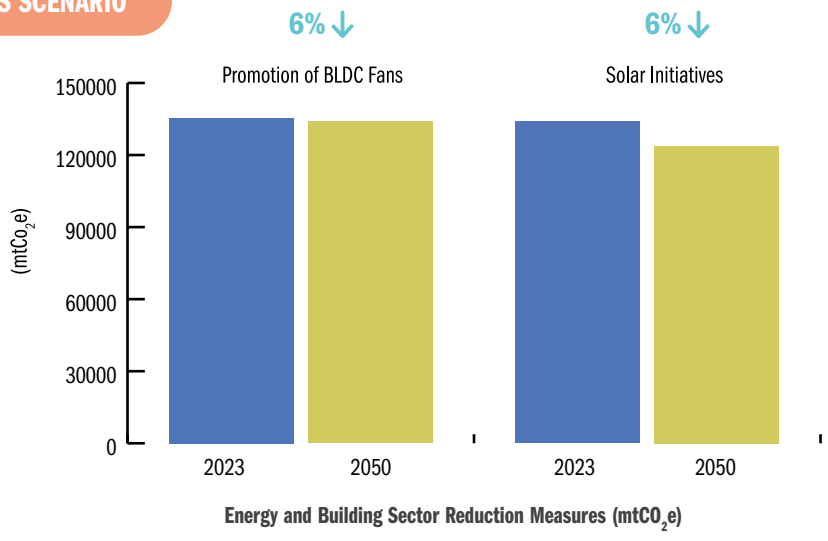
PASSIVE COOLING STRATEGIES

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Passive cooling techniques are critical to Mira Bhayandar because of its warm and humid climate **Recommended steps:** • Position buildings to minimise solar heat gain (east-west axis orientation), design layouts to enhance cross-ventilation, install ventilators or louvered vents at higher levels to expel hot air, and use landscaping or adjacent structures to create shade • Apply high solar reflectance index paints/light, coloured exterior paints, or tiles to roofs • Use external shading devices like overhangs, fins, and pergolas	NA	NA

Co-benefits: Reduced UHI effect and reduced indoor temperatures.

AMBITIOUS SCENARIO

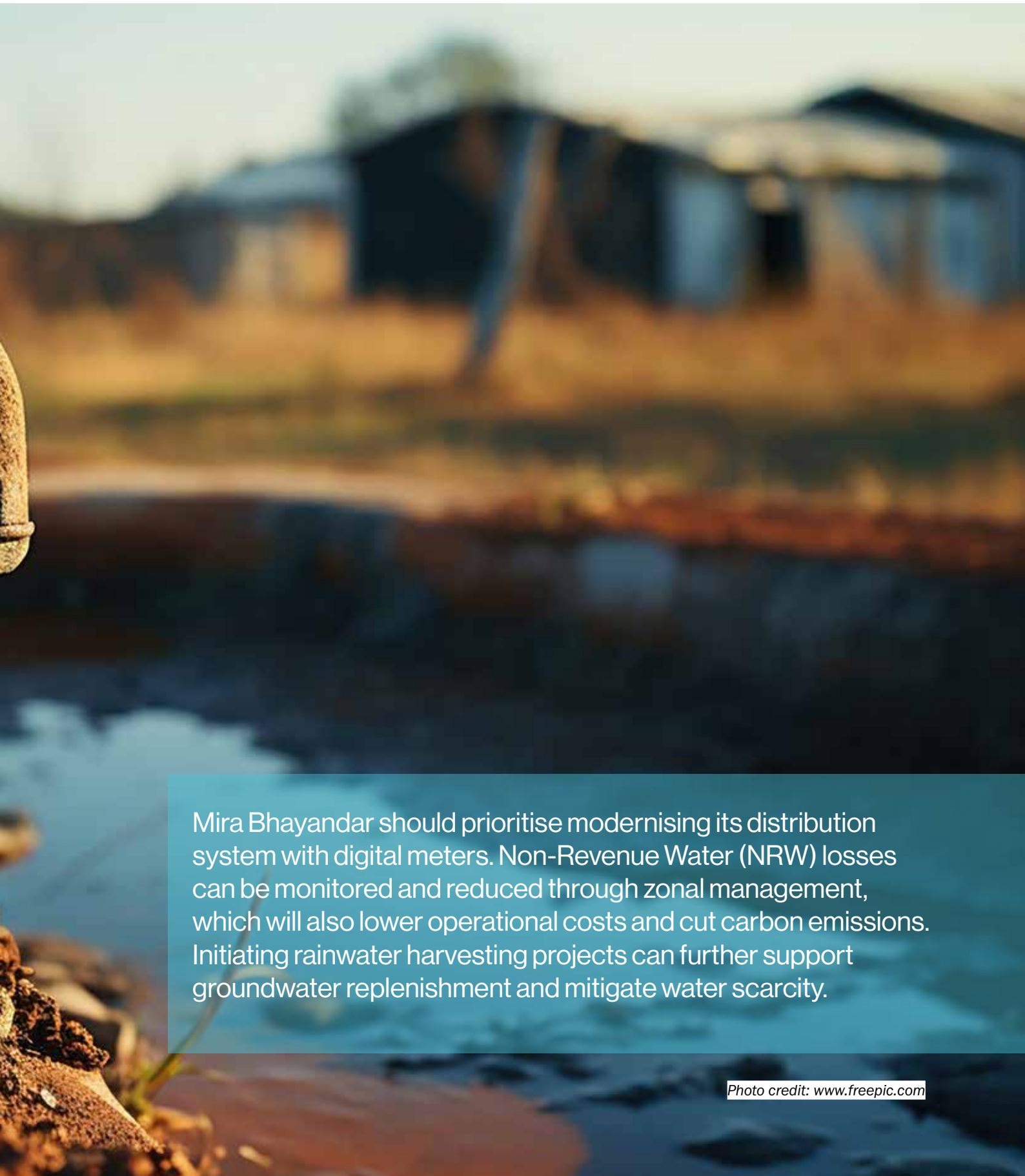


Energy and Building Sector Reduction Measures ($mtCO_2e$)

Source:

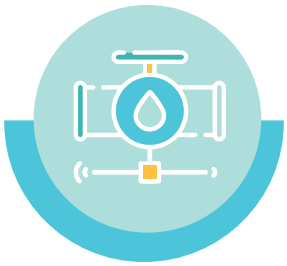
1. *Global Solar Atlas*
2. *MBMC Meditation Centre Bags 'Green Building' Tag*

4.2 Water Supply Management



Mira Bhayandar should prioritise modernising its distribution system with digital meters. Non-Revenue Water (NRW) losses can be monitored and reduced through zonal management, which will also lower operational costs and cut carbon emissions. Initiating rainwater harvesting projects can further support groundwater replenishment and mitigate water scarcity.

Photo credit: www.freepic.com



4.2.1 Demand and Supply

The MBMC requires 235 MLD to meet its requirements. Of this, the Maharashtra Industrial Development Corporation supplies 125 MLD, and the Shahad-Temghar (STEM) water supply scheme supplies 86 MLD. However, only 190 MLD reaches the city due to infrastructural constraints. The MBMC operates water tankers from borewells and bawadis to supplement the city's supply by up to another 1 MLD. Private tankers and borewells, and a reduced supply to households, bridge the remaining 44 MLD gap.

4.2.2 Variation in Distribution

The water supply varies widely across neighbourhoods, ranging from 90 LPCD to 125 LPCD, which is below the WHO benchmark of 135 LPCD. Additionally, the water supply connects only about 75% of households, falling short of the ideal benchmark of universal coverage. The city aspires to upgrade the existing water supply system to ensure a 24/7 supply, but it faces shortages that necessitate periodic 24-hour shutdowns every two or three weeks to stabilise resources. Seasonal fluctuations exacerbate the situation; as a result, the delivery of supply is unreliable and erratic and typically ranges from only 2 to 4 hours per day in most wards.

The city's Non-Revenue Water (NRW) is estimated to be a significant 21%. This is primarily caused by a lack of metering and pricing systems, leakages, and theft. Metered water connections only account for 74%, leaving a significant portion of the distribution unmonitored. Only a few slum households are connected to the formal water supply network; they primarily rely on tanker water that costs approximately ₹1000 per 10,000 litres.

It is imperative to conduct a detailed NRW audit to identify and quantify losses and plan for equitable distribution. As a strong measure, the MBMC has already halted the issuance of new connections for buildings higher than four floors.

4.2.3 Recycling and Reuse Capacity

The wastewater management system includes decentralised treatment plants with a total capacity of 115 MLD, but limited space, poor coverage, and connectivity challenges limit their efficiency. The water from the Tertiary Treatment Plant (TTP) is sold at a subsidised rate of ₹700 per 10,000 litres, typically for use at construction sites, gardens, and other non-potable purposes. To augment the existing capacity, the MBMC has planned to install 9 secondary treatment plants and 1 tertiary treatment plant with a capacity of 5 MLD to enhance the city's wastewater treatment capacity, though space constraints in the city still pose a challenge.

Water quality is examined on a daily basis, but there are cases of reverse siphoning, contamination, and turbidity that the city is trying to address.

4.2.4 Augmentation and Modernisation

The MBMC has initiated modernisation programmes, such as exploring digital metering solutions and implementing Integrated Water Resources Management (IWRM) to reduce leakage, bolster management, and upgrade and expand the existing infrastructure. The city can reduce both operational costs and carbon footprints by adopting IWRM principles and integrating renewable energy for pumping systems.

The MBMC has also undertaken various water conservation efforts in the recent past, including mandating rainwater harvesting for new residential welfare associations and offering 5% tax rebates as incentives. However, post-installation, monitoring of this new infrastructure is often lacking, which affects the long-term sustainability of the initiatives. Active community participation and monitoring measures can be incorporated into the ongoing tree plantation drives and water conservation programmes to make them more engaging, collaborative, and sustainable.

235 MLD

Mira Bhayandar city requirement

125 MLD

Supplied by Maharashtra Industrial Development Corporation

86 MLD

Supplied by Shahad-Temghar water supply scheme

190 MLD

Reaches the city due to infrastructural constraints

Photo credit: Youth Conclave Students | SPA Bhopal

4.2.5 Key Priority Actions

4.2.5.1 Eco Sewage Treatment Plants

The city is planning to construct 8 Sewage Treatment Plants (STP) and 2 Tertiary Treatment Plants (TTP) to meet the current gap of 17.5 MLD. Traditional STPs often face challenges such as high energy costs, maintenance difficulties, and environmental impacts, which highlight the need to adopt a sustainable alternative

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Construct eco STPs, which will use natural, low-energy biological processes for treating wastewater, particularly for informal settlements and areas lacking robust infrastructure	Reduced water contamination Enhanced regulatory compliance Optimised resource management	Water supply and sewerage department	National Water Policy Swachh Bharat Mission National Mission on Sustainable Habitat

TARGET SDGS: 6, 14

CSCAF INDICATOR
ENERGY EFFICIENT WASTEWATER MANAGEMENT SYSTEM

ACTION TIMELINE
SHORT TERM
2030

CASE STUDY: 4.2.5.1
GWALIOR ECO STP

The first-of-its-kind eco-sewage treatment plant in Gwalior, Madhya Pradesh, is a model for sustainable wastewater management in India. This plant was established in 2020 to address the severe water crisis in the city. Rapid urbanisation had led to increased demand for freshwater and the discharge of untreated wastewater into local water bodies. The successful operation of this STP contributed to the reduction of wastewater discharge into the Chambal river. The plant has a treatment capacity of 145 million litres per day, almost three times the capacity of the old STP (52 MLD). The STP utilises Sequencing Batch Reactor (SBR) technology, which is known for its efficiency in treating large volumes of wastewater. SBR processes encompass filling, aeration, settling, and decanting and achieve over 95% removal efficiency for organic matter and suspended solids. This makes the treated water suitable for agricultural use and contributes significantly to the conservation of freshwater resources.

4.2.5.2 NRW Reduction Strategy

There lies a data gap in quantifying the quantum of NRW; it is currently projected at around 21%

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Develop and implement a comprehensive NRW Reduction Strategy through a public-private partnership model to maximise resource utilisation and enhance service reliability	Community trust and engagement	Water supply and sewerage department	Jal Jeevan Mission (Urban)
	Informed decision-making	Revenue department	Smart Cities Mission
	Financial benefits		National Mission on Sustainable Habitat

TARGET SDGS 6

CSCAF INDICATOR
EXTENT OF NRW

ACTION TIMELINE
MID TERM
2040

Puri district in Odisha has implemented the zonal distribution system, which has reduced NRW from an estimated 54% to 15%. The city has adopted a 24/7 water supply project under the Drink from Tap Mission that involves creating 19 District Metered Areas (DMAs).

CASE STUDY: 4.2.5.2
IMPLEMENTATION OF ZONAL DISTRIBUTION SYSTEM TO REDUCE NRW IN PURI

Puri district in Odisha has implemented the zonal distribution system, which has reduced NRW from an estimated 54% to 15%. The city has adopted a 24/7 water supply project under the Drink from Tap Mission that involves creating 19 District Metered Areas (DMAs). Each DMA is equipped with bulk water meters that allow for precise monitoring of water consumption and effective management of the supply network. This zonal approach facilitates the identification of leaks and unauthorised connections, enabling targeted maintenance and operational efficiency. Moreover, dedicated service tanks serve each DMA, ensuring decentralised control over water distribution and enhancing accountability and service delivery.

Implement a phased rollout of the ultrasonic metering system as a pilot, covering 10%–15% of target households, which allows for testing the ultrasonic metering technology and addressing any operational challenges before scaling up and expand water supply infrastructure and community outreach programmes to increase household coverage to 100%.

4.2.5.3 Zonal Distribution Systems

Currently, the city lacks a distribution zone classification, which restricts its ability to fortify against thefts and leakages, and to precisely identify the consumption patterns of both commercial and household units. Zonal distribution systems are equipped with bulk water meters to isolate zones for maintenance and monitor consumption patterns, enabling efficient water management and tracking

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Establish zonal distribution and bulk metering systems to ensure targetted interventions that directly address water loss and support equitable water supply	Reduced water consumption Optimised resource management	Water supply and sewerage department Revenue department Public works department	Jal Jeevan Mission (Urban) Smart Cities Mission National Mission on Sustainable Habitat

TARGET SDGS

CSCAF INDICATOR
WATER RESOURCE MANAGEMENT AND ENERGY EFFICIENT WATER SUPPLY MANAGEMENT

ACTION TIMELINE
MID-TERM
2040

CASE STUDY: 4.2.5.3
ADOPTION OF VOLUMETRIC TARIFF STRUCTURE BY HYDERABAD METROPOLITAN WATER SUPPLY AND SEWERAGE BOARD

In order to promote efficient water use and ensure cost recovery, the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) has adopted a volumetric tariff structure. This structure charges consumers based on their actual water consumption measured through meters. The price per kilolitre (kl) increases with higher consumption levels, thereby encouraging consumers to save water. The tariff is structured into several slabs: for domestic users, the rates start at ₹6.00 per kl for the first 15 kl and rise to ₹35 per kl for consumption above 200 kl. This approach also incorporates cross-subsidisation, wherein higher-income households help subsidise lower-income users, promoting equity in access to water resources.

The price per kilolitre (kl) increases with higher consumption levels, thereby encouraging consumers to save water. The tariff is structured into several slabs: for domestic users, the rates start at ₹6.00 per kl for the first 15 kl and rise to ₹35 per kl for consumption above 200 kl.

4.2.6 Recommendations for Urban Water Supply Management

METERING SYSTEMS AND TARIFFS

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Prioritise fully metered high-consumption zones and commercial areas, offer subsidies or rebates to capture significant portions of unmetered water usage, and simplify and expedite the procedures for new meter installations • Implement a phased rollout of the ultrasonic metering system as a pilot, covering 10%–15% of target households, which allows for testing the ultrasonic metering technology and addressing any operational challenges before scaling up • Implement usage-based water tariffs in areas consuming more than the standard supply of 135 LPCD to effectively recover operating and maintenance (O&N) and capital expenditures (CapEx) costs • Expand water supply infrastructure and community outreach programmes to increase household coverage to 100% • Create provision of 24/7 water supply by upgrading the current distribution system	• Water supply and sewerage department • Revenue department • Garden tree department	• Atal Mission for Rejuvenation and Urban Transformation • Jal Jeevan Mission (Urban) Swachh Bharat Mission • National Mission on Sustainable Habitat

Co-benefits: Decreased water loss, enhanced water security and quality, and decreased wastage.

DEVELOP WATER BALANCE PLAN

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Develop a water balance plan for the city • Mandate the reuse of at least 20% inline treated water for gardens, flushing, and industries, as per the National Mission on Sustainable Habitat guidelines	• Water supply and sewerage department • Revenue department • Garden tree department	• Atal Mission for Rejuvenation and Urban Transformation • Jal Jeevan Mission (Urban) • Swachh Bharat Mission • National Mission on Sustainable Habitat

Co-benefits: Reduced water contamination, enhanced regulatory compliance, optimised resource management, sustainable water management, reduced water loss, and improved water security.

GROUNDWATER MONITORING

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Deploy an IoT-enabled metering and GPS tracking system for water tankers and borewells to enhance monitoring, prevent unauthorised extraction, and improve the efficiency of water distribution • Initiate rainwater harvesting projects after conducting detailed hydrogeological surveys to map shallow aquifers and identify recharge zones • Integrate the findings into urban planning to maximise groundwater replenishment and mitigate water scarcity	• Water supply and sewerage department • Revenue department	• Jal Jeevan Mission (Urban) • Smart Cities Mission • National Mission on Sustainable Habitat

Co-benefits: Reduced water contamination, enhanced regulatory compliance, optimised resource management, and minimised saltwater intrusion.

EFFICIENCY MEASURES

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Mandate the installation of low-flow fixtures like aerators in residential complexes to reduce per capita water consumption and sensitise people to water usage • Optimise water pump operations by incorporating advanced energy-efficient technologies and transitioning to solar or wind (renewable sources) to reduce energy consumption and operational costs • Limit cross-connections in the water supply network by strategic zoning, installation of isolation valves, and use of supervisory technologies like Supervisory Control and Data Acquisition (SCADA) for real-time monitoring and control	• Water supply and sewerage department. • Revenue department • Electrical works department • Public works department	• Jal Jeevan Mission (Urban) • Smart Cities Mission • National Mission on Sustainable Habitat • Atal Mission for Rejuvenation and Urban Transformation

Co-benefits: Reduced water contamination, enhanced regulatory compliance, and optimised resource management.

Sources:

1. *CPHEEO Manual on Water Supply and Treatment*
2. *Surya Detailed Project Report*
3. *Mira-Bhayandar: MBMC To Link Water Tanker Bills With GPS Records*
4. *Case Study on 145MLD Sewage Treatment Plant (STP) (SBR Technology) in Gwalior*
5. *Drink From Tap Mission In Puri City*
6. *Cost Recovery and Tariff Practices for Urban Water Supply and Sanitation in India*

Photo credit: Youth Conclave Students | SPA Bhopal

4.3 Urban Flooding

The frequency of extreme rainfall events has increased over the last three decades, and the inadequacies in existing stormwater infrastructure have exacerbated Mira Bhayandar's vulnerability to urban flooding and waterlogging. The city can build resilience by implementing a multi-faceted approach that includes upgrading infrastructure, adopting nature-based solutions, and enforcing robust urban planning measures.

Photo credit: www.freepic.com

4.3.1 Climatic Trends and Rainfall Patterns

4.3.1.1 Rainfall trends (1991–2021) and frequency of rainfall events

The rainfall data between 1991 and 2021 *(Figure: 4.3.1)* highlights an upward trend in cumulative annual rainfall. It shows the increase in intense and heavy rainfall events over the last three decades. The city has witnessed flooding events in 2010, 2018, and 2019 caused mainly by the limited capacity of the stormwater drainage to accommodate excess surface runoff.

The rainfall intensity distribution from 1991 to 2021, categorised into four intensity levels: light, moderate, heavy, and very heavy rainfall *(Figure: 4.3.2).* The data indicates that the city primarily experiences light to moderate rainfall events. On average, heavy and very heavy rainfall events are less frequent, but there is a notable increase in the proportion of heavy and very heavy rainfall events, particularly in recent years. Such extreme rainfall events overwhelm the city's stormwater drainage systems, leading to flash floods and prolonged waterlogging in vulnerable areas.

4.3.1.2 Intensity-Duration-Frequency Analysis

The IDF (Intensity-Duration-Frequency) curve, shows the relationship between the amount of rain, how long it lasts, and how often it falls *(Figure: 4.3.3)* This curve gives us important information about how likely it is that a variety of extreme rainfall events will happen. Intense precipitation events can deliver large amounts of rain over a short period of time, saturating stormwater drains that are not designed to handle peak intensities.

Even though extreme rainfall events are less frequent, the city has been experiencing intense precipitation over a short period of time, leading to water stagnation and flash floods. The drainage system requires urgent upgradation to accommodate the intensities of rainfall associated with higher return periods, particularly for durations like 12 and 24 hours, where the risk of urban flooding is more pronounced.

The data indicates that the city primarily experiences light to moderate rainfall events. On average, heavy and very heavy rainfall events are less frequent, but there is a notable increase in the proportion of heavy and very heavy rainfall events, particularly in recent years.

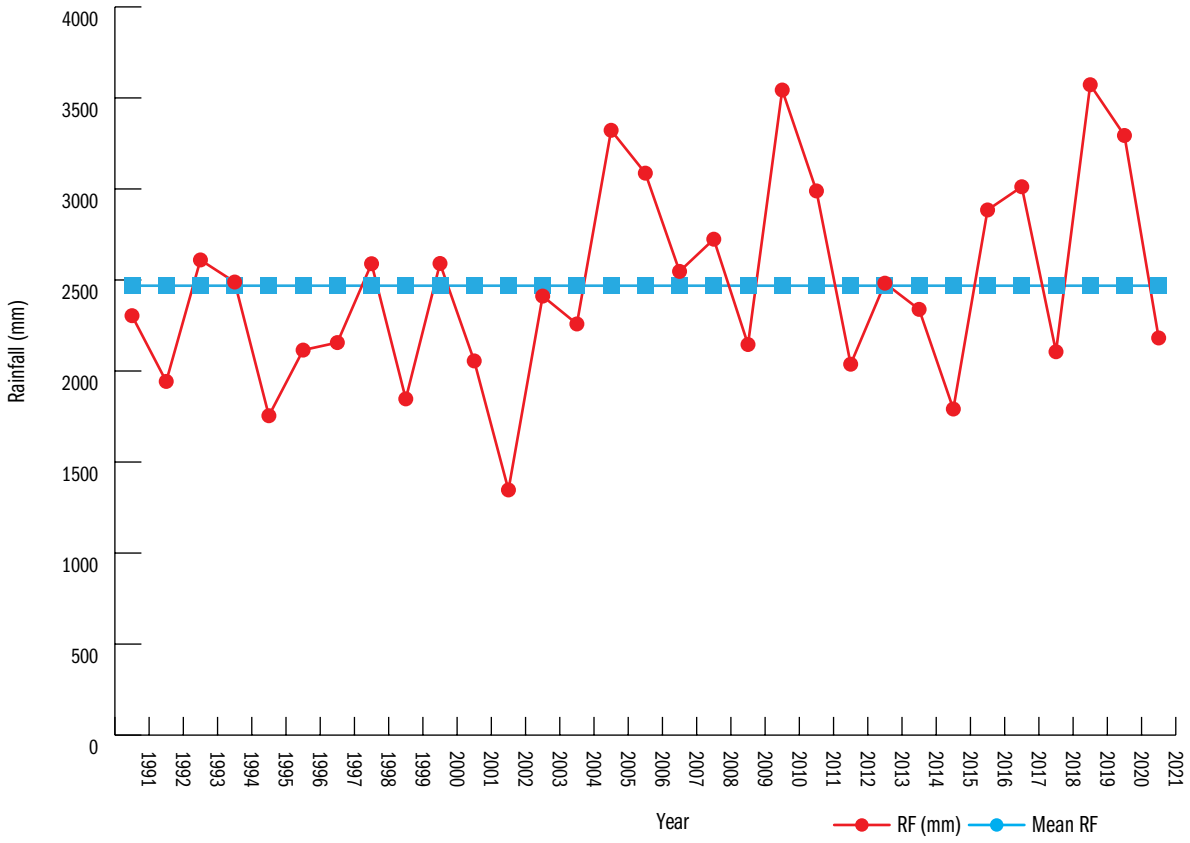


Figure 4.3.1: Cumulative Annual Rainfall Trend in Mira Bhayandar (1991–2021)
[Graph: Annual rainfall trend based on provided data]

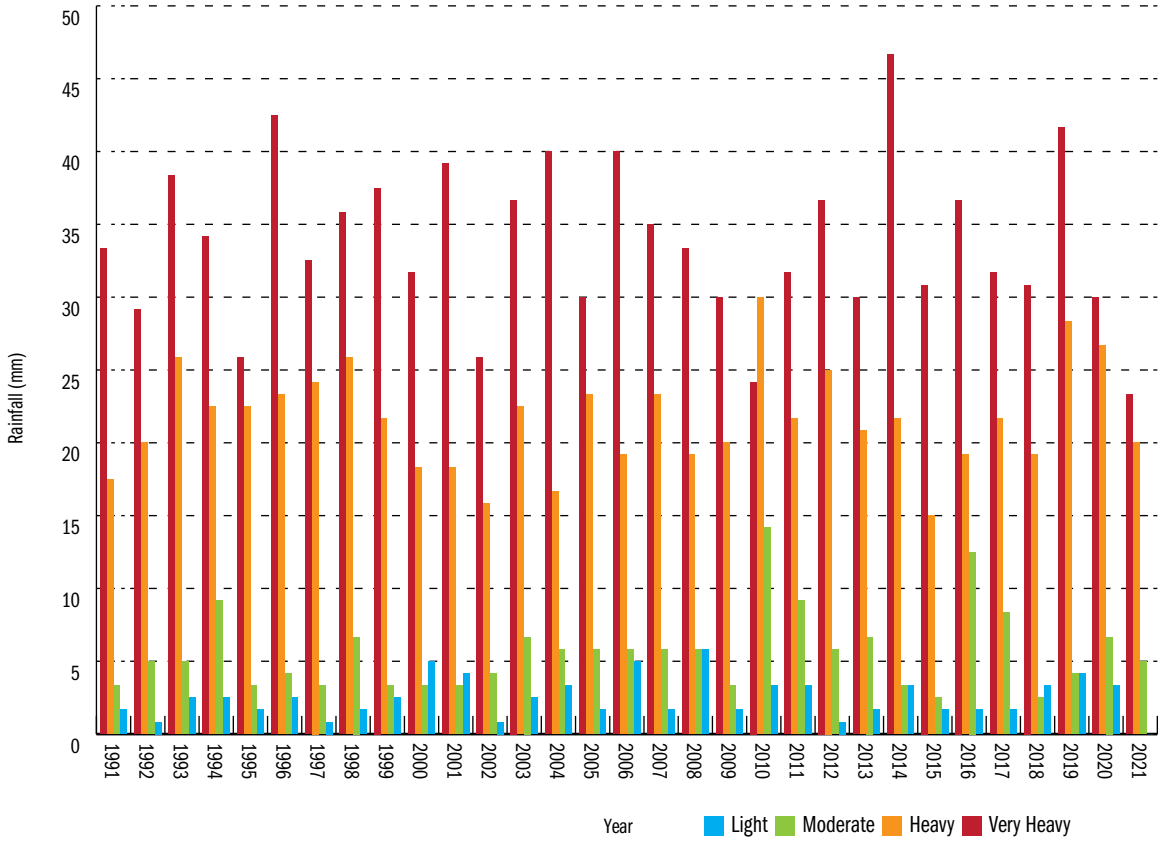


Figure 4.3.2: Rainfall intensity distribution over time
[Graph: Frequency distribution of light, moderate, heavy, and very heavy rainfall events]

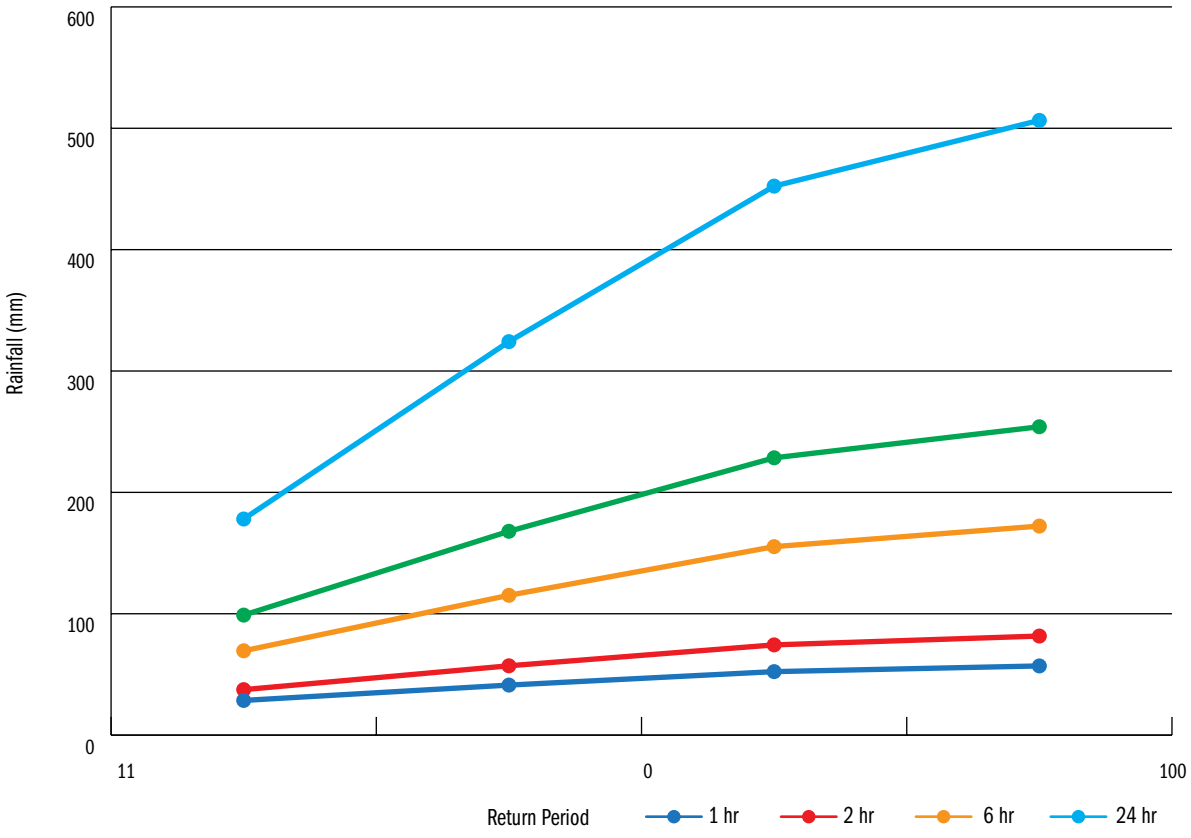


Figure 4.3.3: IDF Curve for Mira Bhayandar
[Graph: an IDF curve showcasing the rainfall intensities over various durations and return periods]

Much of Mira Bhayandar's stormwater infrastructure lacks the capacity to handle the current and projected rainfall intensities and duration. Irregular drain cleaning exacerbates the problem by causing blockages and waterlogging during the rainy season. Furthermore, rapid concretisation of permeable surfaces has lowered groundwater recharge, intensifying surface runoff and waterlogging situations.

Landmark	Length (m)	Width (m)	Req Breadth (m)
Sagar Complex	7.54	0.76	4.85
Old Raviraj Complex	48.82	0.74	0.75
Old Raviraj Complex	48.78	0.74	0.75
Old Raviraj Complex	47.89	0.74	0.76
Old Raviraj Complex	48.07	0.74	0.76
Old Raviraj Complex	6.86	0.67	5.33
Kheteshwar Chowk	13.11	1.26	2.79
Kheteshwar Chowk	13.20	1.26	2.77
Bhayandar Imaging Centre	39.30	0.73	0.93
Navghar Shamshan Road	6.39	0.66	5.73
Orchid Multispeciality Hospital	30.41	1.26	1.20
Orchid Multispeciality Hospital	5.66	0.56	6.46
Orchid Multispeciality Hospital	50.84	0.72	0.72
Your V Care Multispeciality Hospital	24.81	1.30	1.47
N H English Academy	11.45	1.57	3.19
LBS Marg	16.31	1.61	2.24
Silver Crown Apartment	24.85	1.28	1.47
Om Shanti Chowk	44.11	0.74	0.83
Om Shanti Chowk	16.84	1.12	2.17
Om Shanti Chowk	12.14	1.17	3.01
Jain Mandir	9.63	1.13	3.80
Jain Mandir	11.17	1.33	3.28
BAPS Shri Swaminarayan Mandir Mira Bhayandar	33.26	0.73	1.10
BAPS Shri Swaminarayan Mandir Mira Bhayandar	7.36	0.86	4.97
BAPS Shri Swaminarayan Mandir Mira Bhayandar	28.81	0.73	1.27
BAPS Shri Swaminarayan Mandir Mira Bhayandar	29.04	0.73	1.26
BAPS Shri Swaminarayan Mandir Mira Bhayandar	6.26	0.64	5.85
Mira Road Railway Station	8.08	0.99	4.53
Manav Kalyan Kendra	7.84	0.89	4.67
Sector 4 ground	9.58	1.07	3.82

Figure 4.3.4: Drainage discharge capacity in Mira Bhayandar

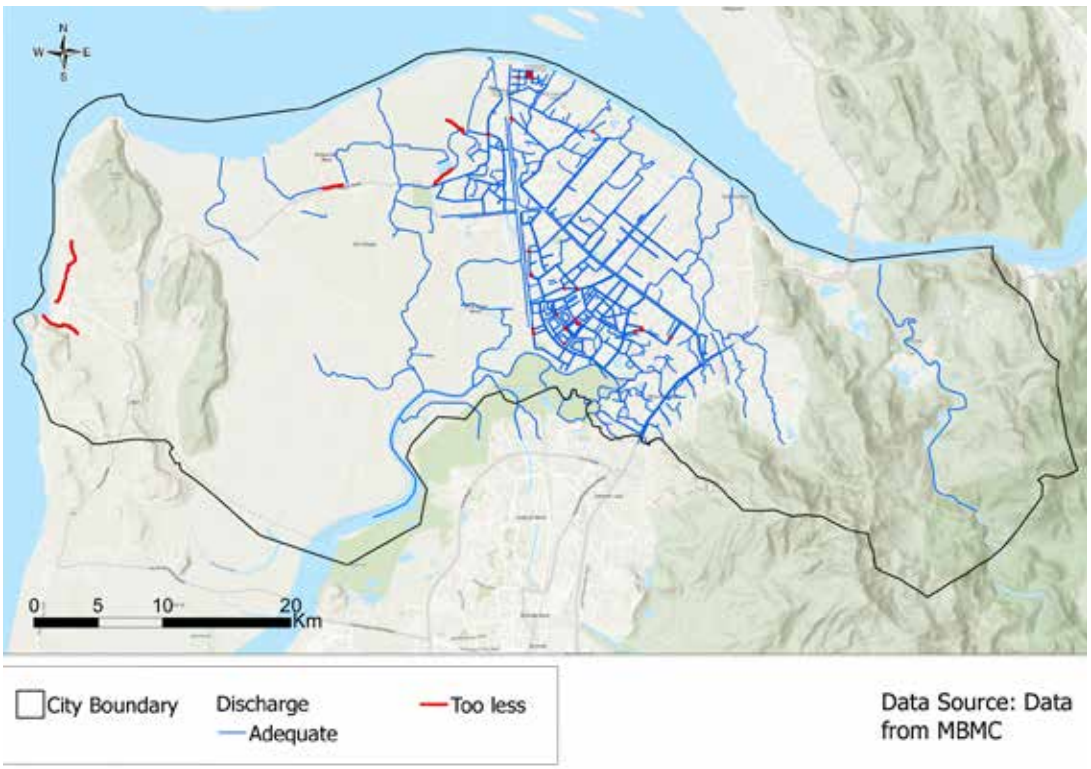


Figure 4.3.5: Drainage discharge capacity in Mira Bhayandar

Figure 4.3.6: Temperature Anomaly calculated between 1991 and 2021 for Mira Bhayandar

4.3.2 Challenges of Existing Drainage Infrastructure

The drainage discharging capacity in Mira Bhayandar as illustrated in *Figure 4.3.4.* The drainage lines marked in red indicate low discharge capacity, which means that excess rainwater fails to drain out, leading to stagnated water and urban flooding in the area. There needs to be a focussed approach to improve the capacity of the stormwater drains in the landmarks shown in the map *(Figure 4.3.5)* in which waterlogging-prone landmarks are listed.

Much of Mira Bhayandar's stormwater infrastructure lacks the capacity to handle the current and projected rainfall intensities and duration. Irregular drain cleaning exacerbates the problem by causing blockages and waterlogging during the rainy season. Furthermore, rapid concretisation of permeable surfaces has lowered groundwater recharge, intensifying surface runoff and waterlogging situations.

4.3.3 Strategies for Risk Management

STRATEGIES	DESCRIPTION
Infrastructure Upgrades	• Redesign and expand the drainage network to meet rainfall intensities projected for higher return periods (12 to 24 hours) • Install sensor-based monitoring systems to detect blockages and optimise discharge performance • Installation of floodgates at 9 priority drainage locations to avoid the storm surge
Nature-Based Solutions	• Protect and rehabilitate natural lakes, wetlands, and ponds to serve as flood buffers • Develop urban green spaces and retention ponds to absorb excess rainwater • Promote the use of pervious pavements to enhance groundwater recharge and reduce surface runoff
Urban Planning and Zoning	• Restrict construction in vulnerable, low-lying areas • Require rainwater harvesting systems in residential and commercial buildings • Ensure climate-resilient urban growth by integrating flood risk assessments into development control plans
Early Warning and Flood Forecasting Systems	• Real-time rainfall monitoring systems with early warning alerts for extreme weather events • Employ flood forecasting models to prepare for impending rainfall and flooding
Community Participation	• Educate citizens on flood preparedness and proper waste disposal to prevent drain blockages • Involve community stakeholders in disaster response plans and local flood action plans

4.3.4 Key Priority Actions

4.3.4.1 Upgrade Drainage Infrastructure and Implement Nature-Based Solutions

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Invest in the expansion and modernisation of the city's drainage systems, especially in the 'high' and 'very high' risk wards – 13, 20, 23, 10, and 4. This includes increasing the capacity of existing drains, constructing new drainage channels, and ensuring regular maintenance to prevent blockages	Improved forecasting accuracy	Town planning department	Swachh Bharat Mission (Urban)
	Enhanced public safety	City Engineer	National Water Policy
	Reduced waterlogging	Garden department	Atal Mission for Rejuvenation and Urban Transformation
	Improved drainage lines	Water supply and sewerage department	
		Solid waste management department	National Mission on Sustainable Habitat
Restore and protect natural water bodies to serve as flood buffers			
Implementing advanced stormwater management systems, such as green roofs, permeable pavements, and rain gardens, can help in reducing surface runoff and recharging groundwater levels			
Install floodgates at 9 key drainage points to block high-tide creek water and address waterlogging in vulnerable areas			

TARGET SDGS

CSCAF THEME
FLOOD/WATER STAGNATION RISK MANAGEMENT

ACTION TIMELINE
MID TERM
2040

Photo by: Vikrant Harankhede

A recommended key priority action is to integrate Sustainable Urban Drainage Systems (SuDS) into urban planning so that new developments are designed to manage water sustainably.

4.3.4.2 Enforce Urban Planning Regulations

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Enforce strict zoning regulations to prevent development in flood-prone areas; this can reduce the risk of property damage and loss of life	Zoning of areas to identify low-lying areas	Town planning department	Maharashtra State Action Plan on Climate Change
Implement strict zoning rules to restrict construction in low-lying areas	Controlled development to reduce urban flooding	City Engineer	National Policy on Disaster Management
Integrate Sustainable Urban Drainage Systems (SuDS) into urban planning so that new developments are designed to manage water sustainably			Integrated Coastal Zone Management
Mandate rainwater harvesting systems in all new and existing buildings			

TARGET SDGS: 6, 11

CSCAF THEME: DISASTER RESILIENCE

ACTION TIMELINE: SHORT TERM 2030

4.3.4.3 Establish Early Warning Systems

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Introduce real-time flood monitoring and early alert mechanisms to provide timely warnings to residents	Reduced risk during peak rainfall	Disaster management department	Maharashtra State Action Plan on Climate Change
Employ flood forecasting models to prepare for impending rainfall and flooding			National Policy on Disaster Management
			Flood Management and Border Areas Programme

TARGET SDGS: 6, 11, 14

CSCAF THEME: FLOOD AND STAGNATION RISK MANAGEMENT

ACTION TIMELINE: SHORT TERM 2030

CASE STUDY: 4.3.4.1
ROLE OF FLOOD EARLY WARNING SYSTEM (FEWS) IN GUWAHATI

Guwahati, a flood-prone city in Assam, has successfully implemented a Flood Early Warning System (FEWS) designed to predict and manage urban flooding. The Energy and Resources Institute, in collaboration with the National Disaster Management Authority and local agencies, launched this system in August 2020. It aims to provide timely alerts about flash floods and heavy rainfall, which are common occurrences in the region due to its geographical and climatic conditions. An integrated urban drainage module in the system enables street-level flood predictions. Google Maps allows for the visualisation of flood levels and hotspots, aiding in the identification of flood-affected zones and assisting authorities in their disaster preparation.

CASE STUDY: 4.3.4.2
CHENNAI DRAINAGE SYSTEM

Chennai improved its drainage system through an integrated waterway management approach, involving its rivers, canals, and estuaries. Due to the inefficient drainage system, sandbar formation at river mouths, inadequate tidal flushing, and stagnant waterways became common occurrences. To address the issues, a network was created connecting the Cooum and Adyar rivers and the Buckingham Canal to the sea, enabling tidal flow for continuous flushing. Modifications to channel dimensions and river mouths were made to optimise water movement. Simulations and engineering interventions ensured residual flow for water quality improvement. Furthermore, regular maintenance, such as dredging and sand bypassing, was given priority.

Photo by: Vikrant Harankhede

4.3.5 Recommendations in Urban Flooding Management

ENGAGE COMMUNITIES

ACTION TIMELINE
CONTINUED PROCESS

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Foster local participation in flood mitigation and preparedness activities through awareness programmes and community-based action plans • Engaging the community in flood risk management through education and awareness programmes can foster a culture of preparedness and resilience	All in-line departments of the municipal corporation	• National Policy on Disaster Management • National Mission for Sustainable Habitat

Co-benefits: Increased resilience as communities are educated about hazards, and ways to prepare and respond.

INTEGRATE PAST AND FUTURE CLIMATE RISKS, TRENDS, AND PROJECTIONS TO PLAN AND IMPLEMENT PUBLIC AND PRIVATE CLIMATE-PROOFING INFRASTRUCTURE, SUCH AS STORMWATER DRAINS, OUTFALLS, AND HOUSING PROJECTS

ACTION TIMELINE
CONTINUED PROCESS

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Climate criteria as part of environmental impact assessment and internal approval processes • Dedicated data, norms and guidelines included in the feasibility, detailed project report, and implementation plans related to the following: ◦ Assets protected in storm surge flooding; ◦ % of heavy rainfall leading to landslides/erosion/flooding; ◦ Number of deaths due to natural disasters per 100,000 population; ◦ Percentage of population vulnerable to natural hazards, such as excessive heat, droughts, flooding, landslides, earthquakes, and cyclones	• Disaster management department • Solid waste management department • Storm water drainage department	• Smart Cities Mission • Maharashtra State Action Plan on Climate Change • Flood Management and Border Areas Programme • National Hydrology Project

Co-benefits: Availability of future projections about climatic events, and establishment of climate-proofing infrastructure.

INTEGRATE A NATURE-BASED, ECOSYSTEM-BASED, AND COMMUNITY-BASED APPROACH IN OVERALL DISASTER RISK MANAGEMENT

ACTION TIMELINE
CONTINUED PROCESS

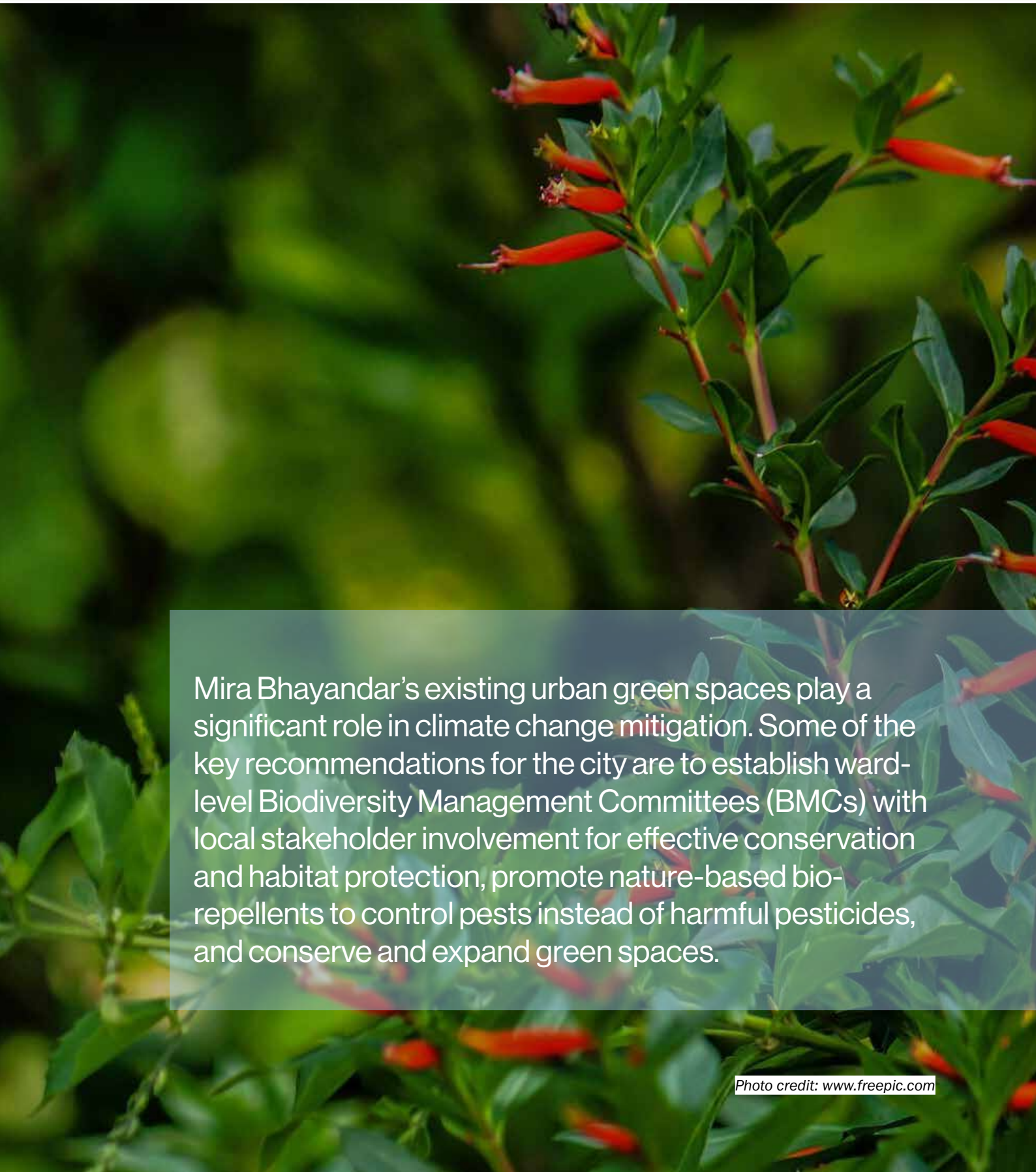
RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
◦ Reduced disasters and communities affected ◦ Reduced percentage of population vulnerable to natural hazards, such as excessive heat, droughts, flooding, landslides, earthquakes, and cyclones ◦ Reduced losses – physical, financial, and human – to infrastructure	• Disaster management department • City engineer • Town planning department	• National Policy on Disaster Management • National Mission for Sustainable Habitat

Co-benefits: Community awareness and involvement, and reduced damages and losses to property and lives.

Sources:

1. *IDF Curve 101*
2. *TERI and NDMA launch Flood Early Warning System (FEWS) to predict floods in Guwahati | TERI*
3. *Chennai Drainage System.doc*

4.4 Urban Greening and Biodiversity



Mira Bhayandar's existing urban green spaces play a significant role in climate change mitigation. Some of the key recommendations for the city are to establish ward-level Biodiversity Management Committees (BMCs) with local stakeholder involvement for effective conservation and habitat protection, promote nature-based bio-repellents to control pests instead of harmful pesticides, and conserve and expand green spaces.

Photo credit: www.freepic.com

4.4.1 Existing Green Cover and Biodiversity

The SGNP is one of the world's largest urban national parks and spans 18.16 square kilometres, which is 39.62% of the total area of Mira Bhayandar. It is home to approximately 1,300 species of flowering plants, 43 species of reptiles, 45 species of mammals, 300 species of birds, and 150 species of butterflies, including several endangered species. This rich biodiversity hotspot supports vital ecosystem services and acts as a critical carbon sink.

Mira Bhayandar's coastline stretches 23.6 kilometres, featuring dense mangrove forests that serve as natural barriers against coastal erosion and storm surges. The intertidal zones serve as important habitats for various marine and bird species, including flamingos, who stay for a long period of time during winters. The wetlands on the east, specifically Ghodbunder Road, serve as stopover points for migratory birds such as stonechat, rose finch, and black-tailed godwit.

Currently, the city has 79 public parks and gardens, along with approximately 120 water bodies, including lakes, ponds, and wetlands. However, within the main built-up area, the city has only 77 hectares of green space, with an average of 0.7 square metres per person. This is much lower than the 10 square metres per person that the Urban and Regional Development Plans Formulation and Implementation (URDPFI) 2014 guidelines specify. The city has 6,47, 963 trees, which translates to only 0.8 trees per person, excluding the area of mangroves and the SGNP, which are not in direct control of the city administration (MBMC Tree Census Report 2017-2018). Based on estimates from tropical regions, the tree census indicates that the city has the capacity to sequester approximately 9,720 MtCO2 annually. This improvement is directly attributed to the MBMC greening initiatives, particularly in recent years.

79
Public parks & gardens

120+
Water bodies, including lakes, ponds, and wetlands

77 ha.
Open green space

0.7 sqm
Per person area

21%
Sanjay Gandhi National Park

15%
Mangroves

23.8 km
Shoreline

4.4.2 Nature-Based Practices

In the western part of Mira Bhayandar, particularly in the peri-urban villages of Dongri and Uttan, the indigenous agricultural and fishing communities live. They have historically upheld the practice of protecting sacred groves (small patches of forest dedicated to local deities or ancestral spirits), along with the mangroves and salt pans, all of which serve as biodiversity reservoirs.

Dongri's historical significance as a centre for salt production and Uttan's Catholic heritage, evident in its ancient churches like the Our Lady of Vailankanni Shrine on a hillock facing the sea, survive as interwoven layers of human and natural history. In Dongri, the Agri, Koli, and Christian fishing communities protect the sacred groves, maintain a strong connection with nature, and gather to celebrate different rituals and festivals all around the year. These traditions not only reinforce the cultural identity of the region but also play a critical role in conserving biodiversity.

Similarly, Uttan's rich heritage includes traditional fishing festivals, a cuisine centred around fresh seafood, ancient temples, and vibrant festivals like the Narali Purnima (coconut festival), which is celebrated by the Koli fisherfolk to honour the sea god. The sacred groves in this area, which are also revered and community-protected, act as natural groundwater recharge pits. They absorb the rainfall while acting as bioswales that direct water runoff while protecting the soil against erosion.

These areas were seen as non-developable areas and were untouched by urbanisation for a long time. Cutting and chopping activities were banned by the dwelling communities. However, there has been observable habitat loss over the years, and the native species of trees, birds, and insects are endangered by anthropogenic activities and pollution.

4.4.3 Citizens' Awareness and Accessibility

There are 79 gardens and public parks in Mira Bhayandar *(Figure 4.4.1)*. Most of them are open during specific hours — between 6 am and 9 am and 4 pm and 7 pm. The spaces are inaccessible in the afternoons when women, children, and senior citizens are free to play or pursue leisure activities, and outdoor workers like street vendors, street sweepers, gig workers, and labourers are likely to take respite from the scorching heat in shaded areas. The absence or limited access during the day, combined with poor provision of essential amenities like shaded areas, drinking water, universal design, and seating, makes these parks less inviting, particularly during the summers. Most slums located in wards 13 and 14 have very few gardens and public parks, which make them even more vulnerable.

The city has undertaken various greening initiatives, but most of them are beautification projects that focus on ornamental trees to enhance the aesthetics. These initiatives could become ecologically more valuable if they promote native plantations of fruit-bearing trees, like jamun, neem, and banyan, that provide better shade and support the local biodiversity. The initiates could also encourage participation from the community in maintaining these spaces. There are few ongoing local initiatives in which the environmentally conscious residents and communities are taking the lead. Green clubs and resident welfare associations have started tree plantation drives and programmes like "Adopt a Tree'. They also advocate for keeping parks open for longer durations and the installation and improvement of facilities for thermal comfort.

Photo credit: www.thebluedrive.com

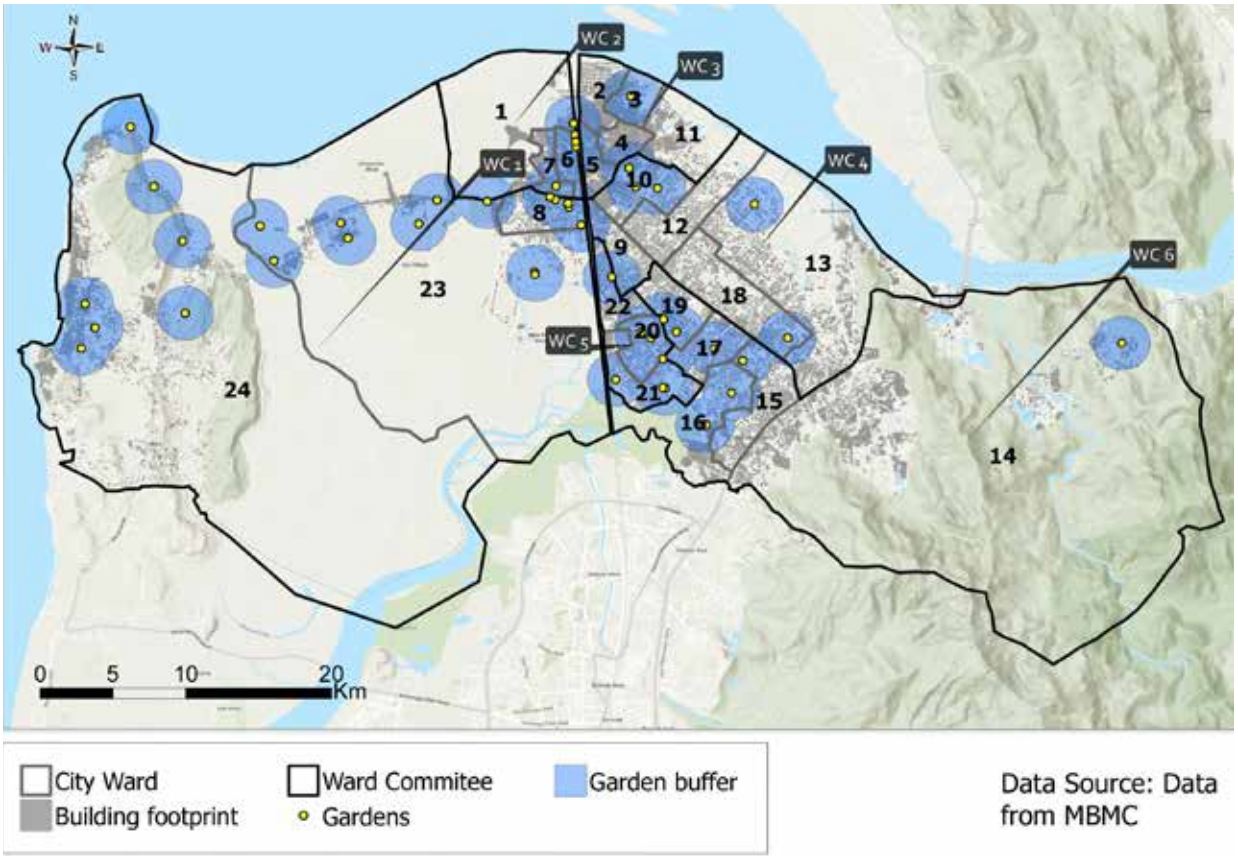


Figure 4.4.1 : Map of Access to Garden and Public Parks in Mira Bhayandar

4.4.4 Citywide Conservation Initiatives

At present, the city has 120+ waterbodies, which include lakes, ponds, wetlands, and the Ulhas Creek. The municipal corporation has undertaken various initiatives to rejuvenate the water bodies, but most of them are short-term, project-based interventions aimed at improving aesthetic and recreational value. Linking them with ecological restoration, community involvement, and safeguarding livelihoods dependent on waterbodies would make the projects environmentally sustainable. In a few locations, beautification interventions, such as the use of concrete, have disrupted the natural recharge of adjacent water bodies. The focus should be on regular desiltation, restoration of natural recharge zones, use of constructed wetlands for wastewater treatment, and enforcement of heavy fines on polluters and other pollution control measures.

It is also imperative to seek participation from local residents in regular checks and the monitoring and maintenance of water bodies. The municipal corporation has launched plantation drives and beach cleanups that actively engage volunteers and NGOs. While these programmes raise awareness to some extent and succeed in imbibing a sense of shared responsibility, they require to be linked with plans for the safe discharge of untreated wastewater and runoff of pesticides and fertilisers from agricultural lands and aggressive steps to mitigate pollution.

It is commendable that MBMC has conducted two tree censuses, with a third underway, to document its green assets. These surveys serve as critical documents for future urban planning and conservation efforts, but the reports are not available in the public domain. It is recommended that these documents be made public, as the integration of these findings into the People's Biodiversity Register will be highly beneficial.

The city's Biodiversity Management Committee (BMC) was established to oversee conservation efforts and ensure sustainable use of local biodiversity. This committee needs to be reactivated with adequate resources and bolstered with strong interdepartmental interlinkages.

4.4.5 Key Priority Actions

4.4.5.1 Establish ward-level Biodiversity Management Committees (BMCs)

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Mandate to involve the local stakeholders, such as wildlife conservationists and rescuers in the BMC, who can bring in valuable insights on species-specific needs, habitat conservation, and rescue efforts, particularly for marine and urban wildlife. Their involvement can also link the committee's work with ground-level expertise in species protection and ecosystem preservation	Enhanced conservation strategies	Garden department	National Biodiversity Action Plan
A standing committee member should serve as the chairman of the central BMC to ensure alignment with municipal priorities and effective governance	Reduced impact on invasive species	Environment department	Atal Mission for Rejuvenation and Urban Transformation
			National Green Mission

TARGET SDGS: 11, 15, 17

CSCAF THEME: REJUVENATION AND CONSERVATION OF WATER BODIES AND OPEN SPACES, AND URBAN BIODIVERSITY

ACTION TIMELINE: SHORT TERM 2030

4.4.5.2 Promote nature-based bio-repellents to avoid pesticides

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Grow fruit-bearing trees that support the flora and fauna using natural repellants to control pests instead of harmful fertilisers which breaks the food system	Enhanced ecosystem resilience through improved species interactions	Garden department	National Mission on Sustainable Habitat
		Environment department	Atal Mission for Rejuvenation and Urban Transformation
			National Biodiversity Action Plan

TARGET SDGS: 11, 15

CSCAF THEME: URBAN BIODIVERSITY

ACTION TIMELINE: SHORT TERM 2030

CASE STUDY: 4.4.5.1
BIO-REPELLENTS IN PUBLIC GARDENS,BANGALORE

Bangalore city promotes the use of nature-based repellents in public gardens under the community-led urban greening projects. With rapid urbanisation leading to diminished greenery and increased mosquito populations, middle-class communities have turned to traditional knowledge and natural solutions to manage pests without relying on chemical pesticides. In this initiative, various plants recognised for their repellent properties, such as citronella (Cymbopogon nardus), tulsi (Ocimum sanctum), and neem (Azadirachta indica), have been cultivated in community gardens and public parks. These plants not only enhance biodiversity but also serve as effective repellents against mosquitoes and other pests. The project has shown favourable outcomes, with significant reductions in mosquito populations reported in areas where these plants are grown.

4.4.5.3 Promote and conserve green spaces

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Promote community-led development of greenery in spaces between road dividers, upcoming metro lines, and any new construction to mitigate the urban heat island effect	Urban cooling and air quality improvement	Environment department	Maharashtra Harit Sena
		Garden department	Sacred Grove Protection Scheme, Maharashtra Forest Department
It is imperative to acknowledge the importance of sacred groves and conserve them in peri-urban villages to protect both cultural and ecological heritages			National Afforestation Programme

TARGET SDGS

CSCAF THEME
URBAN BIODIVERSITY

ACTION TIMELINE
MID TERM
2040

Promote community-led development of greenery in spaces between road dividers, upcoming metro lines, and any new construction to mitigate the urban heat island effect. Furthermore, it is imperative to acknowledge the importance of sacred groves and conserve them in peri-urban villages to protect both cultural and ecological heritages.

CASE STUDY: 4.4.5.2
URBAN SPACE MANAGEMENT STUDY, BHUBANESHWAR

The commissioning of a study on urban green space management in Bhubaneswar, India, highlights the city's efforts to address challenges related to the distribution, accessibility, and quality of green spaces. Currently, Bhubaneswar has a total of 495.1 hectares of urban green space, which is below the recommended standards for recreational use. Key issues identified include unequal distribution of green areas, lack of maintenance, and encroachment on public spaces. The study emphasises the need for a comprehensive urban green space management plan that incorporates public participation and sustainable landscaping practices. Additionally, it points out that government-developed neighbourhoods tend to have more usable open space compared to private land holdings, while certain areas, particularly in the Old Town, suffer from inadequate green spaces due to land constraints. The research advocates for better integration of green spaces into urban planning to enhance air quality, reduce urban heat island effects, and improve the overall quality of life for residents. Effective management and expansion of these spaces are deemed crucial for fostering ecological health and community well-being.

Install informative display boards in parks and green spaces to help citizens identify and learn about the native species in the area, ecological roles, and conservation status. This will develop a deeper connection between the community and the natural environment.

4.4.6 Recommendations for Urban Greening and Biodiversity

MAINTAIN A PEOPLE'S BIODIVERSITY REGISTER (PBR) AT THE CITY LEVEL

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Maintain a People's Biodiversity Register (PBR) at the city level • Engage the community in maintaining a PBR to record and monitor the city's biodiversity, including the migratory variations of species • Identify biodiversity hotspots across urban and peri-urban areas and assess the presence of invasive species in order to protect and sustain flora and fauna • Assess soil quality and the impact of invasive species to ensure plantation efforts are ecologically compatible and not leading to environmental degradation • Position the city as a wildlife-friendly corridor by creating interconnected green corridors, incorporating native vegetation, water bowls, and feeding spots to support avian and terrestrial species • Most importantly, involve local communities, NGOs and volunteers to safeguard biodiversity and the urban ecosystem	• Garden department • Environment department	• National Mission for Sustainable Habitat • Atal Mission for Rejuvenation and Urban Transformation • National Biodiversity Action Plan

Co-benefits: Enhanced ecosystem resilience through improved interactions of species.

NATURE-BASED SOLUTIONS

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Promote butterfly gardens and nana-nani parks by planting a mix of native ornamental and fruit-bearing species • Promote nature-based bio-repellents to avoid pesticides	• Garden department • Environment department	• Smart Cities Mission • Maharashtra State Action Plan on Climate Change • Flood Management and Border Areas Programme • National Hydrology Project

Co-benefits: Availability of future projections about climatic events, and establishment of climate-proofing infrastructure.

CITIZEN AWARENESS AND ACCESSIBILITY

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Develop an informative booklet based on the findings of the PBR and distribute it in both government and private school libraries. The register can act as a guide to Local Biodiversity Strategy and Action Plan (LBSAP) • Install informative display boards in parks and green spaces to help citizens identify and learn about the native species in the area, ecological roles, and conservation status. This will develop a deeper connection between the community and the natural environment • Keep parks open to provide respite from the heat in the noon and afternoon hours to citizens, and gig workers and labourers • Broaden the scope of environmental status reports in Mira Bhayandar to align with Sustainable Development Goals 14, 15, 16 and 17	• Environment department • Garden department • Education department	• National Mission on Sustainable Habitat • Atal Mission for Rejuvenation and Urban Transformation • National Biodiversity Action Plan • Urban Greening Guidelines 2024 by the Town and Country Planning Organisation, Ministry of Housing and Urban Affairs • National Education Policy

Co-benefits: Environmental awareness, enhanced knowledge of local biodiversity, enhanced awareness and knowledge about local ecosystems, enhanced sense of protection of native species, and equitable access to vulnerable populations.

COMMUNITY-LED CONSERVATION INITIATIVES

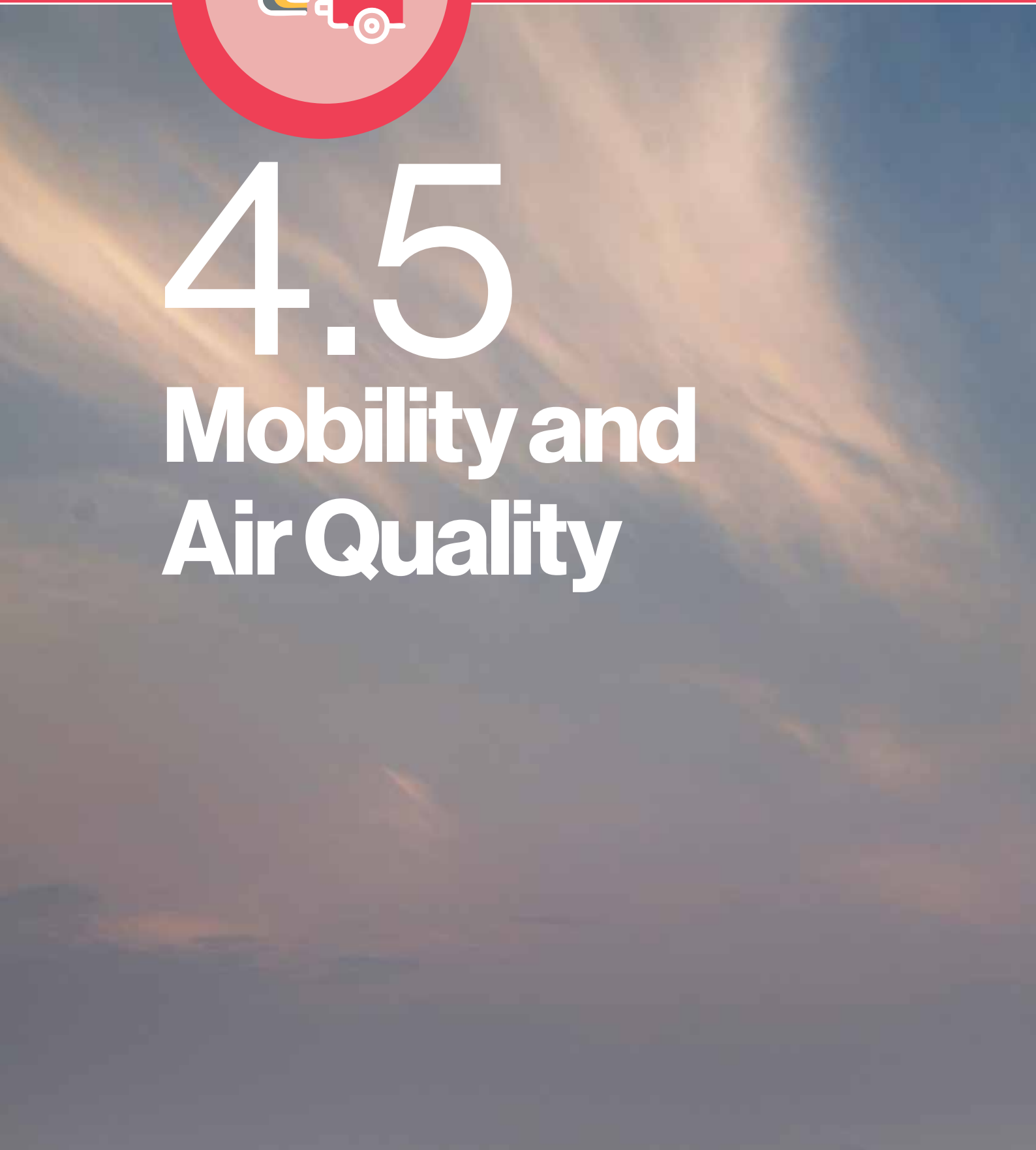
ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Strengthen aquatic ecosystems in Mira Bhayandar by collaborating with local communities for wetland restoration, pollution control, and sustainable fishing practices • Promote community-led development of green spaces, including open spaces, road dividers, and urban parks, while conserving sacred grove practices in peri-urban villages to protect cultural and ecological heritage • Adopt nature-based conservation techniques in the rejuvenation and beautification of lakes and wells • In partnership with local communities and NGOs, explore in-situ bioremediation methods for the Mangrove and Coastal Wetlands Protection programme	• Garden department • Environment department	• Maharashtra Wetland Conservation Strategy • Maharashtra Harit Sena • Sacred Grove Protection Scheme, Maharashtra Forest Department • National Adaptation Plan • Atal Mission for Rejuvenation and Urban Transformation • National Biodiversity Action Plan

Co-benefits: Biodiversity conservation, livelihood enhancement, urban cooling, air quality improvement, and carbon sequestration.

Sources:

1. *Motivations behind gardening in a rapidly urbanizing landscape- A case study of urban gardening in Bangalore, India*
2. *Urban Green Space Management and Planning: A Case Study of Bhubaneswar*



4.5 Mobility and Air Quality

Mira Bhayandar can significantly reduce vehicular emissions and improve air quality by implementing strategies like the Complete Street Concept, which will integrate safe, efficient transportation modes such as walking, cycling, and public transport, while prioritizing green spaces and shading in high-traffic areas. Additionally, creating an emissions inventory will allow the city to track pollution sources and tailor mitigation strategies for cleaner air.

Photo credit: www.freepic.com

4.5.1 Private Transport

Since Mira Bhayandar falls in the Thane district, its vehicle registrations are largely processed at the Thane Regional Transport Office (RTO) because the city had no RTO until recently. In 2020, responding to a long-pending demand, the state government established an RTO subcentre on Ghodbunder Road. The analysis of vehicle registrations across categories between 2015 and 2023 as shown in *Figure 4.5.2* and *Figure 4.5.3* provides valuable insights into fuel-usage patterns, showcasing both the dominance of conventional fuels and the steady transition to low-emission, renewable-energy options, and future mobility trends.

Private vehicles constitute only 21% of the total fleet. The pressure on the public transport systems continues to increase as the city and its population grow. The MBMC is actively working towards increasing the share of eco-friendly public transportation, such as electric and hybrid buses that will be critical for reducing congestion and emissions.

Diesel vehicles are steadily losing their market share. There has been a cumulative drop of over 34% for diesel-run four-wheelers since 2015. It highlights the impact of stricter emission norms and incentives to switch to cleaner alternatives. Electric Vehicles (EV) across both three-wheeler and four-wheeler categories demonstrate the highest growth rates. EV registrations in the four-wheeler category have surged from 1 in 2015 to 489 in 2023. It highlights the impact of favourable government policies and schemes, cost-saving benefits, and growing environmental awareness.

4.5.2 Non-Motorised Transport

A significant 20% of the city's population are pedestrians. 5% of people use bicycles. The average walking distance for commuters is 1.5 kilometres, while cyclists cover around 2 kilometres per trip. However, nearly 60% of the roads have no dedicated footpaths for pedestrians, particularly in densely populated neighbourhoods. There are also no dedicated cycling lanes in the city, which deters residents from switching to this sustainable, eco-friendly, and cost-effective mode of transportation. Dedicated and safe bike parking stations are available at only three locations near major transit hubs with a total capacity for 50 bicycles. There are only 15 marked crosswalks across major intersections, which is insufficient and leads to unsafe road-crossing.

The integration of Non-Motorised Transport (NMT) such as footpaths, crosswalks, and cycle parking stations with the existing public transport infrastructure is crucial. Currently, only 30% of bus stops are accessible by footpaths, which limits the ease of commuters transitioning between walking/cycling and public transport.

The city requires an estimated 12,672 Equivalent Car Spaces (ECS) for on-street parking in the MBMC area, which indicates a high demand for parking solutions.

4.5.3 Public Transport

Mira Bhayandar boasts of a diverse public transportation ecosystem. It is a combination of municipal buses, auto-rickshaws, and an upcoming metro line, which together aim to provide seamless connectivity to residents and visitors.

The integration of Non-Motorised Transport (NMT) such as footpaths, crosswalks, and cycle parking stations with the existing public transport infrastructure is crucial. Currently, only 30% of bus stops are accessible by footpaths, which limits the ease of commuters transitioning between walking/cycling and public transport.

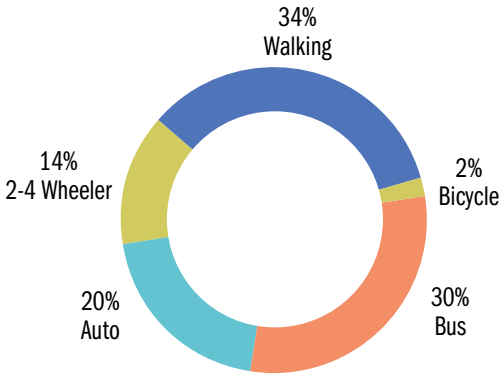


Figure 4.5.1 : Modal Split

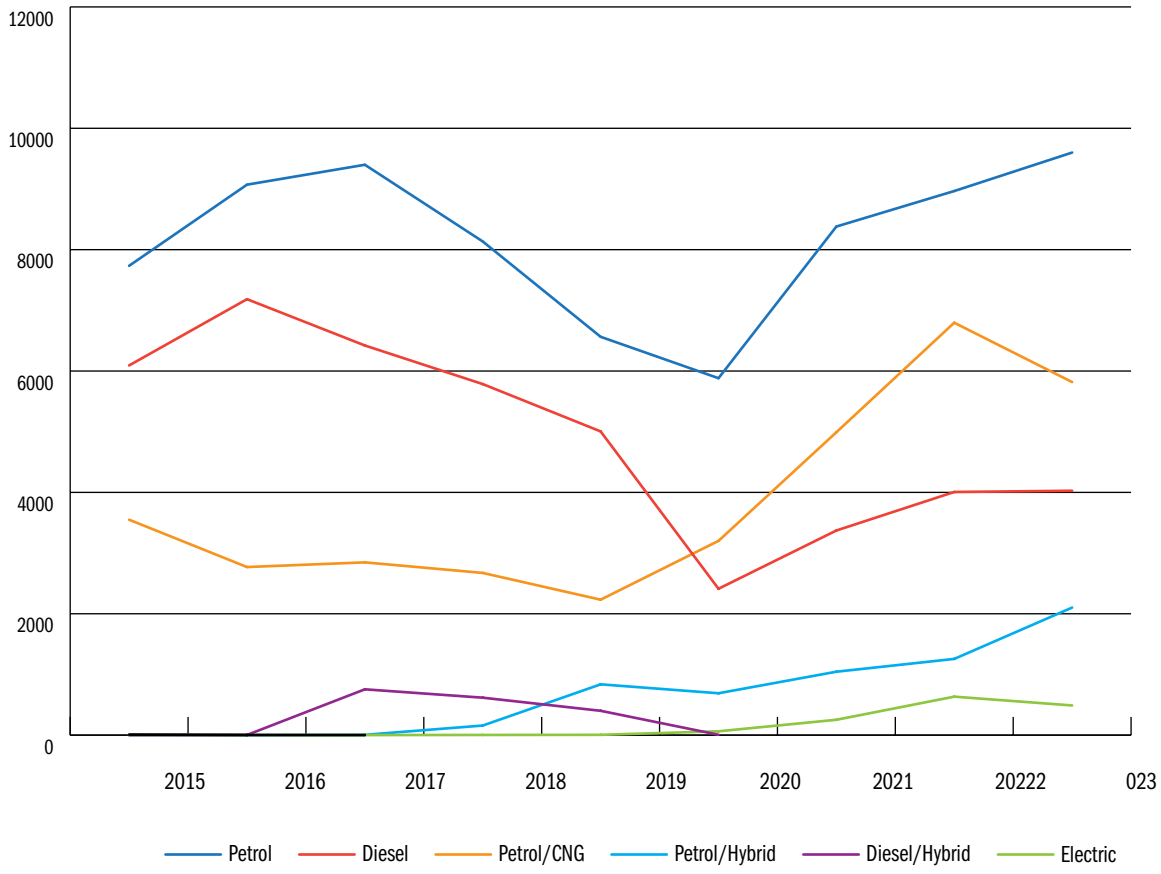


Figure 4.5.2: Trend analysis of different fuel consumption by four-wheelers between 2015 and 2023

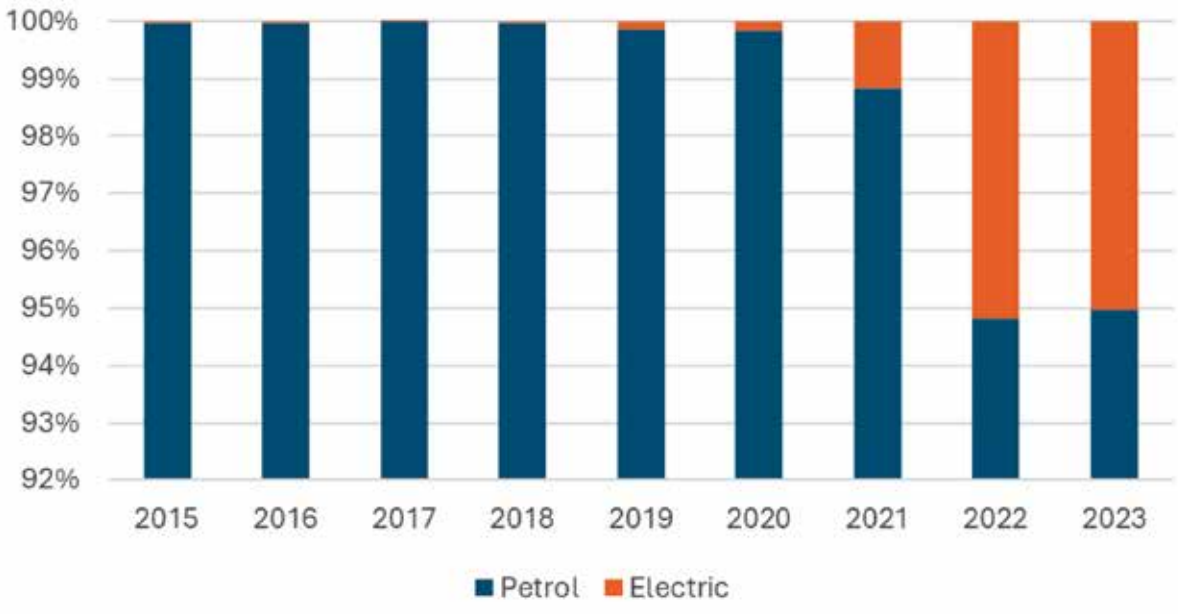


Figure 4.5.3: Trend analysis of different fuel consumption by two-wheelers between 2015 and 2023

4.5.3.1 Mira-Bhayandar Municipal Transport

The Mira-Bhayandar Municipal Transport (MBMT) was established in 2006 as the key public transport provider in the region. It operates 29 bus routes that serve 93 bus stops, offering reliable intra-city and inter-city connections. The routes extend from Ambedkar Nagar to Ghodbunder Gaon and from Bhayandar railway station on the west side to Manori Tar. The city has two primary bus stations, one located in Mira Road and the other in Bhayandar.

The MBMT fleet predominantly comprises diesel and CNG buses. It plans to integrate 42 electric buses into the system by 2030 as part of a green mobility initiative. The total daily movement of passengers across the city, including internal and external trips on roads, highways, and railways, is around 15,00,000, demonstrating the substantial mobility demand for the region.

The Origin-Destination matrix informs that inter-city trips account for 25% of the daily trips facilitated by the MBMT and the intermediate public transport, while trips originating from the MBMC to external locations and vice versa comprise 19%. The national highway 48 that passes through the city's centre accounts for 37% of the daily trips.

4.5.4 Intermediate Public Transport (IPT)

The road network in Mira Bhayandar is 112 kilometres which carries both public and private transport vehicles. CNG-powered auto-rickshaws offer affordable rides that range on average between ₹10 and ₹20 and offer last-mile connectivity.

Metro Connectivity

The upcoming Metro Line 9 is a game-changer for Mira Bhayandar's public transportation. The metro corridor is elevated and spans 10.41 kilometres, connecting Dahisar to Bhayandar (West) with eight stations. It is being developed in two phases:

Phase 1: The Dahisar to Kashigaon line is now 87% complete and is expected to commence operations in June 2025.

Phase 2: The phase connecting Kashigaon to Subhash Chandra Bose Maidan in Bhayandar (West) is expected to be completed by December 2025.

Once fully operational, Metro Line 9 will be a faster, eco-friendly alternative that will significantly reduce on-road traffic congestion. The project includes the construction of 3 flyovers beneath the metro line to further ease vehicular movement.

METRO LINE 9

Metro Line 9 Is A Game-Changer For Mira Bhayandar's Public Transportation

Phase 1: June '25

The Dahisar To Kashigaon Line Is Now 87% Complete

Phase 2: Dec '25

Kashigaon To Subhash Chandra Bose Maidan In Bhayandar Is Expected To Be Completed By December 2025

3 FLYOVERS

Construction Of 3 Flyovers Beneath The Metro Line To Further Ease Vehicular Movement

The MBMT fleet predominantly comprises diesel and CNG buses. It plans to integrate 42 electric buses into the system by 2030 as part of a green mobility initiative planning.

Photo credit: www.freepressjournal.in

4.5.5 Key Priority Actions

4.5.5.1 Complete Street Concept

Integrate all modes of transportation, including walking, cycling, and public transport, with a focus on safety, efficiency, and environmental health.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Ensure that the streets are well-lit, there are frequent seating arrangements, and there is active usage of street-level spaces by businesses such as shops and cafés to increase foot traffic and reduce isolation	Improved air quality	Town planning department	National Clean Air Programme
Design streets with features like ramps, tactile paving, and wide pathways to accommodate wheelchairs, strollers, and individuals with mobility challenges	Enhanced public health	Public works department	Grants or loans under state/ national urban renewal schemes
Involve women, non-binary individuals, and other under-represented groups in the planning process to reflect diverse needs	Increased safety and social inclusion	Electrical works department	
	Increased equity		

ACTION TIMELINE
LONG TERM
(2050)

TARGET SDGS

CSCAF THEME

LEVEL OF AIR POLLUTION, PERCENTAGE OF COVERAGE OF NMT NETWORK (PEDESTRIAN AND BICYCLE IN THE CITY).

4.5.5.2 Walkability and Heat Mitigation for Pedestrians

To improve walkability and mitigate the urban heat island effects, strategic interventions should focus on incorporating shading and greening in areas with high pedestrian activity, such as market streets, transit hubs, and public parks. These measures will enhance thermal comfort and encourage walking.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES
Deploy durable and retractable awnings over sidewalks and shopfronts in commercial area	Improved air quality	Transport department
Replace asphalt with natural paving stones or tiles that absorb less heat and create traditional impervious concrete pavements with permeable materials to reduce heat absorption and improve rainwater infiltration	Enhanced public health	Vehicle department
Set up small, shaded stations in busy zones for pedestrians with water fountains, shaded benches, and cooling features	Increased safety and social inclusion	
Install heat-resistant benches, bollards, and garbage bins made from materials that absorb less heat and remain cool to the touch	Increased equity	

ACTION TIMELINE
LONG TERM
(2050)

TARGET SDGS

CSCAF THEME

PERCENTAGE OF COVERAGE OF NMT NETWORK (PEDESTRIAN AND BICYCLE IN THE CITY)

CASE STUDY:4.5.5.1
PUNE: RECLAIMING STREETS, 1 KILOMETRE AT A TIME

Pune city was ranked as one of the most congested cities globally in 2020, highlighting the urgent need for it to develop improved mobility and public spaces. In response, the city implemented initiatives by partnering with architectural firms to enhance walkability and reclaim public spaces through Complete Street Designs. In total, 9 streets were transformed, including two major commercial streets, Jangali Maharaj Road and Ferguson Road. Four-wheelers and unauthorised activities occupied a significant portion of these streets, leaving limited space for pedestrians. The streetscaping transformed the utility of these roads by widening the footpaths, creating parallel parking spaces to reduce vehicular congestion, adding seating areas with public gym areas, and designating space for street vendors.

CASE STUDY: 4.5.5.2
NON-MOTORISED TRANSPORT NETWORK PLAN FOR COIMBATORE

The lack of a robust Non-Motorised Transport (NMT) infrastructure in Coimbatore, the second-largest city in Tamil Nadu, has raised concerns about the safety of pedestrians and cyclists. Walking and public transport make up 57% of the total trips in the city, and nearly 100,000 people rely on bicycles for their daily commutes. For around 70%, walking and cycling are preferred modes for first-mile and last-mile connectivity. To improve the safety and convenience of NMT users, the Coimbatore City Municipal Corporation developed an NMT Network Plan. It promoted walking and cycling at 26 pedestrian hotspots and proposed a 290-kilometre network of safe, accessible roads for pedestrians and cyclists. The primary objective of this initiative was to create a comprehensive framework that enables Coimbatore to adopt a sustainable, low-carbon mobility future by 2035.

4.5.5.3 Establish Comprehensive Emissions Inventory

At present, Mira Bhayandar does not have a comprehensive emissions inventory. This makes it challenging to identify the main sources of air pollution and take effective action. By creating an inventory, the city can measure emissions from different areas, such as transportation, industries, and waste management. This will help the city decide mitigation strategies, set clear air quality goals, and track progress over time.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Develop an air pollution emissions inventory to identify major pollution sources, establish a baseline for air-quality management, and support the development of targeted mitigation strategies	Improved air quality	Environment department	National Clean Air Programme
Regular updates will help monitor progress and refine policies to achieve cleaner air	Enhanced public health	Town planning department	National Biogas and Manure Management Programme
	Increased safety and social inclusion		Swachh Bharat Mission
	Increased equity		

TARGET SDGS: 3, 11, 13

CSCAF THEME: LEVEL OF AIR POLLUTION, CLEAN AIR ACTION PLAN (PLANNING AND IMPLEMENTATION)

ACTION TIMELINE: MID TERM (2040)

4.5.6 Recommendations in Urban Flooding Management

EV CHARGING STATIONS — ACTION TIMELINE: MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Develop public EV charging stations on government land under a revenue-sharing model, in partnership with private entities • The initiative will increase accessibility to EV infrastructure, accelerate EV adoption, and generate revenue for the government • Install additional dust monitoring stations to track PM10 and PM2.5 levels	• Electrical works department • Private agencies	• Faster Adoption and Manufacturing of Electric Vehicles (FAME) • National Electric Mobility Mission Plan • Smart Cities Mission

Co-benefits: Reduced incidence of respiratory diseases, improved visibility, reduced urban heat island effect, conservation of biodiversity in affected areas, and enhanced liveability and comfort.

AIR QUALITY MONITORING STATION — ACTION TIMELINE: SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Install more air-quality monitoring stations under the National Air Quality Monitoring Programme. Currently, the city has only 1. These stations, located in high-traffic areas, industrial zones, and residential neighbourhoods will enable a comprehensive database	• Environment department • Town planning department • Traffic Department	• National Clean Air Programme

Co-benefits: Health benefits, and improved air quality.

Implement a time-based, variable parking mechanism and zonal parking pricing in the various parking zones that are determined by traffic density, land use, and the accessibility of public transport. High-density areas will have higher parking charges, whereas peripheral zones would have lower rates.

VARIABLE PARKING MECHANISM

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Implement a time-based, variable parking mechanism and zonal parking pricing in the various parking zones that are determined by traffic density, land use, and the accessibility of public transport. High-density areas will have higher parking charges, whereas peripheral zones would have lower rates	NA	• Smart Cities Mission • National Urban Transport Policy

Co-benefits: Reduced traffic congestion, improved air quality, revenue generation, and behavioural shift.

DESIGNATED HAWKING ZONES

ACTION TIMELINE
SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Conduct surveys to map areas with the highest vendor density, such as markets in Bhayandar (West), Mira Road station, and commercial zones like Shanti Nagar and Kanakia Road • Prioritise zones where street vending obstructs pedestrian movement and creates traffic bottlenecks • Allocate designated vending zones with clear boundaries near market hubs, malls, and railway stations • Include essential facilities like shaded areas, drinking water, waste bins, and public restrooms to support vendors and customers • Install signage to guide pedestrians to these designated vending areas • Sanction permits for vendors operating in designated zones to prevent overcrowding and illegal vending	• National Association of Street Vendors of India • Police departments • Traffic management authorities	• The Street Vendors (Protection of Livelihood and Regulation of Street Vending) Act, 2014 • Smart Cities Mission • Atal Mission for Rejuvenation and Urban Transformation

Co-benefits: less traffic congestion on roads, smooth movement of pedestrians, protecting livelihoods of vendors and their dignity.

REGULATIONS ON PARKING SPACE

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Introduce regulations that require proof of adequate parking space to own vehicles and discourage unnecessary purchases • Designate certain roads as car-free zones on specific days to promote walking, cycling, and public transport usage • Allow parking only in designated areas, eliminating illegal parking that often contributes to congestion and environmental degradation	• Transport Department	• National Urban Transport Policy • Faster Adoption and Manufacturing of Electric Vehicles (FAME) • Smart Cities Mission

Co-benefits: Reduced air pollution, less congestion, encouragement for public transport, and improved urban aesthetics.

EV CHARGING INFRASTRUCTURE

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES

• Provide dedicated parking spaces with integrated charging facilities at high-traffic and accessible locations such as:
  • Commercial hubs
  • Public parking lots
  • Airports and railway stations
  • Residential neighbourhoods
• Offer subsidised parking rates to incentivise EV ownership and usage
• Power charging stations with renewable energy sources, like solar panels, can be established to reduce dependence on non-renewable energy
	• Town planning department
	• Revenue department
		NA

Co-benefits: Reduction in air pollution and greenhouse gas emissions, promotion of green jobs, and support for seamless transition to EVs.

NON-MOTORISED TRANSPORT

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Implement continuous and well-marked cycle lanes to encourage cycling as a viable commuting option • Develop and maintain well-lit, clean, and safe pathways for pedestrians and cyclists • Remove encroachments on footpaths and cycle tracks to ensure safe usage • Engage local experts and community members to ensure inclusive planning and consistent maintenance	• Transport department • Town planning department • Public works department	• National Urban Transport Policy • Atal Mission for Rejuvenation and Urban Transformation • Smart Cities Mission

Co-benefits: Reduced traffic congestion, enhanced health, improved air quality, and increased accessibility.

FREIGHT TRANSPORT

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES

• Conduct a comprehensive freight movement study to understand the logistics landscape in Mira Bhayandar. The study should map out:
  1. Freight movement patterns across different zones
  2. Types of vehicles – light, medium, or heavy-duty
  3. Fuel usage trends and associated greenhouse gas emissions
  4. Routes with high freight activity or congestion hotspots
• Launch pilot projects focused on electrifying municipal service fleets
• Accelerate the transition to EVs by offering a comprehensive incentive package
	• Transport department
	• Revenue department
		NA

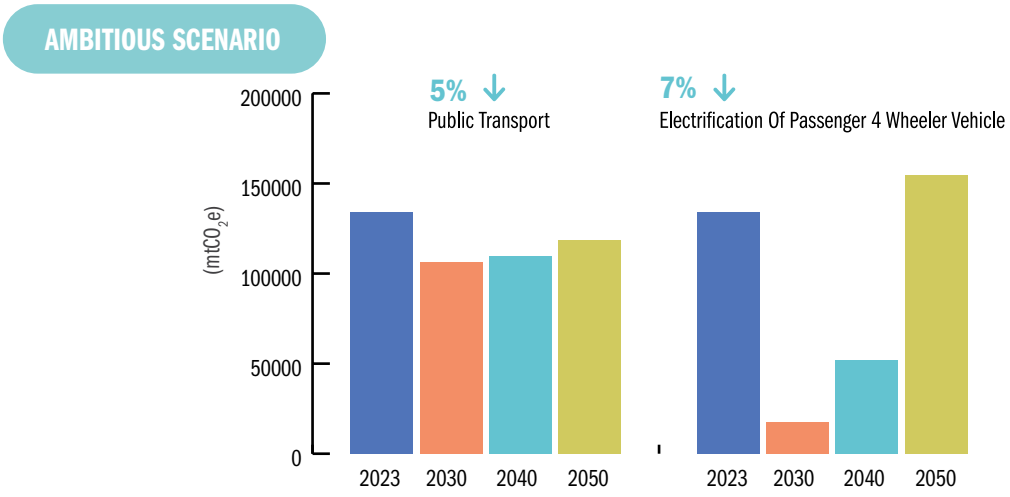
Co-benefits: Reduced traffic congestion, enhanced health, improved air quality, and increased accessibility.

ELECTRIC THREE-WHEELER AUTO-RICKSHAWS

ACTION TIMELINE
MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Offer upfront purchase subsidies, battery-swapping station subsidies, or interest-free loans to the customers • Establish fast-charging technology hubs near high-traffic areas such as public transport nodes, markets, and residential zones to minimise downtime for drivers • Incentivise private players to develop battery-swapping networks, reducing operational delays for e-auto drivers • Develop an integrated fare system allowing passengers to seamlessly transfer between e-autos and public transport, potentially leveraging QR codes or mobility cards	NA	• Faster Adoption and Manufacturing of Electric Vehicles (FAME) • National Electric Mobility Mission Plan • Atal Mission for Rejuvenation and Urban Transformation • National Clean Air Programme

Co-benefits: Reduced tailpipe emissions, lowered operating costs, improved driver income, and enhanced accessibility.



MOBILITY AND AIR QUALITY REDUCTION MEASURES ($mtCO_2e$)

Photo credit: Youth Conclave Students | SPA Bhopal

Source:

1. *MBMC Mobility Plan 2023-2053*
2. *Pune's "Reclaiming Streets, 1 Kilometer at a time"*
3. *A Sustainable Asset Valuation of Non-Motorized Transport in Coimbatore, India*

4.6 Waste Management

Mira Bhayandar can significantly reduce its emissions from waste by implementing strategies to manage construction and demolition (C&D) waste. By mandating the use of recycled C&D materials in municipal contracts, offering incentives to contractors, and implementing traceability systems like QR codes, the city can reduce landfill diversion and conserve resources. Additionally, establishing scheduled collection days for bulky furniture waste will reduce landfill pressure and promote responsible disposal and recycling.

Photo credit: www.freepik.com

4.6.1 Waste Collection and Generation

Mira Bhayandar generates approximately 650 tonnes of waste daily, which amounts to 569 grams per capita per day for residents and 284.50 grams per capita per day for the floating population. The major sources of solid waste include households, fresh produce markets, meat and chicken shops, hotels, commercial establishments, schools, colleges, and other institutions. Residential areas, colonies, and apartment complexes generate 82% of the total waste, whereas commercial and market areas contribute 16% and 2%, respectively.

The city has an efficient waste management system and ODF++ status (Swachh Survekshan, 2021). Its generated waste is predominantly wet, consisting of food and organic waste, which accounts for 61.18% of the total waste. Plastics, including plastic bags, account for 10.69%, while miscellaneous inert materials such as ash, soil, and silt constitute 11.42%. Paper waste contributes 8.68%, and horticulture waste and wood make up 5.76%, which could be composted or reused by recovering the resources. Glass and metals (1.62%), leather, rubber, synthetics (0.69%), tetra packs and laminated plastics (2.52%), and clothes and rags (3.20%) hold minor shares in the total waste generation. The waste composition emphasises the need for targeted strategies to effectively manage wet waste (food and organic content) and undertake measures to reduce plastic waste and recycle or repurpose other materials.

The waste collection system is primarily door-to-door, and the city is bin-free. However, occasional dump points are found near markets, railway stations, transit points, and other areas where there is heavy footfall. The waste is being collected by the Mira Bhayandar Municipal Corporation (MBMC) in two categories — wet and dry — using a QR-based system, although this system does not cover the slum areas and few other pockets. An online database stores all waste-related data to aid in solid waste management planning. Street sweeping is conducted in two shifts: from 7:00 am to 10:30 am and from 2:30 pm to 6:30 pm.

4.6.2 Wet Waste

Biodegradable wet waste, including food and garden waste account for 61.18% of the total waste. Saurashtra Enviro Projects Private Limited is responsible for managing and processing this waste on a Design, Build, Finance, Operate, and Transfer (DBFOT) basis. However, the city has the potential to scale up composting operations, given the immense amount of wet waste generated daily; it currently composts only 10% of the total waste.

The MBMC has operationalised four of the seven biogas plants by leveraging a bio-methanation technology developed by the Bhabha Atomic Research Centre. These plants collectively

The waste collection system is primarily door-to-door, and the city is bin-free. However, occasional dump points are found near markets, railway stations, transit points, and other areas where there is heavy footfall.

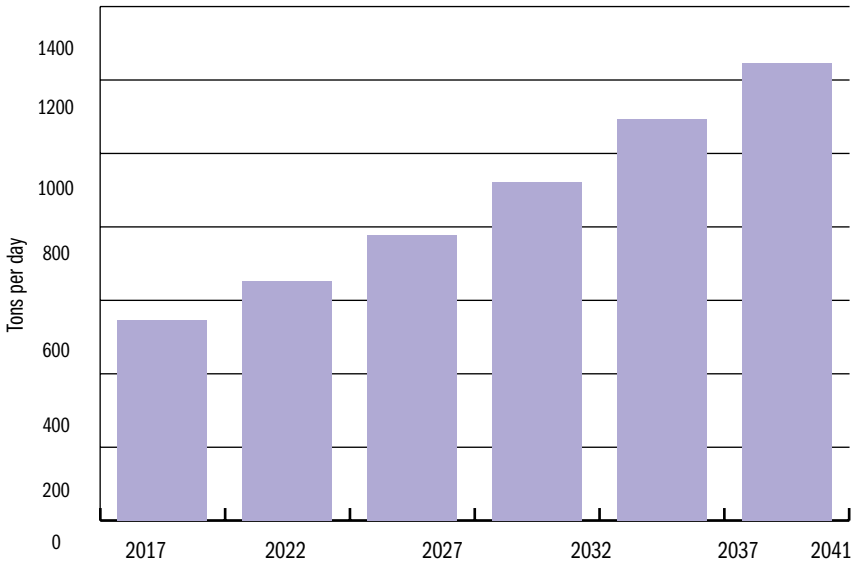


Figure 4.6.1: Projections in waste generation (TPD) from 2017 to 2041
Source - *Solid Waste Management, DPR 2019*

recycle 50 tonnes of wet garbage daily, generating 275 kVA of electricity. The city administration plans to expand the capacity to 100 tonnes and 575 kVA across all seven plants. The decentralised model not only reduces waste transportation costs but also enables the facility to operate sustainably using the generated electricity. The municipality uses the compost as manure and distributes it to citizens via women's self-help groups. The MBMC aims to transmit surplus energy to the grid, promoting the use of renewable energy, energy efficiency, and cost savings.

The city has also implemented innovative strategies like the 'On-the-Go Composting' programme, which utilises mobile tow-go vans to convert wet waste into compost while simultaneously collecting garbage throughout the city. These vans are CNG- and solar-powered with a carrying capacity of 1.5 tonnes of waste daily. Other initiatives include collecting the waste oil from the restaurant and discharging the liquid waste into the nallahs after treatment. At present, there is no mechanism to manage the 5 tonnes of poultry waste produced per day, but the MBMC is keen on tackling the challenge.

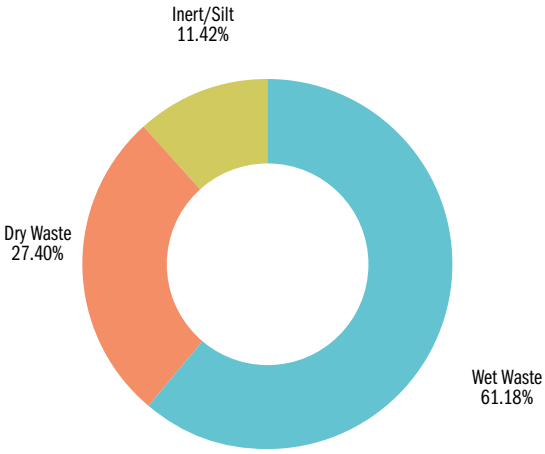


Figure 4.6.2: Waste Composition
Source - *Solid Waste Management, DPR 2019*

The MBMC has operationalised four of the seven biogas plants by leveraging a bio-methanation technology developed by the Bhabha Atomic Research Centre. These plants collectively recycle 50 tonnes of wet garbage daily, generating 275 kVA of electricity. The city administration plans to expand the capacity to 100 tonnes and 575 kVA across all seven plants.

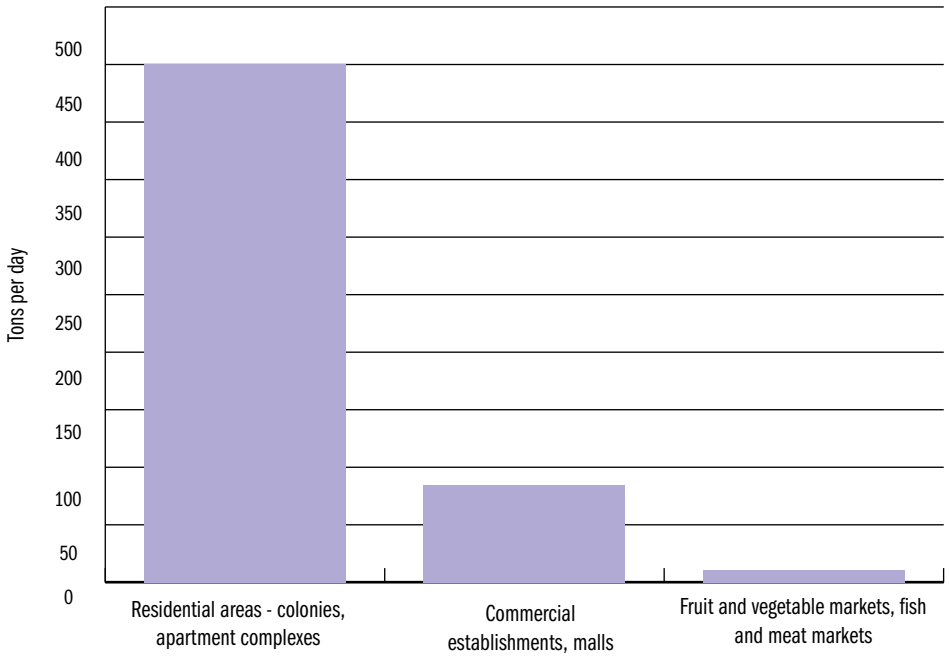


Figure 4.6.3: Waste Generation (TPD)
Source - *Solid Waste Management, DPR 2019*

Mira Bhayandar uses the Supervisory Control and Data Acquisition (SCADA) technology to optimise the sewage treatment infrastructure, achieving a 42% cost reduction and a savings of 4.61 crore annually to the administration. The technology enables real-time monitoring, which supports efficiency in operations and water reuse through a tertiary treatment plant for non-potable applications.

4.6.3 Dry Waste

The non-biodegradable dry waste accounts for 27.40% of the total, consisting of materials such as paper, plastic, cloth, and other recyclables. A substantial portion of the dry waste is informally recycled by the unorganised sectors. The data available on these activities is limited. The city has entrusted the dry waste processing to Saurashtra Enviro Projects Private Limited. The primary processing facility in Uttan receives 150 tonnes of segregated waste daily, and a portion of it is converted into refuse-derived fuel for the Ultratech Cement Company.

4.6.4 Hazardous Waste

The city collects and treats hazardous and mixed waste through a plasma technology-based plant, which has an installed capacity of 8 tonnes. With an investment of ₹8.27 crore, the project processes 8 tonnes of waste daily at a facility in Dhaavgi village, Uttan. The innovative thermal treatment technology produces fewer harmful by-products and transforms the waste into 7% ash, a valuable resource for construction materials like cement and pavement blocks. This initiative will not only help the city in managing hazardous and mixed waste but also address the challenge of limited space and harmful emissions into the air.

4.6.5 Waste Transportation and Disposal

Municipal solid waste is collected using diesel-operated vehicles, but the city lacks transfer stations, which increases its transportation costs and reduces efficiency in waste handling. Presently, the waste is directly transported to the dumping site at Uttan.

A majority of the waste ends up in the landfills, but the city administration can explore alternatives like composting and recycling to achieve zero waste to landfills. There are challenges in managing leachate from garbage hills, which impacts local farms and pollutes nearby water bodies. Additionally, the absence of a comprehensive construction and demolition waste management strategy has led to illegal dumping near wetlands and public spaces.

4.6.6 Wastewater

The city has 10 Sewage Treatment Plants (STP), 8 of which are operational. They collectively treat 110.5 MLD which includes a tertiary treatment plant of 5 MLD capacity. These plants are stationed at different parts of the 107-kilometre drainage network. Although, the total installed capacity of the 10 STPs is 128 MLD, there exists a gap of 17.5 MLD in the existing treatment capacity. The administration has budgeted for installing an STP with a loading capacity of 48 MLD and it is currently under construction.

Moreover, Mira Bhayandar uses the Supervisory Control and Data Acquisition (SCADA) technology to optimise the sewage treatment infrastructure, achieving a 42% cost reduction and a savings of ₹4.61 crore annually to the administration. The technology enables real-time monitoring, which supports efficiency in operations and water reuse through a tertiary treatment plant for non-potable applications.


Photo Credit: AKAH

Photo by: Vikrant Harankhede

4.6.7 Key Priority Actions

4.6.7.1 Construction and Demolition Waste

Construction and demolition (C&D) waste accounts for nearly half the solid waste generated globally each year. This type of waste includes materials such as concrete, wood, metals, glass, and plastics, which are produced during the construction, renovation, and demolition of buildings and infrastructure. At present, Mira Bhayandar lacks a comprehensive strategy to manage this waste.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Include clauses in municipal and government contracts mandating a minimum percentage of recycled C&D materials for construction projects	Landfill diversion	Solid waste management department	Construction and Demolition Waste Management Rules, 2016
Offer financial incentives or tax rebates for contractors and developers using recycled C&D materials	Resource conservation	Maharashtra Pollution Control Board	National Resource Efficiency Policy, 2019
Implement QR codes on C&D waste trolleys to track the source, quantity, and destination of waste	Cost efficiency for projects	Public works department	Swachh Bharat Mission

Indicators to track progress:

- Quantity of recycled C&D waste
- Volume of C&D waste reused or recycled annually
- Recycling rate of C&D waste
- Number of projects using recycled C&D materials;
- Reduction in C&D waste at dumping sites

TARGET SDGS: 9, 11, 12, 13, 15

CSCAF THEME: C&D WASTE MANAGEMENT

ACTION TIMELINE: MID TERM (2040)

4.6.7.2 Furniture Waste

The management of bulky furniture waste in Mira Bhayandar is a pressing issue for the city administration.

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Establish specific monthly collection days for registered bulky furniture waste, ensuring items are segregated for reuse, recycling, or pro-cessing into biochar and compost to decrease landfill pressure	Landfill pressure reduction	Solid waste management department	Solid Waste Management Rules, 2016
Implement scheduled collection days so that residents can plan ahead and ensure that bulky items are disposed of responsibly rather than being left on sidewalks or in yards	Resource recovery		National Biogas and Manure Management Programme
	Environmental improvement		Swachh Bharat Mission 2.0
	Community awareness		
	Employment opportunities		

Indicators to track progress:

- Monthly Collection Rate: Percentage of
- households participating in bulky furniture waste collection days
- Waste Diversion: Amount of furniture waste diverted from landfills and processed

TARGET SDGS: 11, 12, 13, 15

CSCAF THEME: EXTENT OF DRY & WET WASTE PROCESSED

ACTION TIMELINE: SHORT TERM (2030)

CASE STUDY: 4.6.7.1
COCONUT WASTE RECYCLING

The MBMC established a mini processing unit in Bhayandar to recycle leftover tender coconut shells. This unit converts the shells into organic manure and coir ropes, adhering to sustainable waste management practices. With a capacity to process 40 tonnes of coconut shells, the initiative aims to reduce the burden on dumping grounds while producing valuable by-products for societal benefit. Recognising the project's impact, the MBMC has provided space and infrastructure to enhance recycling operations.[1]

1 From Coconut to Coco Peat: The Manufacturing Process

CASE STUDY: 4.6.7.2
RRR INITIATIVE

The MBMC has launched a Reduce, Reuse, and Recycle (RRR) initiative, setting up 24 centres across the city to encourage sustainable waste management. These centres collect items such as old clothes, books, toys, and e-waste for refurbishment or recycling and later distribute them to those in need. A mobile RRR van complements the effort, promoting community participation and environmental conservation. This initiative, a part of the Swachh Bharat Mission-Urban 2.0, aligns with fostering sustainable living habits and reducing waste generation.[1]

1 Mira-Bhayandar: MBMC sets up six 'reduce, reuse and recycle' units at ward level

Establish designated collection points at poultry markets and shops with a daily collection schedule, using specialised vehicles to process collected waste through composting for organic fertiliser and anaerobic digestion for biogas production

4.6.7.3 Poultry Waste

The management of poultry waste in Mira Bhayandar is currently inadequate, with no established mechanism to treat it. Poultry markets and shops generate significant amounts of organic waste, which, if not properly managed, can lead to public nuisance, environmental pollution, and health hazards

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Establish designated collection points at poultry markets and shops with a daily collection schedule, using specialised vehicles to process collected waste through composting for organic fertiliser and anaerobic digestion for biogas production	Reduced environmental pollution Improved public health	Solid waste management department	Solid Waste Management Rules, 2016 National Biogas and Manure Management Programme Swachh Bharat Mission

Indicators to track progress: Percentage of collected poultry waste processed through composting or anaerobic digestion

TARGET SDGS: 3, 6, 7, 11, 13

CSCAF THEME: EXTENT OF WET WASTE PROCESSED

ACTION TIMELINE: MID TERM (2040)

4.6.7.4 Biogas for Waste Collection

Currently the city has biogas plants of 50 tonnes and utilises the generated electricity to run the facility operations. There is a scope for the city administration to use the generated electricity to run waste collection vehicles and earn revenues

ACTIONABLE STEPS	CO-BENEFITS OF ACTION	CONCERNED AGENCIES	ALIGNED SCHEMES
Install purification systems to upgrade raw biogas to biomethane by removing impurities such as carbon dioxide and hydrogen sulphide, making it suitable for vehicle use Retrofit existing waste collection vehicles to run on Compressed Biogas (CBG) instead of diesel	Energy generation from renewable sources Processing of organic wet waste	Solid waste management department	Sustainable Alternative Towards Affordable Transportation Swachh Bharat Mission

TARGET SDGS: 7

CSCAF THEME: EXTENT OF WET WASTE PROCESSED

ACTION TIMELINE: MID TERM (2040)

4.6.8 Recommendations in Waste Management

STRATEGIES FOR DUST MANAGEMENT

ACTION TIMELINE SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Effective dust management in Mira Bhayandar is essential to address air quality concerns caused by particulate matter (PM10 and PM2.5) emissions **1. Construction dust control:** • Enforce the covering of construction and demolition sites with tarpaulin or similar materials • Use water sprinklers and fog cannons to suppress dust at construction sites • Mandate daily water sprinkling during active construction phases and temporary storage for C&D waste to avoid scattering • Use GPS-enabled vehicles for proper transportation of C&D waste to designated sites **2. Road dust management:** • Prioritise paving all unpaved roads to minimise dust from vehicular movement • Deploy mechanised sweepers with High Efficiency Particulate Air (HEPA) filters for regular cleaning of major roads and intersections • Use tanker trucks with spray nozzles for daily water sprinkling on major dust-generating roads **3. Green barriers and landscaping:** • Prioritise planting dust-tolerant native species like neem, focus, and cassia • Convert vacant plots into temporary green spaces to prevent loose soil from becoming airborne **4. Policy and enforcement:** • Introduce penalties for non-compliance, such as failure to cover materials or improper waste disposal **5.** Install additional dust monitoring stations to track PM10 and PM2.5 levels	• Solid waste department	• Construction and Demolition (C&D) Waste Management Rules, 2016

Co-benefits: Reduced incidence of respiratory diseases, improved visibility, reduced urban heat island effect, conservation of biodiversity in affected areas, and enhanced liveability and comfort.

EXTENDED PRODUCER RESPONSIBILITY FOR WASTEWATER

ACTION TIMELINE SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
1. Mandate for new and existing housing societies: • Mandate to install and operate on-site decentralised wastewater treatment for new societies with high water consumption (>5,000 litres/day) and introduce a minimum wastewater reuse target • Existing Societies should be encouraged to obtain treated water from centralised facilities and procure Extended Producer Responsibility (EPR) certificates **2. Mandate for industries:** • Meet reuse targets based on total water consumption • Report freshwater usage, wastewater treatment, and reuse annually • Create a dedicated platform to monitor and ensure compliance with water consumption, wastewater generation, treatment, and reuse data • Provide incentives or subsidies for treated wastewater adoption, such as reduced water tariffs or EPR certification benefits • Plan and establish satellite STPs for zones with high residential or industrial densities • Implement penalties for non-compliance or delay in achieving reuse targets • Treated water must meet both the central and the state pollution board standards	• Solid waste department	• Construction and Demolition (C&D) Waste Management Rules, 2016

Co-benefits: Reduced incidence of respiratory diseases, improved visibility, reduced urban heat island effect, conservation of biodiversity in affected areas, and enhanced liveability and comfort.

Set up small Materials Recovery Facilities (MRF) and waste collection centres in designated wards, establishing a local buyer network for recyclable materials such as glass and paper. Power these centres with solar energy to reduce carbon emissions, and consider a mobile MRF facility to offer flexible, decentralised waste management solutions.

SETTING UP OF MRF CENTRES

ACTION TIMELINE MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
Set up small Materials Recovery Facilities (MRF) and waste collection centres in designated wards, establishing a local buyer network for recyclable materials such as glass and paper. Power these centres with solar energy to reduce carbon emissions, and consider a mobile MRF facility to offer flexible, decentralised waste management solutions	• Solid waste department	• Swachh Bharat Mission (Urban)

Co-benefits: Landfill diversion, increased recycling rates, economic growth and job creation, and community empowerment.

BULK WASTE GENERATOR

ACTION TIMELINE SHORT TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Bulk waste generators (BWG) should segregate waste at the source into categories such as wet, dry, e-waste, and hazardous waste • Encourage BWGs to set up composting units or biogas plants for wet waste and partner with authorised recyclers for dry and e-waste • Revise municipal waste management by-laws to redefine BWGs as entities generating 50 kg or more waste per day	• Solid waste department	• Swachh Bharat Mission

E-WASTE MANAGEMENT POLICY

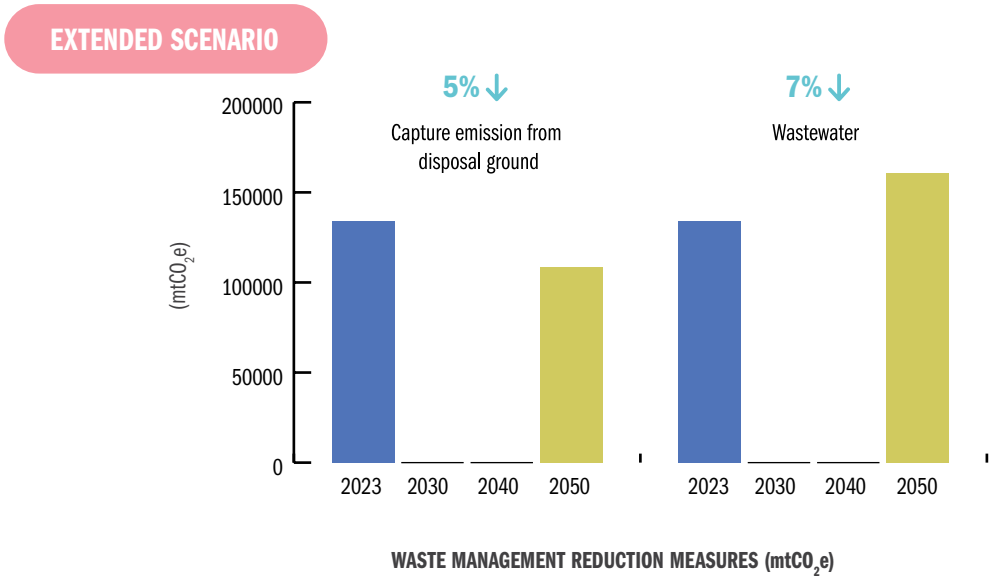
ACTION TIMELINE MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES	ACTION PLANS:
• Develop city-wide e-waste collection centres to accept batteries, electric vehicle (EV) components, and other electronic waste • Partner with certified recyclers to process and safely extract materials such as lithium, cobalt, and nickel from EV batteries • Mandate Extended Producer Responsibility (EPR) for EV manufacturers to ensure safe disposal and recycling of their products • Regularly track e-waste volumes, collection rates, and recycling efficiencies especially from the commercial buildings	• Solid waste department	• Swachh Bharat Mission	**1. Short Term (0–3 years):** • Set up pilot collection centres and recycling units • Partner with EV manufacturers for EPR compliance **2. Medium Term (3–7 years):** • Expand infrastructure to ensure city-wide coverage • Develop policies for sustainable sourcing and recycling incentives **3. Long Term (7+years):** • Integrate e-waste management into city planning and smart city frameworks

COMPREHENSIVE WASTEWATER MANAGEMENT AND SUSTAINABLE SLUDGE TREATMENT STRATEGY

ACTION TIMELINE MID TERM

RECOMMENDATION	RESPONSIBLE AGENCY	ALIGNED SCHEMES/POLICIES
• Ensure 100% coverage within the city limits with a fully closed and underground sewer collection network • Transition all domestic wastewater treatment plants to aerobic systems either by constructing new or upgrading existing anaerobic STPs • Maintain and regularly operating sludge removal systems in all STPs, with the collected sludge repurposed for bio-methanation or compost production. • Ensure proper and safe disposal of sludge to reduce environmental impact (National Policy on Faecal Sludge and Septage Management, 2017)	• Environmental department	• Atal Mission for Rejuvenation and Urban Transformation • Swachh Bharat Mission • National Policy on Faecal Sludge and Septage Management 2017, National Urban Sanitation Policy

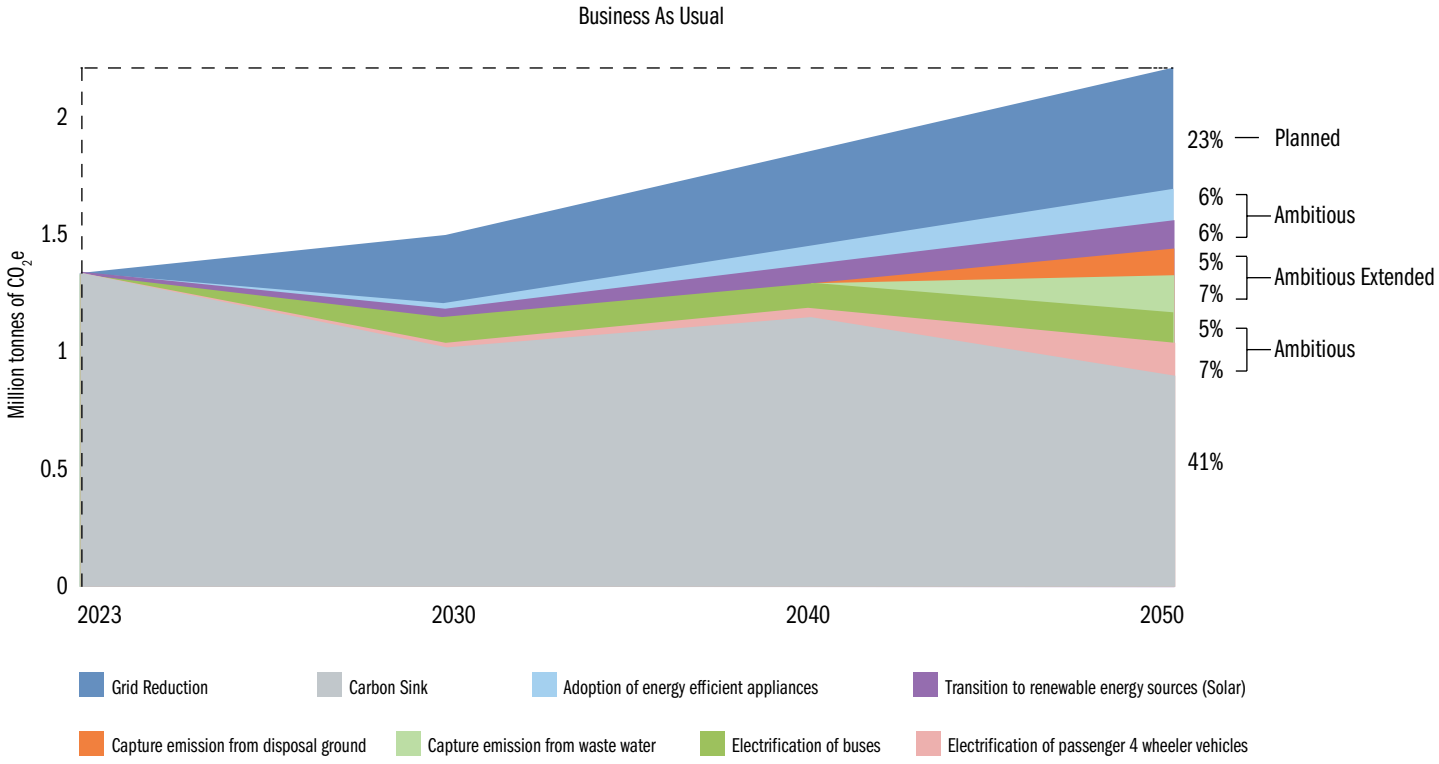


Sources:

1. *Solid Waste Management Detailed Project Report for Mira Bhayandar*
2. *Mira- Bhayandar: MBMC Aims To Save More Than ₹ 4.61 Crore Annually With SCADA System*
3. *Mira-Bhayandar: MBMC sets up six 'reduce, reuse and recycle' units at ward level*

4.7 Summary of Mitigation Actions

Photo credit: www.downtoearth.org.in



Summary of Mitigation Actions

In order to meet the internationally agreed-upon goal of net-zero emissions by 2050, there are a number of key priority actions and recommendations broken down by sector that could help lower greenhouse gas emissions.

Owing to limitations in methodology and data, the Mira Bhayandar Climate Action Plan has only enumerated the mitigation potential of 7 recommendations, further classifying them into the following three scenarios.

- **Planned Scenarios:** These consider the effect of ongoing city actions in keeping with the regional and national policies that are already in force. In India, grid electricity relies heavily on coal, resulting in a high emission factor of 0.716 tons per MWh. However, the Central Electricity Authority of India projects this to decrease to 0.477 tons per MWh by 2029-30 due to a national shift toward renewable energy. While this transition is outside the city's direct control, Mira Bhayandar can support these efforts by enhancing its local energy mix and reducing 23% of its emissions by 2050.
- **Ambitious Scenarios:** These include the most ambitious yet achievable strategies for the city, over and above the planned scenarios. They aim to further reduce emissions by 24% by 2050 through measures such as the accelerating rooftop solar adoption across residential, commercial, and industrial buildings, solarising municipal infrastructure like streetlights and facilities and promoting energy-efficient appliances such as BLDC fans and BEE star-rated devices. These scenarios also recommend large-scale solar energy adoption and comprehensive electrification of private and public transport systems.
- **Extended Ambitious Scenarios:** The development of these scenarios stemmed from the understanding that the ambitious scenarios alone were insufficient to achieve the net-zero target by 2050. These scenarios include those which are currently not feasible due to political, legal, economic, social, and technical barriers. Here, it includes strategies like capturing emissions from the waste sector, contributing an additional 12% reduction.

5 Conclusion

The vision of the Mira Bhayandar Climate Action Plan is to transform Mira Bhayandar into a futuristic, sustainable, and resilient city by 2047, aligning with India's broader net-zero goals.

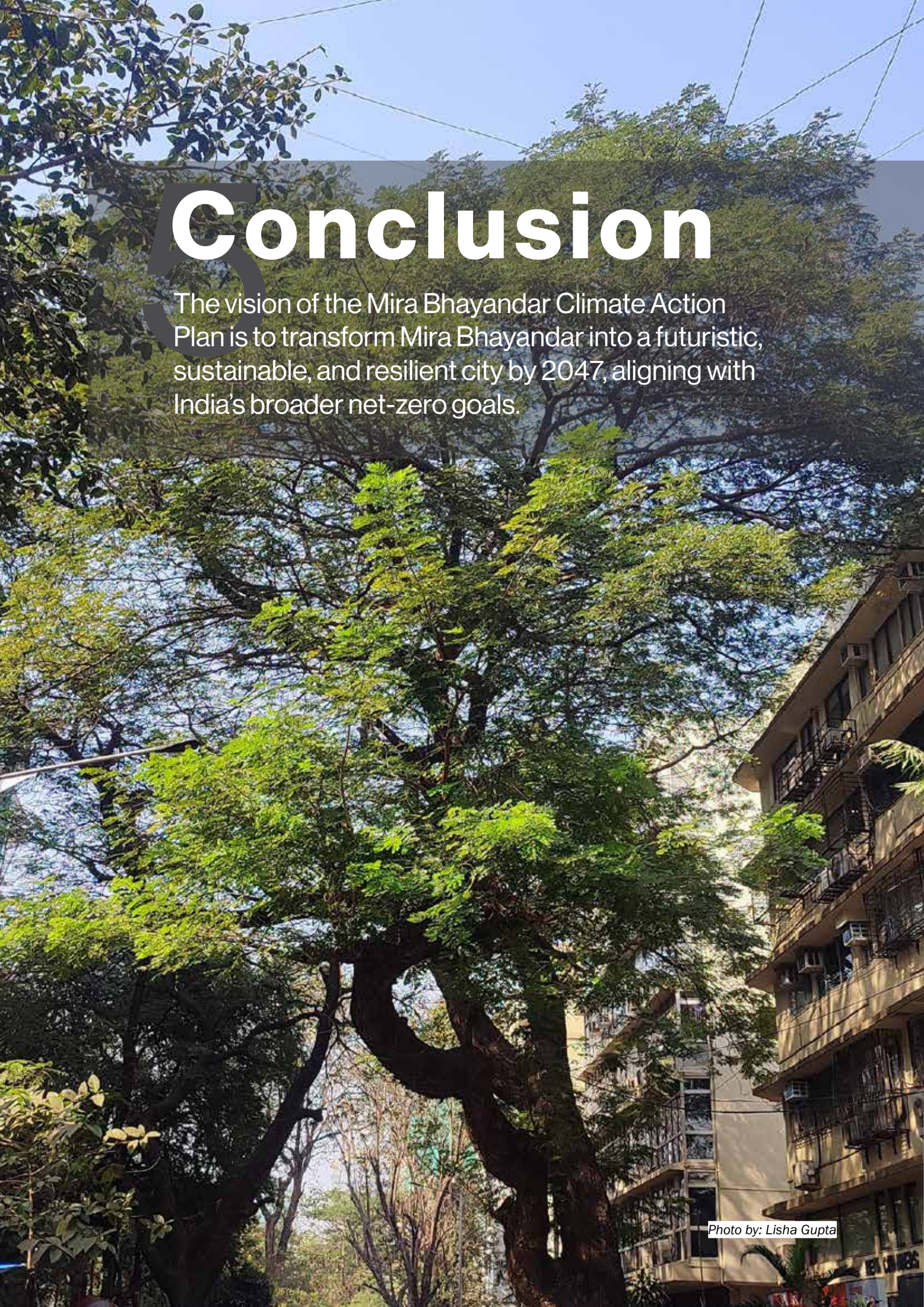


Photo by: Lisha Gupta

Conclusion

The Mira Bhayandar Climate Action Plan (MBMCCAP) 2024-2047 is a significant initiative aimed at creating a resilient and sustainable urban environment by addressing the multifaceted challenges posed by climate change. The plan outlines actionable solutions to effectively mitigate and adapt to climate impacts by analysing Greenhouse Gas (GHG) emissions, climate hazards, vulnerabilities, risks, exposures, and sector-specific scenarios. The GHG inventory highlights the primary sources of emissions. Stationary energy accounts for 62%, largely for residential electricity consumption. Transportation contributes 22%, reflecting a dependency on fossil fuels, and waste management adds 16%. These emissions persist despite the adoption of renewable energy, the enhancement of energy efficiency, and the improvement of waste management practices.

Mira Bhayandar faces multiple climate hazards, including the Urban Heat Island (UHIs) effect, flooding, and coastal risks. Rapid urbanisation and vegetation loss have exacerbated the UHI effect; densely built-up areas are experiencing elevated temperatures. The city also faces issues of waterlogging every year caused by the ageing drainage system that bears structural inefficiencies. The socially and geographically marginalized populations, especially those in informal settlements near water bodies and forest peripheries, are most at risk due to inadequate infrastructure and limited adaptive capacity. A rapid climate risk assessment reveals that densely populated wards and regions with high building density face heightened vulnerabilities due to inadequate public infrastructure such as access to public transportation, educational institutes, open spaces, healthcare, and socio-economic disparities. These systemic inequalities can be addressed through inclusive urban planning and community-focussed interventions, which are critical to build resilience.

The energy sector's reliance on traditional sources necessitates an urgent need to transition to renewable energy. The recommendations include developing a city-level solar policy, adopting public-private partnership models for rooftop solar, and retrofitting buildings with energy-efficient technologies. Promoting low-carbon construction practices and implementing district cooling systems can further reduce emissions. Equitable water management strategies, such as increased wastewater recycling, modernised infrastructure, and rainwater harvesting, aim to conserve resources and mitigate urban flooding.

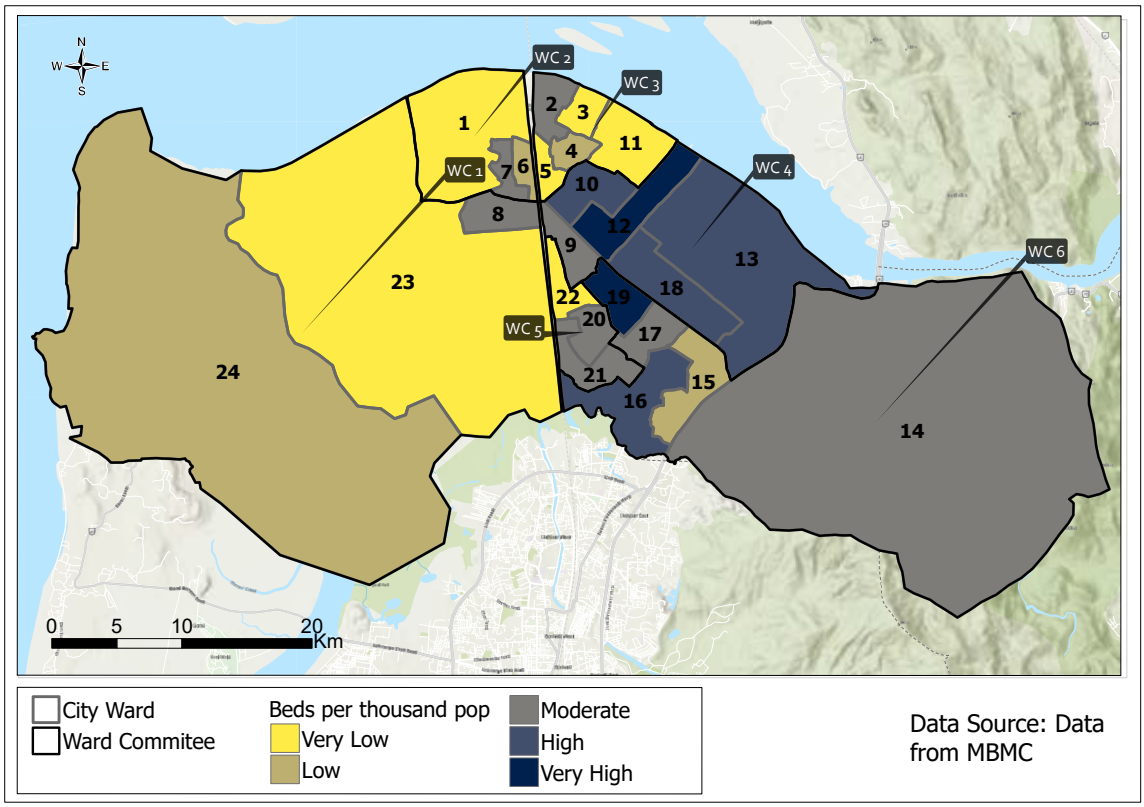
To address the year-on-year basis of urban flooding, the city is required to upgrade its stormwater drainage systems, enhance green cover to absorb runoff, and adopt nature-based solutions like mangrove restoration. These measures can mitigate waterlogging, reduce associated economic losses, and bolster ecological resilience. Enhancement of urban green cover and conservation of biodiversity are imperative to reduce the UHI effect and improve ecological health. Nature-based solutions, such as rejuvenation of lakes, creation of biodiversity parks, and enforcement of eco-sensitive zone regulations have to be prioritised to enhance environmental sustainability.

Sustainable mobility solutions are crucial to improving air quality and reducing transport emissions. The city should expand its public transportation, promote non-motorised transit options, and introduce electric vehicles that can alleviate air pollution. Creation of stronger regulatory frameworks and robust air quality monitoring systems will guide effective mitigation strategies. Improvement of waste management — better segregation, increase in recycling rates, and scientific disposal of hazardous waste — is essential to reduce environmental impacts. It is imperative to acknowledge and integrate waste workers into the formal economy and provide training opportunities that will strengthen the circular economy and enhance social equity.

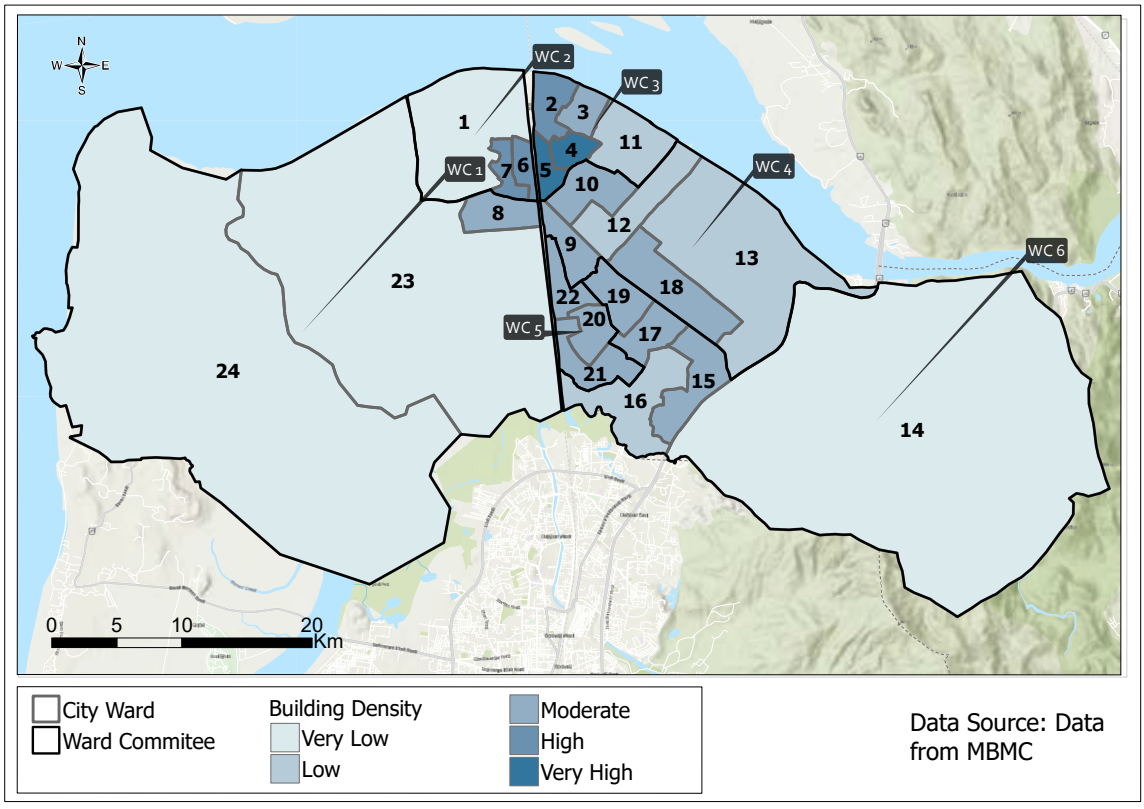
The successful implementation of the MBMCCAP relies on cross-cutting strategies. Community engagement and awareness campaigns can drive behavioural changes, while capacity-building initiatives can equip local governments and communities with essential skills to tackle climate challenges. Establishing a governance framework in line with state and national policies will guarantee consistency and responsibility in all actions.

The vision of the MBMCCAP is to transform Mira Bhayandar into a climate-resilient city by 2047, aligning with India's broader net-zero goals. This entails reduction in emissions, equitable urban development, and enhancement in adaptive capacities to withstand climatic stresses and uncertainties. To achieve this vision, it requires coordinated efforts across sectors, sustained investments in innovative solutions, and active participation from government bodies, private entities, and local communities. By implementing these strategies, Mira Bhayandar can serve as a model for urban centres, demonstrating that resilience and sustainability are attainable through proactive and inclusive planning.

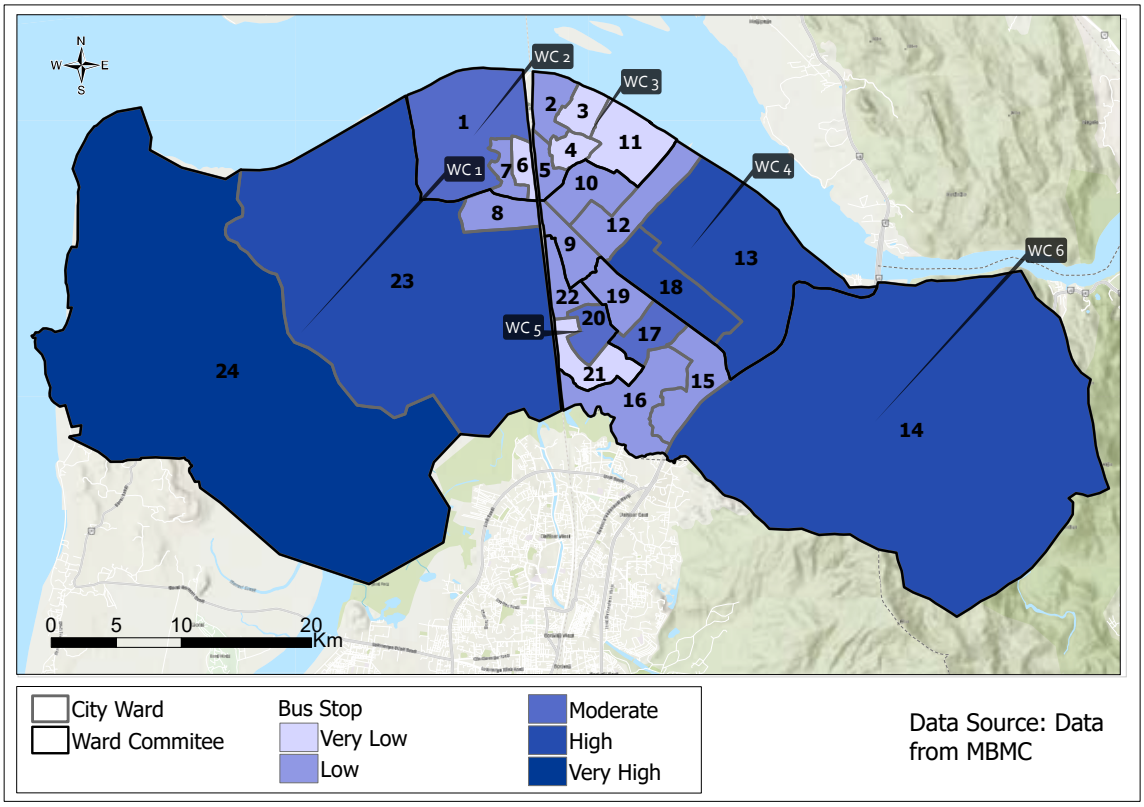
ANNEXURE



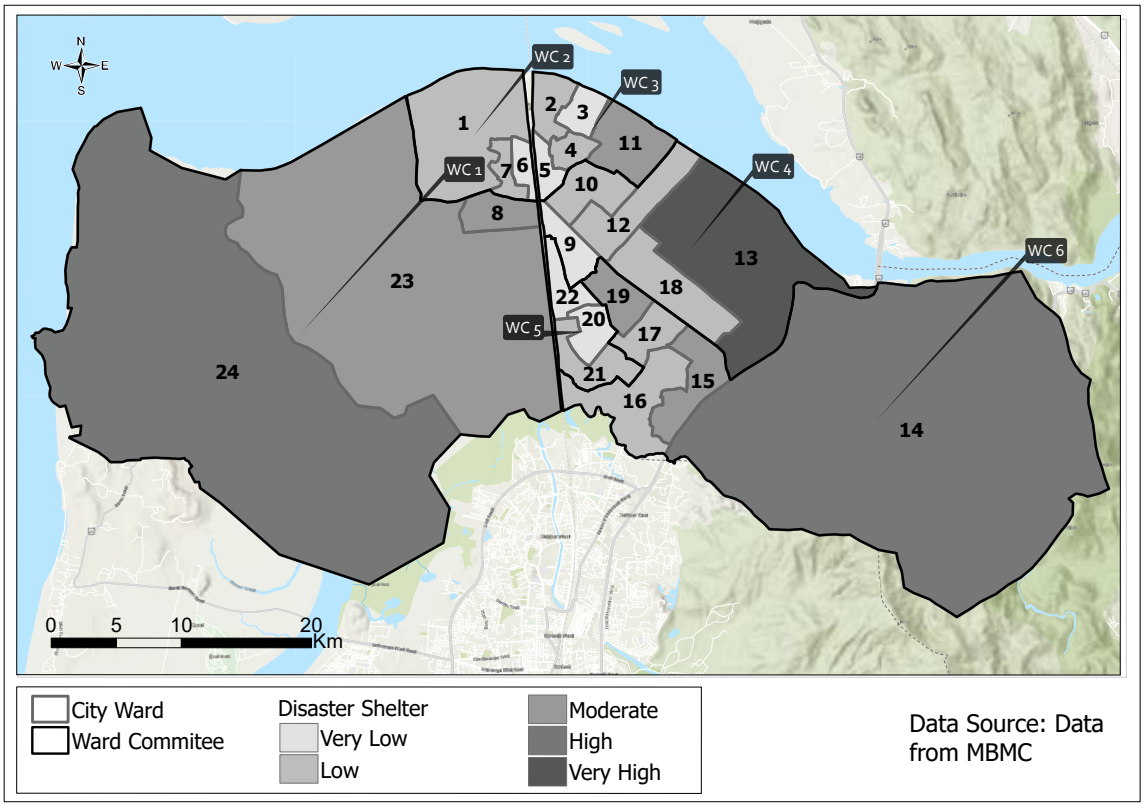
Map showing the beds per thousand population in Mira Bhayandar



Map on building density of Mira Bhayandar

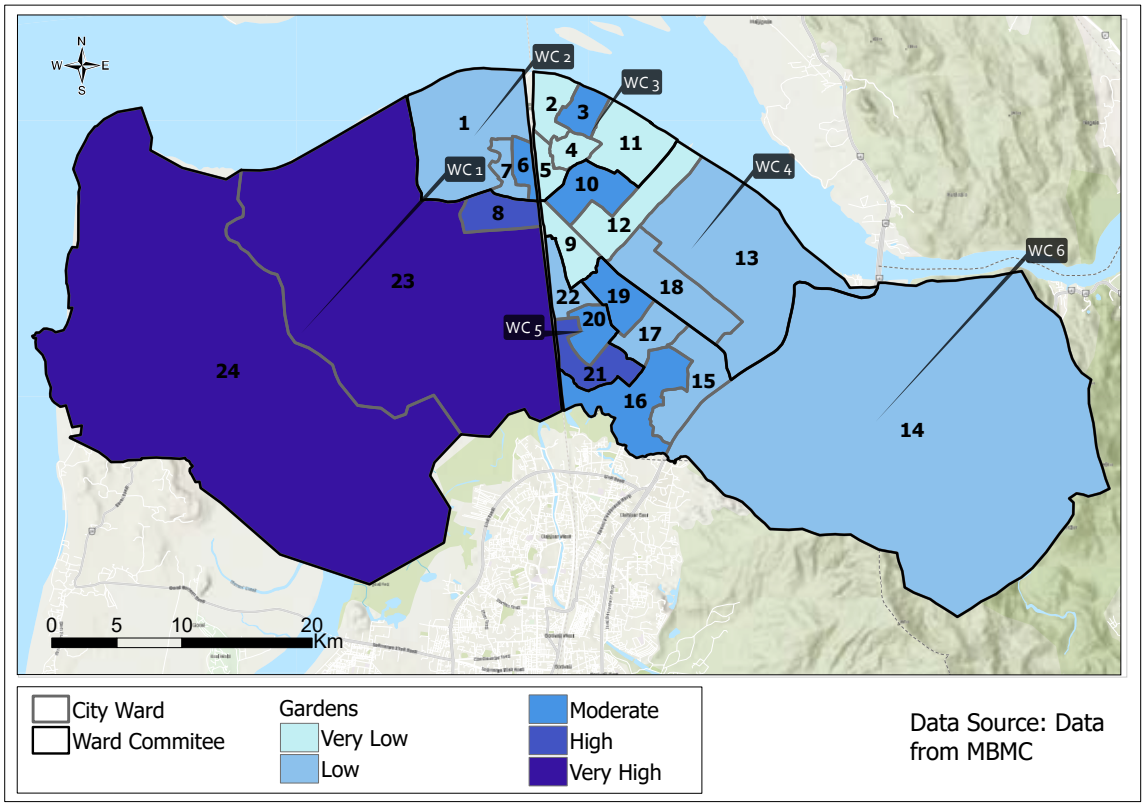


Map showing the bus stops in Mira Bhayandar

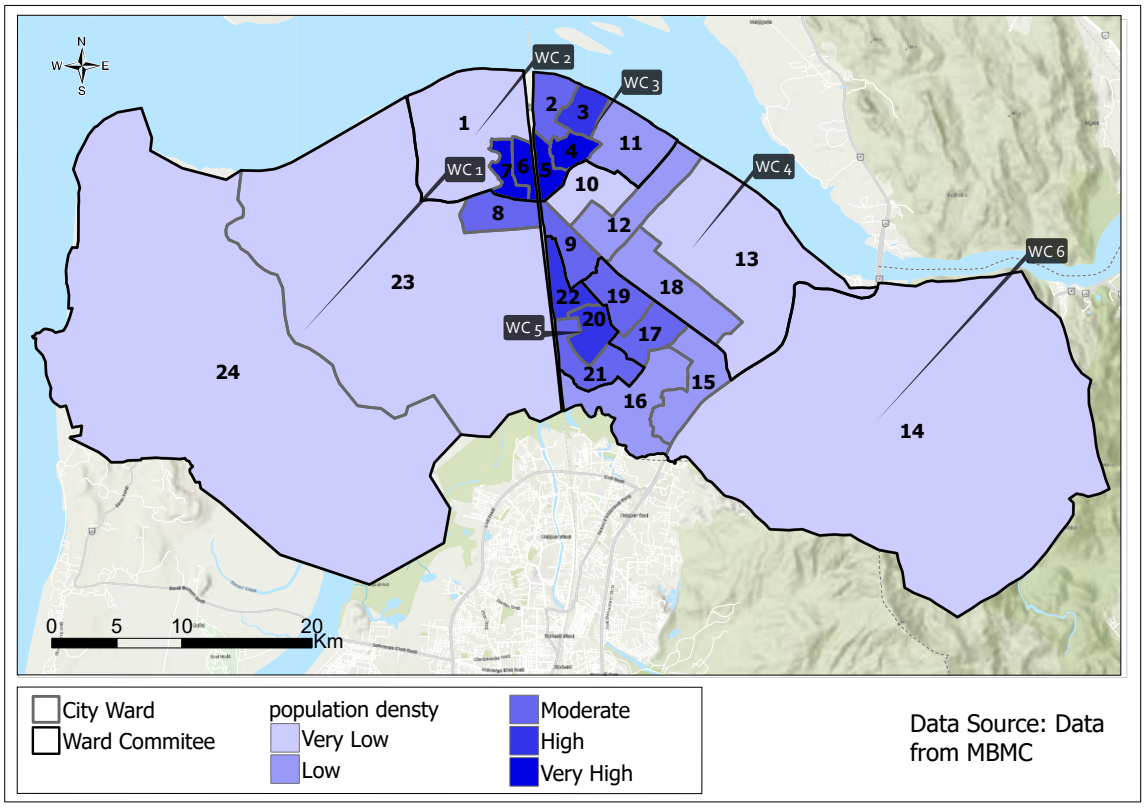


Map of disaster shelters in Mira Bhayandar

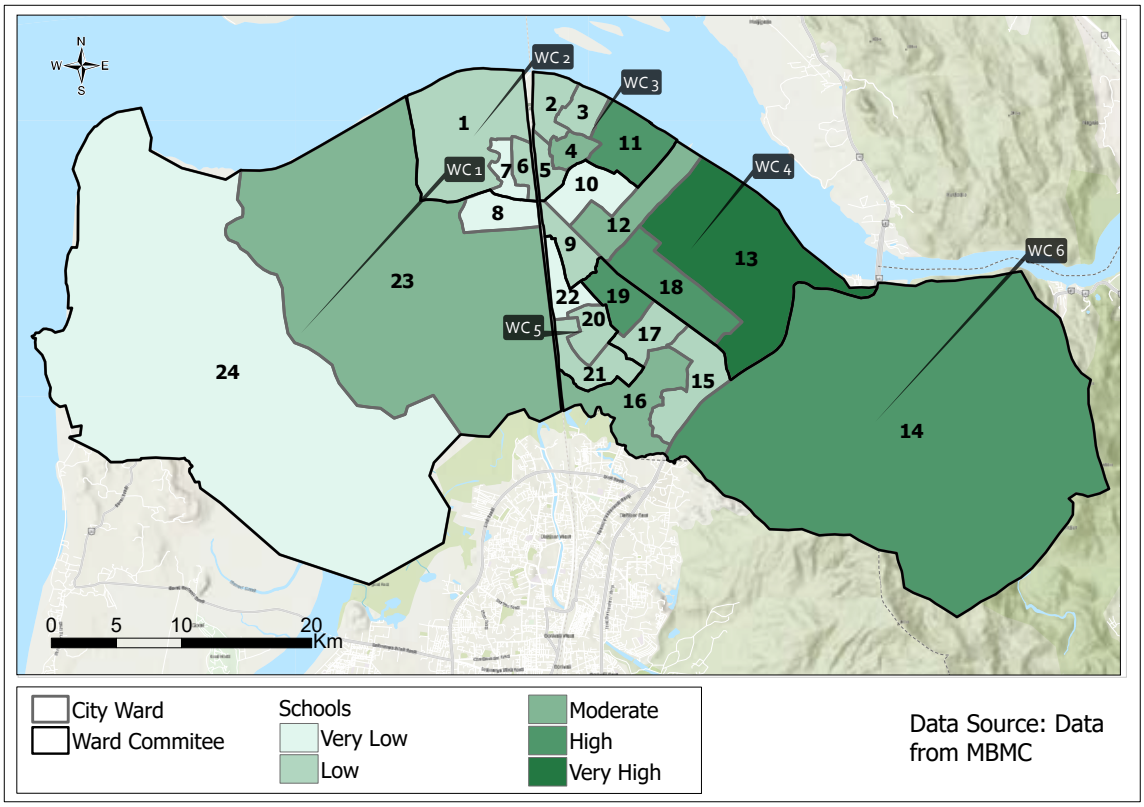
ANNEXURE



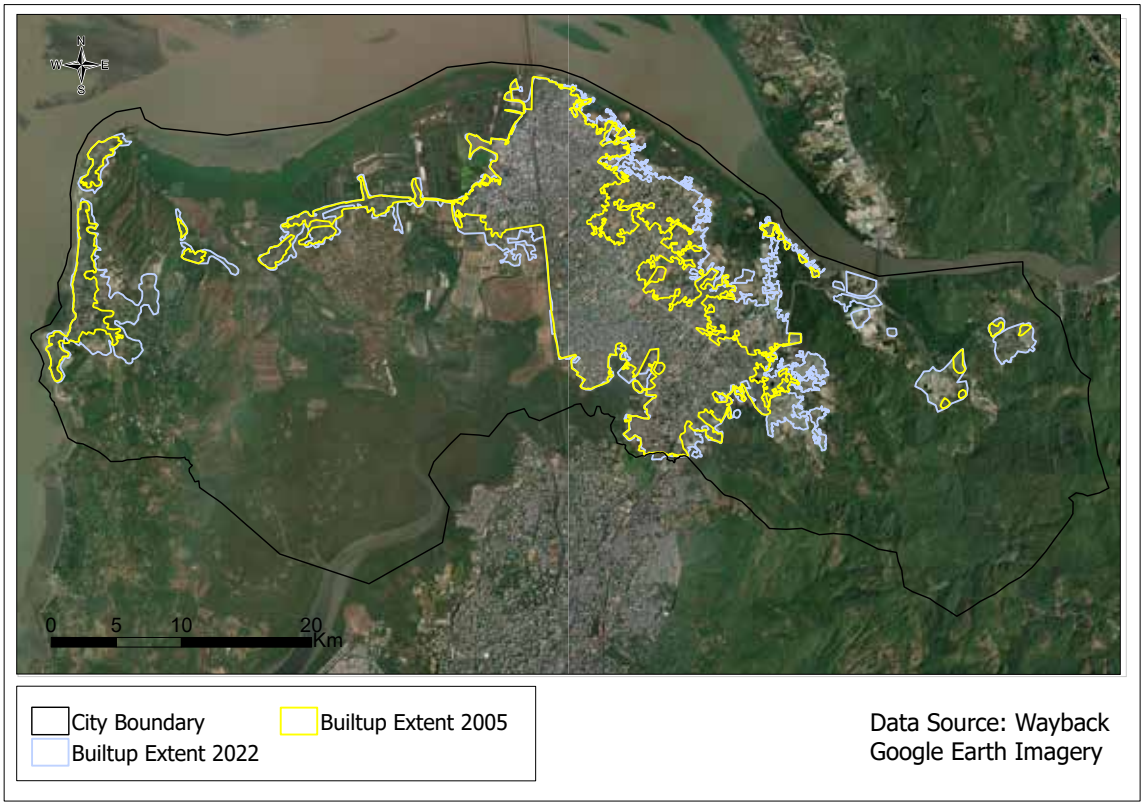
Map of gardens in Mira Bhayandar



Map on Population Density of Mira Bhayandar



Map on Schools in Mira Bhayandar



Map showing the Urban Agglomeration of Mira Bhayandar from 2005 to 2022

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MIRA BHAYANDAR

CITY CLIMATE ACTION PLAN
2024 - 2047