Chennai

Climate action Plan

சென்னை

C40 CITIES

Source: Urban Management Centre

ماء

Chennai

Climate action Plan

Thiru. M.K. Stalin,
Hon'ble Chief Minister,
Tamil Nadu

Global warming has occurred due to high carbon emissions. Many scientists have said the world should achieve carbon neutrality by 2050. Last year at COP26 the Indian government declared that it will become carbon neutral by 2070. Let me assure you that Tamil Nadu will achieve carbon neutrality before that. Our government views climate change as a major humanitarian crisis. We have taken various measures to protect the environment after assuming power.

Honourable Minister
Thiru. Siva.V. Meyyanathan,
Minister to Government,
Department of Environment and Climate Change,
Government of Tamil Nadu

"As evidence unfolds, the interlinkage between human actions and climate change is coming into fore. The launch of Tamil Nadu State Mission on Strategic Knowledge with components of Tamil Nadu Climate Change Mission, Wetlands Mission and Green Tamil Nadu Mission would go a long way in promoting preparedness by Tamil Nadu. I congratulate Greater Chennai Corporation on preparation of Chennai's first Climate Action Plan and assure all cooperation in its successful implementation."

Honourable Minister
Thiru K.N.Nehru,
Minister to Government,
Department of Municipal Administration,
Urban and Water Supply

Tackling the challenges arising due to the climate crisis at the local and global level require multi-scalar approaches. The Chennai Climate Action Plan comes as an opportunity to identify climate action as a priority agenda in Chennai. With support from C40 Cities and Urban Management Centre, the GCC takes a huge step forward with the launch of Chennai's first climate action plan.

Tmt. Supriya Sahu IAS,
Additional Chief Secretary,
Department of Environment,
Forests and Climate Change

I congratulate the Greater Chennai Corporation for this pioneering effort in preparation of the Chennai Climate Action Plan with support from C40 and UMC. The Chennai Climate Action Plan is in line with the Tamil Nadu State Action Plan on Climate Change with a special focus on adaptation to climate change in the context of more explicitly known disasters like cyclones and floods, but also the under-explored sea level rise. More appreciable is the emphasis on inclusivity – the impact on vulnerable sections of the city and the actions that may ameliorate the conditions.

Thiru. Shiv Das Meena IAS,
Additional Chief Secretary to Government,
Municipal Administration and Water Supply
Department

I do believe that the Chennai Climate Action Plan will help the city to realise its vision of Carbon Neutrality and Water Balance therein also systematically addressing climate risks. Further reducing loss of life & damages to property & livelihoods due to climate change. The identified actions will support enhancement of the city's coping capacity against climate change thus improving the quality of life for the citizens of Chennai.

R. Priya,
Honourable Mayor of Chennai

I, along with my team of councillors, commit to enhanced citizens engagement in order to proactively contribute to reducing emissions and to be better equipped to adapt to upcoming climate induced events. I am indeed happy that the Chennai Climate Action Plan elaborately addresses the potential impact on the weaker sections of the population as well as lists down actions that the city must implement in order to build resilience through inclusion.

Dr. J. Radhakrishnan IAS,
Additional Chief Secretary / Commissioner,
Greater Chennai Corporation

Climate Change is one of the most pertinent issues of our times and the city of Chennai is committed towards addressing this issue by improving its resilience to climate risks. I appreciate the efforts of C40 and UMC in drafting the Chennai Climate Action Plan. I trust that the Chennai Climate Action Plan will help Greater Chennai Corporation and the Line Departments address the effects of climate change in a holistic manner.

Dr. G.S. Sameeran IAS,
Joint Commissioner Works,
Greater Chennai Corporation

It is evident that the solutions towards carbon neutrality by Chennai require integrated effort by a multitude of departments and institutions. Transport, energy, buildings, green areas, appropriate land use, waste management practices, all contribute to greenhouse gas emissions and thus hold the key for its reduction as well. It is also important for all the departments to come together and join hands towards implementation of Chennai's Climate Action Plan.

Mrs. Shruti Narayan,
Regional Director,
South and West Asia, C40 Cities

Chennai has committed to play its fair role in reducing carbon emissions and setting a roadmap to becoming carbon neutral by 2050 aligned with the Paris Agreement, thereby setting targets of 1% by 2030, 40% by 2040 (compared to 2018-19) and achieving net zero by 2050. Chennai has led the way in showcasing how political commitment and leadership can result in an ambitious and implementable plan — which is particularly of importance to the global south, which is home to some of the most dense and fastest- growing cities of the world.

Source: Urban Management Centre

ACKNOWLEDGEMENTS

The development of the Chennai Climate Action Plan was done under the leadership and guidance of the Department of Environment, Forests and Climate Change and the Greater Chennai Corporation. We'd like to sincerely thank the individuals listed below for their support and contributions to the Chennai Climate Action Plan:

Government of Tamil Nadu

Honorable Minister Thiru. Siva.V. Meyyanathan, Minister to Government, Department of Environment and Climate Change, Government of Tamil Nadu.

Tmt. Supriya Sahu I.A.S., Additional Chief Secretary to Government, Department of Environment, Climate Change and Forests, Government of Tamil Nadu

Thiru. Gagandeep Singh Bedi I.A.S., Principal Secretary to Government, Health and Family Welfare Department and Former Commissioner, GCC

Thiru. M S Prasanth I.A.S., Additional Director (General), Commissionerate of Rural Development and Panchayat Raj and Former Deputy Commissioner (Works), GCC

Ms. Mrinalini Premnath, Communications Officer, Tamil Nadu Green Climate Company

Greater Chennai Corporation

Dr. J. Radhakrishnan I.A.S., Additional Chief Secretary/ Commissioner, GCC

Dr. G. S. Sameeran, I.A.S., Joint Commissioner (Works), GCC

Mr. N.Mahesan, Chief Engineer (SWM), GCC

Mr. S.Rajendiran, Chief Engineer (General), GCC

Mr. V. Bhuvaneshwaran, Chief Engineer (Buildings and Parks), GCC

Mr. B. V. Babu, Superintending Engineer (Special Projects, Smart City, Buildings & Registration of Contractors), GCC

Ms. Christy Leema Rose, Public Engagement Officer, Chennai Smart Cities Limited

Mr. Raj Cherubal, Former Chief Executive Officer, Chennai Smart Cities Limited

Ms. Keerthi, Former Senior Environmental Officer, Chennai Smart Cities Limited

C40 Cities

Shruti Narayan, Regional Director for South and West Asia Region

Max Jamieson, Head of Technical Aid

Ryan Green, Technical Manager for Climate Change Mitigation

Siyasanga Sauka, Technical Head, Adaptation Planning

Kirsty Griffin, Senior Technical Manager, Adaptation Planning

Benjamin John, City Advisor, Chennai and Bengaluru

Urban Management Centre

Manvita Baradi, Director

Meghna Malhotra, Deputy Director

Dr. P. Jayapal, Team Lead – Chennai Climate Action Plan

Anurag Anthony, Chief Technical Officer

Kaninik Baradi, Strategic Initiatives Officer

Sweta Delwadia, Program Coordinator

Sakshi Sharma, Project Associate

Neha Modi, Program Coordinator

Sneha Varma, Project Associate

Sandeep Chattrola, GIS Analyst

Greater Chennai Corporation would like to thank all the advisors and reviewers from C40 Cities and Urban Management Centre, all Assistant Commissioners, Deputy/Joint commissioners, all Chief Engineers, all department heads at the ward level and Zonal Deputy Municipal Commissioners, stakeholders and external agencies who participated in the stakeholder consultations of the Chennai Climate Action Plan.

Edited by Ateendriya Gupta

Report designed by Chitrapat Ideas Foundry.

Source: Urban Management Centre

CONTENTS


Source: Chennai Smart Cities Limited


Source: Chennai Smart Cities Limited

6

Chennai's Climate Actions 136

7

Implementing the Climate Actions 256

8

Annexures 278

Source: Chennai Smart Cities Limited

LIST OF ABBREVIATIONS

AAQ	Ambient Air Quality
BEE	Bureau of Energy Efficiency
BGI	Blue-Green Infrastructure
CCAP	Chennai Climate Action Plan
CCRA	Climate Change Risk Assessment
CII	Confederation of Indian Industry
CIRIS	City Inventory Reporting and Information System
CMA	Chennai Metropolitan Area
CMA	Chennai Metropolitan Area
CMP	Comprehensive Mobility Plan
CMRL	Chennai Metro Rail Limited
CMWSSB	Chennai Metropolitan Water Supply and Sewerage Board
CNG	Compressed Natural Gas
CUMTA	Chennai Unified Metropolitan Transport Authority
CSAP	City Sanitation Action Plan
CSCL	Chennai Smart Cities Limited
CSS	Centrally Sponsored Schemes
DC	Duck-curve
DC	Deputy Commissioner
DDMA	District Disaster Management Authority
DEOC	District Emergency Operation Centre
E&P	Existing and Planned
ECBC	Energy Conservation Building Codes
ECBC-R	Energy Conservation Building Codes -Residential
ENS	Eco-Niwas Samhita
EV	Electric Vehicles
GFC	Garbage Free Cities
GHTC	Global Housing Technology Challenge
GoTN	Government of Tamil Nadu
GPC	Global Protocol for Cities
ICCR	Indian Council for Cultural Relations
ICMA	International City/County Management Association
IEA	International Energy Agency
IOCL	Indian Oil Corporation Limited
IPCC	Intergovernmental Panel on Climate Change
IRES	India Residential Energy Survey
IRS	Incident Response System
KPI	Key Performance Indicator
KW	Kilowatt
LST	Land Surface Temperature
MER	Monitor Evaluation & Reporting
MNRE	Ministry of New and Renewable Energy
MoEFCC	Ministry of Environment, Forest, and Climate Change
MoHFW	Ministry of Health and Family Welfare
MRF	Material Recovery Facilities

MRTS	Mass Rapid Transit System
MTC	Metropolitan Transport Corporation
$MtCO_2e$	Million Tonnes of Carbon Dioxide Equivalent
MW	Mega Watt
NAPCC	National Action Plan on Climate Change
NAPCCHH	National Action Plan on Climate Change and Human Health
NBS	Nature Based Solutions
NCDC	National Centre for Disease Control
NCC	National Cadet Corps
NDC	Nationally Determined Contribution
NDVI	Normalized Difference Vegetation Index
NDWI	Normalized Difference Water Index
NULM	National Urban Livelihoods Mission
NSS	National Service Scheme
NYK	Nehru Yuva Kendra
OND	October, November, December
OSR	Open Space Reserves
PM	Particulate Matter
PMAY-U	Pradhan Mantri Awas Yojana - Urban
RCP	Representative Concentration Pathway
RE	Renewable Energy
Resilient Cities	RC
RRC	Resource Recovery Centres
RUDF	Resilient Urban Design Framework
RWH	Rainwater Harvesting
SBM	Swachh Bharat Mission
SDG	Sustainable Development Goals
SDMP	State Disaster Management Plan
SEOC	State Emergency Operation Centre
SFCPoA	Slum Free City Plan of Action
SHG	Self Help Groups
SLB	Service Level Benchmarks
SLR	Sea-Level Rise
SPV	Special Purpose Vehicle
SWD	Storm Water Drains
SWM	Solid Waste Management
TANGEDCO	Tamil Nadu Generation and Distribution Corporation Limited
TEDA	Tamil Nadu Energy Development Agency
TNHDB	Tamil Nadu Housing Development Board
TNPTEEA	Tamil Nadu Protection of Tanks and Eviction of Encroachment Act
TNSAPCC	Tamil Nadu State Action Plan on Climate Change
TNSAPCCHH	Tamil Nadu State Action Plan on Climate Change and Human Health
TNSAPCCHH	Tamil Nadu State Action Plan for Climate Change and Human Health'
TNSCB	Tamil Nadu Urban Habitat Development Board
TNSDMA	Tamil Nadu State Disaster Management Authority
TNUHDB	Tamil Nadu Slum Clearance Board
TPD	Tons Per Day
WRD	Water Resource Department

LIST OF FIGURES

LIST OF TABLES

Source: Chennai Smart Cities Limited

Source: creativecommons.org

Executive Summary

Background

Climate change and its associated hazards are impacting cities and their residents, especially the poor and marginalized populations; and the severity of climatic hazards is expected to increase in the coming decades. This will add to the existing burden on local governments, which are already overstretched in their efforts to provide basic services to their citizens.

While cities contribute a significant share to environmental degradation and GHG emissions, they also present opportunities and role models of sustainability, efficiency, inclusivity, and committed actions.

At COP26, India pledged to achieve 50 per cent of its energy requirement through renewable energy by 2030 and to achieve "net zero carbon"[1] by 2070.[2] Chennai has been a C40 city since 2016 and is committed to contributing its fair share in having global greenhouse gas emissions by 2030 and achieving emissions neutrality by 2050.

Project Inception and Preparation

The preparation of the Chennai Climate Action Plan (CCAP) is led by the Greater Chennai Corporation (GCC) with support from C40 and the Urban Management Centre (UMC). The project officially started in September 2021. The CCAP has adopted a participatory and consultative process with government stakeholders, practitioners, experts from academia, research institutions, and community groups (See Annexure 8.4). The Plan has been prepared in close consultations with important stakeholders such as Tamil Nadu Generation and Distribution Corporation (TANGEDCO), Tamil Nadu Energy Development Agency (TEDA), Indian Oil Corporation Limited (IOCL), Chennai Metro Rail Limited (CMRL), Madras Transport Corporation (MTC), Chennai Metropolitan Development Authority (CMDA), Chennai Smart City Limited (CSCL), Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), Suburban Rails, Tamil Nadu Urban Habitat Development Board (TNUHDB), academic institutions (Anna University, IIT Madras), and civil society organizations on over 200 meetings. The plan presents Chennai as a laboratory of technical and social change to bring about meaningful actions. The CCAP is based on a sound database, utilizing the latest data sets from a range of credible government and academic sources and using C40 tools and models. The CCAP highlights the urgent need for concerted actions to be taken by state and local stakeholders. At the same time, it presents a series of actions that demonstrate the city's ongoing commitment to respond to climate change at a local and more tangible level.

City Context

Chennai is, the fourth-largest city of India and home to a population of 8.5 million people. It is the economic hub and the capital city of the state of Tamil Nadu. In terms of topography, Chennai has a plain terrain and an almost-flat land surface, with contours ranging from 2–10 m (7–33 ft) above mean sea level, and

1 The idea of "net zero" was promoted in a 2018 special report from the Intergovernmental Panel on Climate Change (IPCC) which demanded that countries bring greenhouse gas emissions to "net-zero" by 2050 to keep global warming to within 1.5 °C of pre-industrial levels.

2 India's Stand at COP, Ministry of Environment, Forest & Climate Change, Press Information Bureau, Delhi (https://pib.gov.in/PressReleasePage.aspx?PRID=1795071#:~:text=Reach%20500GWNon%2Dfossil%20energy%20capacity,by%202030%2C%20over%202005%20levels.)

a few isolated hillocks. The natural ecosystem of Chennai comprises three rivers (Kosasthalaiyar, Cooum, Adyar); five wetlands (Pallikaranai Marsh, Pulicat Lake, Kattupalli Island, Madhavaram and Manali Jheels, Adyar Estuary Creek); and six forest areas.

Chennai has a largely tropical climate, with the maximum temperature ranging from 38°C to 42°C from April to June. The average annual rainfall is about 1,300 mm. In the recent past, the city has been facing the brunt of climatic hazards due to changing weather patterns and heavier rainfalls in shorter spells resulting in floods as well as deficient monsoons leading to drought. These challenges are likely to grow as the city's population and the economy grows. Projections indicate that as climate change accelerates, Chennai will likely experience harsher events of flooding, heatwaves, and sea level rise that pose a risk to human health.

Comparing the Greenhouse Gas Inventory of 2018 greenhouse gas (GHG) emissions with that of the 2015 Inventory, data shows that Chennai's total annual emissions have increased from 13.54 MtCO2e to 14.38 MtCO2e. The largest contributor is stationary energy use (buildings and industry), which accounted for 71 per cent of GHG emissions in 2018. These energy-related emissions resulted primarily from electricity use since Chennai relies predominantly on thermal power plants for a generation. This is followed by transport (private and public transit), which accounted for 16 per cent of the GHG emissions in 2018 – majorly from private vehicles. The solid and liquid waste sectors accounted for 13 per cent of emissions in the same year, with a majority being contributed by the solid waste sector.

Climate Risks Projections

To determine the adaptation measures and targets that Chennai needs to adopt, climate risks and vulnerabilities were assessed using the C40 Cities' CCRA framework. It screened parameters related to past climatic trends and future projections, based on global models and assessment reports such as IPCC, UNFCCC, as well as national-, state-, and city-level plans. The spatial analysis was carried out using GIS and remote-sensing technologies, to identify areas that are highly vulnerable to extreme climate events.

Monitored weather data and publications were used to map decadal, inter-annual, and temporal (monthly, daily, and hourly) trends; presently associated impacts; and project potential future trends in precipitation, temperature, and SLR. The C-FLOWS[3] data was used to visualise zone-level flood risks and identify potential vulnerabilities as well as compromised access to infrastructure and services. Socio-economic sensitivities were mapped using plans developed by the GCC for "Slum Free Cities 2014."[4] Further, GCC's services and amenities data was visualized spatially, to identify underserved areas with poorer adaptive capacities. Finally, these different datasets were correlated to present the interlinkages between climate risks, socio-economic sensitivities, compromised access to infrastructure and services, and vulnerability to communities.

Some of the key outputs from the CCRA study include:

1

By the year 2050, the annual rainfall is expected to decrease by 5 per cent, and the average temperature is expected to increase by 1.9°C.

2

The average change of maximum and minimum temperatures in Chennai is expected to increase by 2.9°C and 3.3°C, respectively, by the end of the century. Due to increasing temperatures and water demands, it is expected that Chennai may face the risk of water scarcity in the future if its water resources are not managed well. Water scarcity will create social-economic imbalances across the city.

3 C-FLOWS (Chennai Flood Warning System) is an integrated web-based GIS decision-support tool for relief and mitigation operations, especially during flooding, developed by National Centre for Coastal Research (NCCR).

4 Slum Free Cities, TNHUDB, 2014.

3

In terms of flood risk, the intensity of flood events is projected to increase. The Climate Change Risk Assessment (CCRA) conducted for Chennai estimates that 32 per cent of the current GCC area will likely become inundated during a 1-in-10-year flood event, and 46 per cent in a 1-in-25-year event.

4

The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR6) regional factsheet for Asia states that the relative sea level around the continent is expected to rise to 134 cm by 2100s, with rapid coastal area loss and shoreline retreat. It is projected that around 215 slum settlements are at risk of inundation by sea-level rise by the year 2100.

Emissions Forecast

To determine the mitigation pathways and targets that Chennai needs to adopt to achieve Chennai's Climate Vision, C40's Pathways tool was used to model four scenarios:
The strategies and scenarios in the 'Pathways Model'

1

Business As Usual (BAU)

Assumes that no specific actions are undertaken to reduce GHG emissions.

2

Existing and Planned Actions (E&P)

Informed by existing national, state, and local policies and programmes.

3

Ambitious Actions

Informed by key stakeholders and consultations with all relevant departments to help set an ambitious yet realistic set of key actions.

4

Extended Scenario

Implementation of all strategies under the Ambitious Scenario have the potential to deliver significant emission reductions, but these strategies together do not help achieve the Paris-aligned emissions trajectory, and hence there is a need for short term actions by 2030 and 2040. In 2050, the total emissions are still projected at around 12.5 MT CO2e in the ambitious scenario. Chennai will need to identify additional strategies to reduce the remaining emissions. This "Extended Scenario" includes strategies that are necessary, but are currently unfeasible due to major political, institutional, technological, or financial barriers.

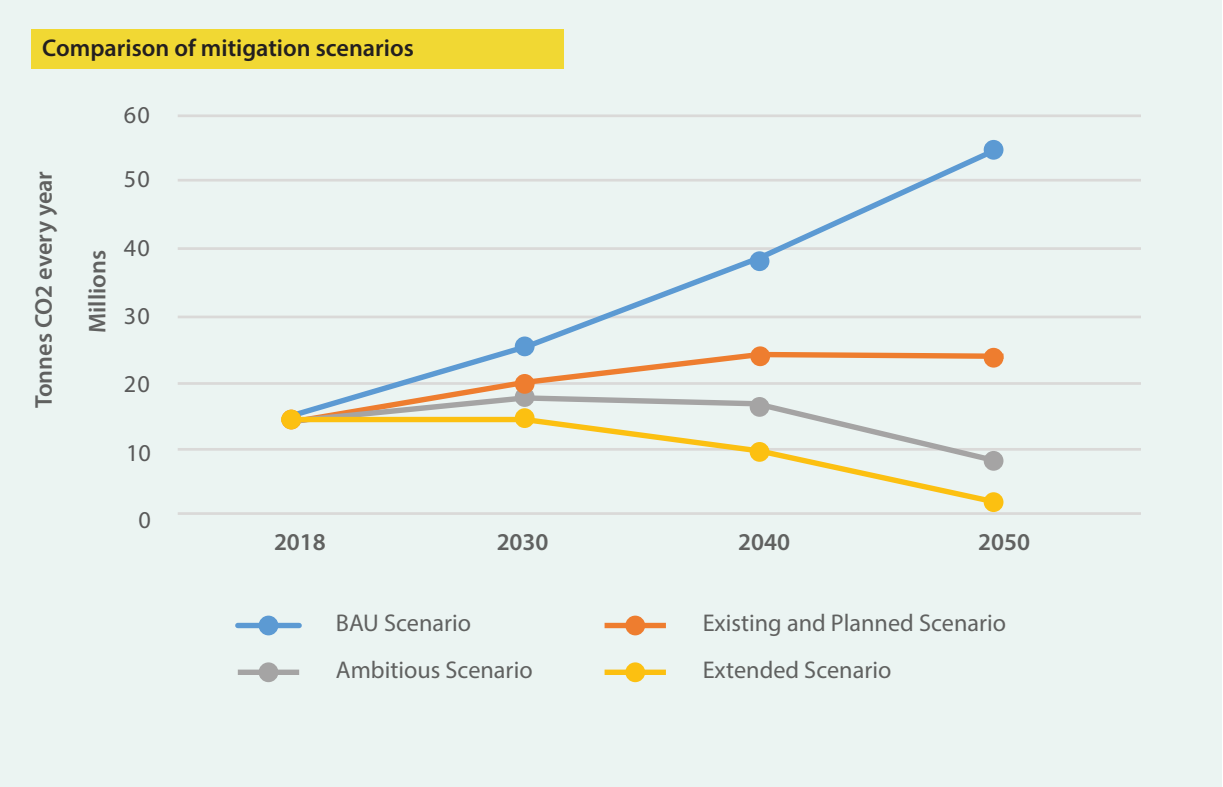


Figure 1: Comparison of Mitigation Scenarios

have been compiled from extensive stakeholder consultations, key informant interviews, and the state and national level climate policies to achieve reductions based on realistic yet ambitious targets. Under the BAU Scenario, emissions are expected to almost quadruple by 2050, compared to the emissions in the base year of 2018 due to high population and GDP growth in the city . The E&P Actions Scenario will also result in an increase in citywide emissions, albeit a significant decrease compared to the BAU, which demonstrates the need for more ambitious actions to be implemented in order to deliver on the goals of the Paris Agreement. In the Ambitious Scenario, the city's emissions still result in an increase above the base year – 24.8 per cent by 2030 and 13.2 per cent in 2040 – and then gradually decrease by 44 per cent in 2050. To close the gap between the 'Ambitious yet Feasible' strategies in the Ambitious scenario and the goals of the Paris Agreement, an Extended Scenario was modelled to demonstrate what strategies would be required but are deemed currently infeasible due to significant barriers to implementation. The strategies identified (detailed in Table 8 along with barriers to implementation)) have the potential to help Chennai peak GHG emissions by 2030 and reduce its emissions by 40 per cent by 2040 and 92 per cent by 2050 (compared to emissions in the base year of 2018), which has been used to inform the citywide emission reduction targets set in this CAP.

Source: Chennai Smart Cities Limited

VISION

Source: Photo by Thanuj Mathew on unsplash.com

மீள்திறனும் முற்காப்பும் உடைய சென்னை

Resilient and Proactive Chennai

GOALS BY

2050

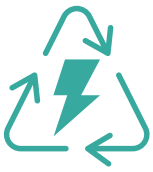
1 CARBON NEUTRALITY

2 WATER BALANCE

Source: Urban Management Centre

To realize its vision, Chennai has identified a set of detailed actions for reducing and avoiding the impacts of climate change and building the city's resilience. The adaptation strategy involves actions to make Chennai resilient against floods and droughts, with a focus on their significant impact on vulnerable populations. The city's mitigation strategy includes actions towards reducing emissions in four sectors namely Electric Grid & Renewable Energy, Building Energy, Waste, and Transportation. The GCC along with concerned stakeholders is setting targets to reduce citywide GHG emissions by 1 per cent by 2030, 40 per cent by 2040 compared to 2018 levels, as well as achieve net zero by 2050. These targets align with the Paris Agreement, demonstrating Chennai's vision to create a cleaner, greener, and healthier city that aspires to meet the highest goals of the Paris Agreement.

Table 1 Sectoral Visions



Electrical GRID and Renewable Energy

Enabling access to reliable, affordable, and zero-emission energy for all residents

Building Energy

"Making all buildings energy efficient"

Transport

"Moving towards sustainable mobility"

Waste

"Efficient, effective, and resilient waste-management system"

Urban flooding and Water scarcity

"From a water-reactive to a water-proactive Chennai"

Vulnerable Population & Health

Climate Proofing for All

Each of the sectoral actions is built around the principles of Inclusivity and Equity, Focussed Acceleration based on select high impact opportunities and is aligned with State, National and Global priorities. These principles represent non-negotiables, against which all decisions and projects must be measured, and which are in line with the GCC's commitment to ensuring a high quality of life for all its residents. Further, every climate action is supported by four pillars – representing the foundational approach through which plans can be carried out effectively. Timelines for each action have been proposed for the short (by 2030), medium (by 2040), and long-term (by 2050). These timelines are based on the opportunity for accelerated GHG emissions and alignment with timelines of national and state programmes.

In the built environment, key mitigation emissions reduction opportunities are found in energy efficiency (e.g., stricter building standards/ codes) and renewables (e.g., rooftop solar PV). Transport emissions can be reduced through a modal shift from private to public transport and the use of cleaner fuels (e.g., electric and hybrid vehicles). Emissions from waste can be reduced by diverting solid waste from dumpsites and ensuring 100 per cent processing (e.g., through recycling and composting).

To enhance climate resilience and adapt to climate change impacts, the city will focus on strategies for implementing flood and water-scarcity management, conserving natural ecosystems, building resilience through improving disaster risk-reduction measures, developing climate-proof housing and infrastructure, and enhancing the health and wellbeing of communities.

As Chennai begins implementing the identified actions across the various identified sectors, a number of co-benefits can be achieved for the city such as decreased road congestion, a more walkable and cyclable Chennai, improved air quality, decreased instances of flooding, improved health and quality of living.

The proposed Department of Climate Change Initiatives at the GCC will work closely with TN Green Climate Company, to ensure the implementation of enabling policies and regulations. The upcoming Chennai Development Plan for the horizon year 2046 also presents a huge opportunity for the city to review and propose regional, city-level, and local-level actions for reducing GHG emissions and increasing resilience to climate risks. Some of these include enabling the creation of blue-green infrastructure, supporting non-motorized transportation, and guiding and incentivizing building-level efficient designs. Chennai will continue to collaborate with various stakeholders at the state and district level to implement the actions identified. The Chennai CAP envisions a safer, healthier, and more inclusive city for all its residents.

How to Read This Document

The CCAP report is divided into 7 chapters. Chapter 1 titled "Chennai at a Glance" sets out the socio-economic and ecological contours of Chennai. Chapter 2 titled "Towards a Resilient and Pro-active Chennai" addresses the question of why Chennai needs a Climate Action Plan. Chapter 3 titled "Process of Preparation" lays out the entire plan preparation process. Chapter 4 titled "Chennai's Climate Risks and Vulnerabiliites" outlines the detailed Climate Change Risk Assessment the city has undertaken for understanding Chennai's climate risks, which provides the context for actions that should be implemented to adapt to climate change and build resilience for its citizens, assets, the environment, and the economy. Chapter 5 titled "Chennai Current and Future Emissions" includes an analysis of the Stationary Energy Sector, Transportation Sector, and Waste Sector. The GHG inventory enables the planning and prioritisation of actions for reducing emissions and mitigating climate change. To achieve carbon neutrality by 2050, the city, in furtherance to its commitment to 'Deadline 2020', has set interim and long-term evidence-based goals. Chapter 6 titled "Chennai's Climate Action Plan" identifies and explains the objectives, actions, and targets for each priority sector. Chapter 7 titled "Implementing Climate Actions" sets an implementation and monitoring framework for Chennai to implement the identified climate actions. Chapter 8 comprises the annexure.

Source: creativecommons.org

CHAPTER

1

Chennai at a Glance

1.1 Location and Demographics

The city of Chennai, formerly known as Madras, is the capital of Tamil Nadu. Located on the Coromandel Coast off the Bay of Bengal in the North-East part of Tamil Nadu, the city is bounded by the northern latitudes of 12°59′ 10″ and 13°08′ 50″ and the eastern longitudes of 80°12′ 10″ and 80°18′ 20″. A coastal city, with a coastline of 19 km,[5] Chennai's Marina Beach is one of the widest beaches in the world.

The city was first established as a port of trade by the British in the 1600s. The Portuguese arrived in the region in 1522, and when the East India Company built their first major settlement in the country, the city – known at the time as Madraspatnam – became the centre of the growing colonial empire. Chennai now acts as a prominent cultural, social, economic, and educational centre in the south of India.

Currently, Chennai is governed by the Greater Chennai Corporation (GCC), which is the oldest municipal institution in India and was established on 29 September 1688. The GCC administers an area of 426 sq. km, expanding from 174 sq. km in 2011, and covers three revenue districts of Chennai and parts of Kanchipuram and Tiruvallur. The GCC is responsible for providing basic services to its residents – such as roads, solid waste management, primary health services, urban poverty alleviation, and slum upgradation. The Chennai Metropolitan Development Authority (CMDA), formed in 1974 and covering an area of 1,189 sq. km, takes up the planning and development functions of the entire Chennai Metropolitan Area (CMA), which covers GCC, 16 Municipalities, 20 Town Panchayats, 10 Panchayat Unions, and two Cantonments. The GCC's growth, economy, and prosperity are intrinsically linked to that of the CMA, and this symbiotic relationship is further strengthened by the extension of the road, rail, and metro rail networks. The CMDA's Second Master Plan, 2026, is currently under implementation, while preparatory actions have been initiated to frame the Third Master Plan, with the perspective year of 2046. The CCAP has been prepared for the GCC jurisdiction and applies to the entire 426 sq. km under it.

Tamil Nadu is one of the most urbanized states in India, with 48.45 per cent of its population living in urban areas. As per Census 2011, the population of Chennai was 6.67 million, and the current population of Chennai is estimated at 8.5 million (as of 2021), with a population density of 26,553 people per sq.

5 ENVIS Centre: Tamil Nadu, Coastal Profile. Accessed 26 August 2022, from http://tnenvis.nic.in/Database/TN-ENVIS_900.aspx.

km and is projected to reach 10.677 million by 2030.[6] Women currently comprise 49.3 per cent of the total population. With a decadal rate of 32 per cent, Chennai is by far the most densely populated city of Tamil Nadu and the fourth most populous metropolitan city in the country.[7]

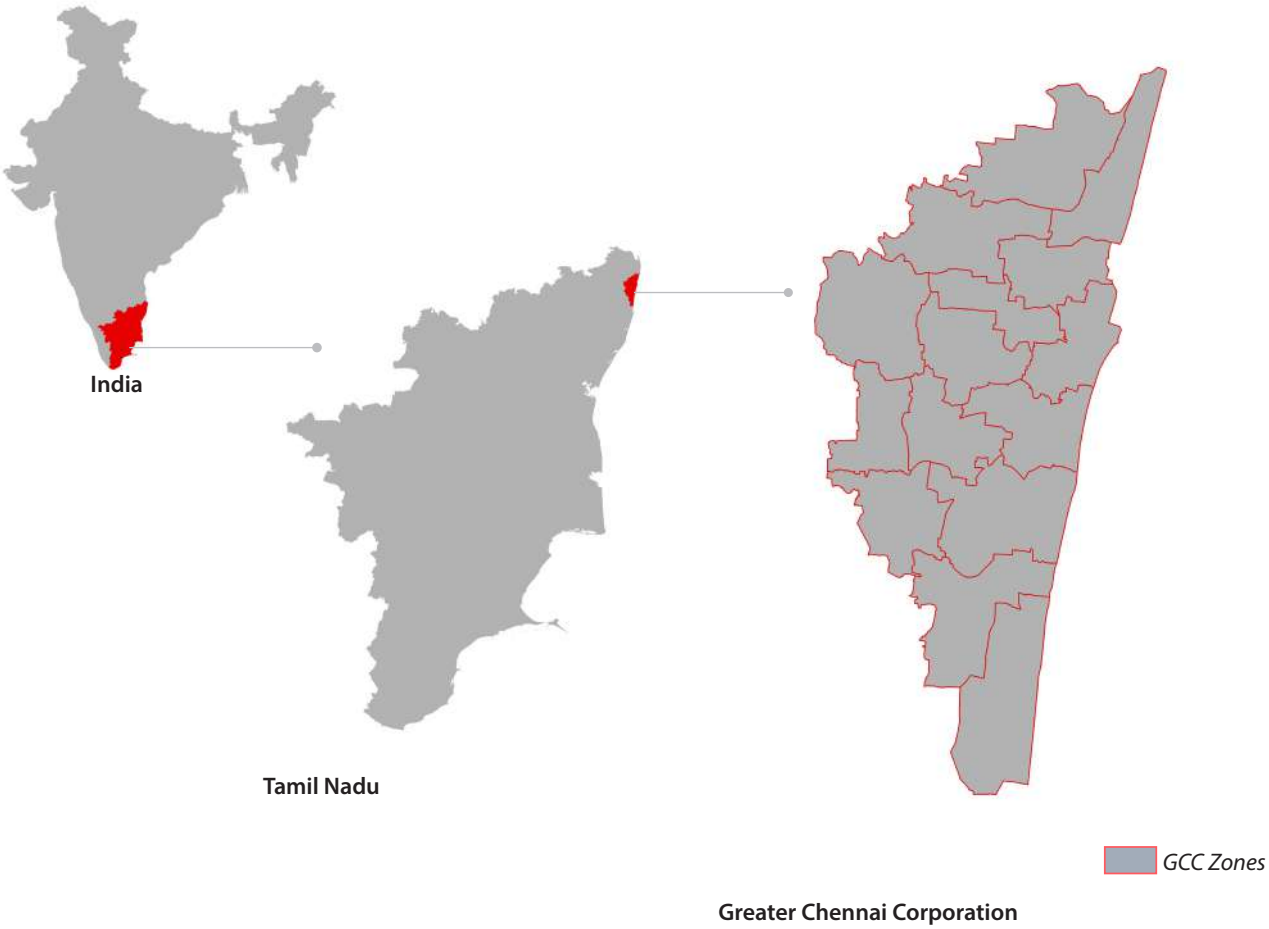


Figure 2: Location of Chennai

6 City Action Plan, SWM Department, 2021.

7 Directorate of Census Operations, Greater Chennai Corporation, 2011/2021.

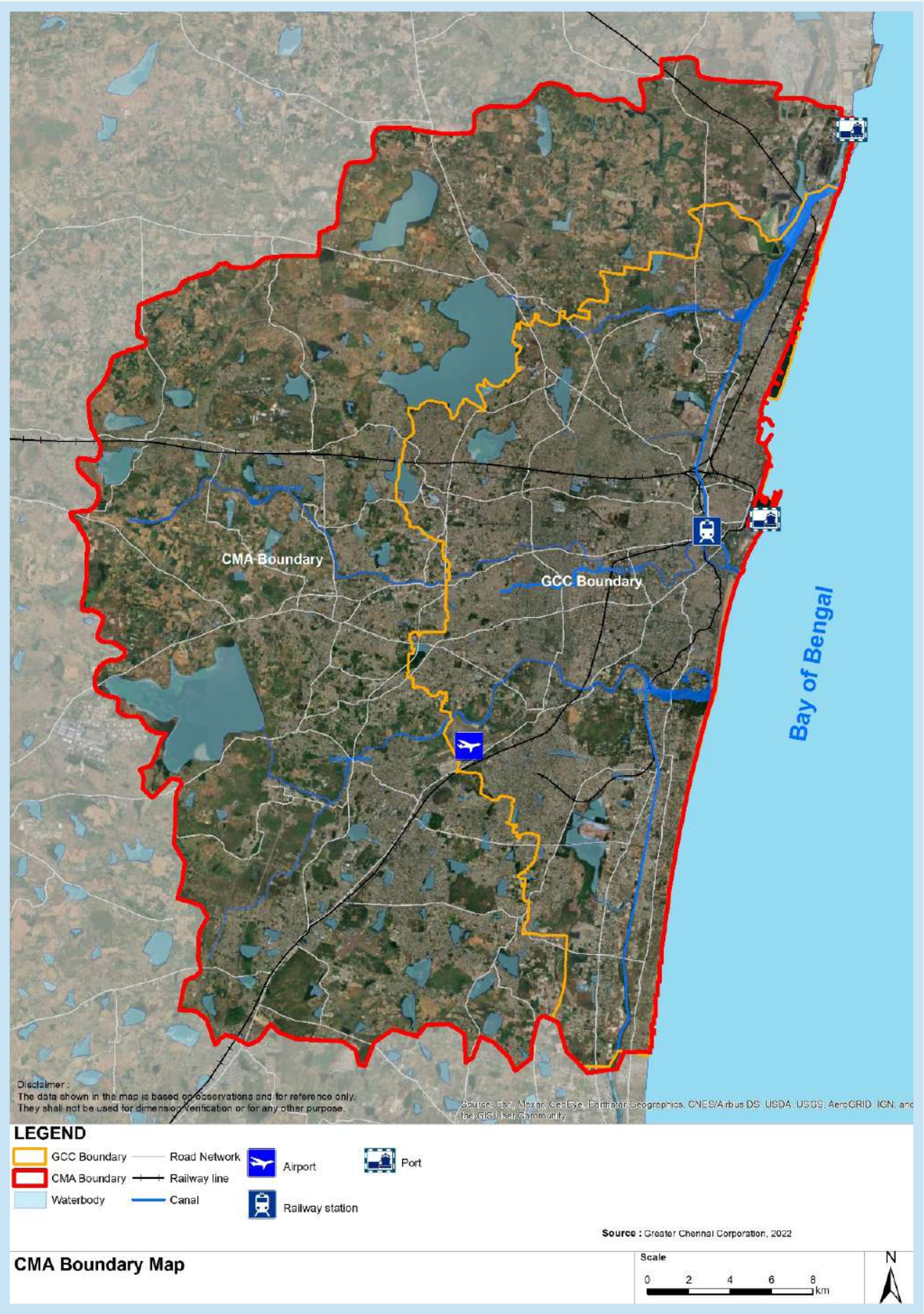


Figure 3: Administrative Boundaries of the Chennai Metropolitan Area and the Greater Chennai Corporation

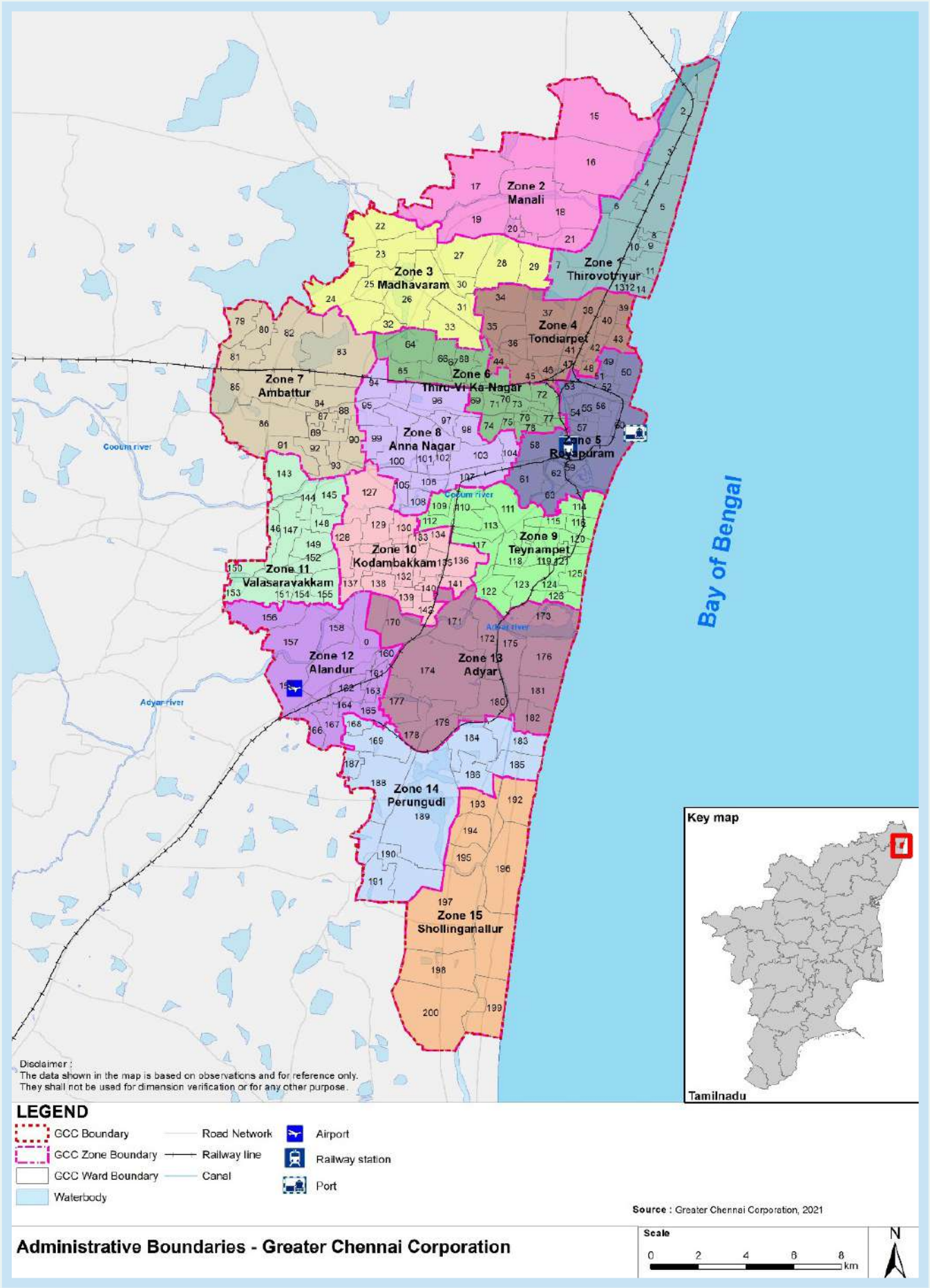


Figure 4: Administrative Boundaries within the Greater Chennai Corporation

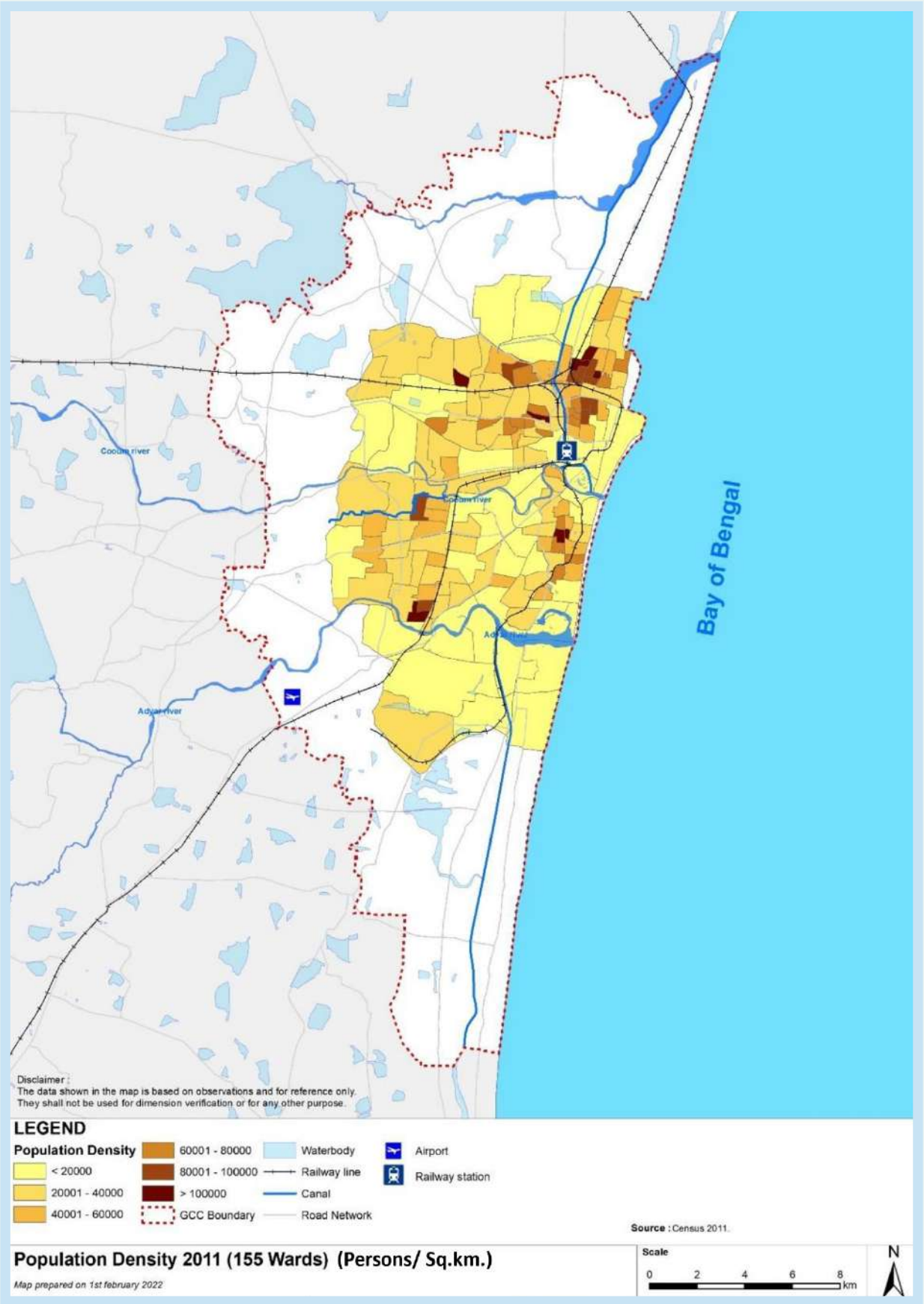


Figure 5: Ward-wise Population Density of Chennai

Note: Ward-wise population as per Census of India, 2011 only contains details of 155 wards as per the earlier GCC boundary of 186 sq. km. The details of ward-wise population are not available for expanded GCC area of 436 sq.km, consisting of 200 wards.

Source: Urban Management Centre

Governance and Administration

The GCC governs the city of Chennai through its elected and administrative wings. The elected wing is led by the Mayor, who presides over the Council, along with 200 Councillors, each of whom represents one of the wards of the city. The administrative wing is led by the GCC Commissioner, who is supported by a team of Deputy Commissioners, various Heads of Departments, and Zonal Officers. The functions of the GCC are governed by the Chennai City Municipal Corporation Act, 1919, and overseen by the Municipal Administration and Water Supply Department at the state level.[8]

For administrative ease and decentralized services provision, the GCC is divided into 15 Zones, which are further divided into 200 Divisions. The Zones are organized into three Regions called "Regional Deputy Commissioner Office" – in the North, Centre, and South. Work is ongoing to systematically organize the GCC administration into well-defined, hierarchical structures, with duties and responsibilities allocated at each level (for details, see Chapter 7).

The overall planning for the city of Chennai, along with the metropolitan, is undertaken by the CMDA. The GCC is in charge of providing basic services such as roads, solid waste management, primary health services, urban poverty alleviation, and slum improvement. However, the functions of water supply and sewerage are undertaken by the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB), a statutory board under the Government of Tamil Nadu (GoTN). Additionally, electricity generation and distribution are the responsibility of Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO), a company owned by the GoTN. Transportation is governed by a multitude of agencies, including Chennai Metro Rail Limited (CMRL) and Chennai Suburban railways, and Metropolitan Transport Corporation (bus transportation).

8 https://www.tn.gov.in/department/21

Source: iStock Photo

1.2 Socio-economic Background

Chennai's vibrant economy is based on the automobile, software industry, medical tourism, hardware manufacturing, and financial services. Petrochemicals, textiles, and apparels form the bulk of the industrial base of the Chennai region, with the Chennai and Ennore ports serving as major economic drivers. According to GCC estimates, there are approximately 15,000 industries and factories licensed in the Chennai city and GCC alone accounts for 11 per cent of the state's income.[9]

In the absence of GCC's GDP data, data from the CMA has been used to assess the economic potential of the city. The CMA accounts for almost 16.21 per cent of the state income from all sectors[10] and contributes an estimated GDP of US$78.6 billion (as of 2021),[11] which is expected to increase to US$100 billion by 2025.[12] The CMA also hosts more than 20 electronic hardware technology parks in major IT-centric Special Economic Zones of Sriperumbudur, Mahindra World City, and Oragadam.[13]

As per Census 2011, workforce participation within the city is at around 40 per cent of the total population. Out of this, only about 25 per cent are women, marginally lower than the national urban women workforce participation at 28 per cent. As is the case in most Indian cities, a significant proportion of the total working population is engaged in the informal sector, which comprises self-employed traders, hawkers, family-based workers, and low-paying sectors such as rickshaw pulling, repair of bicycles, and personal services.[14] Census 2011 puts non-workers within the city at 42 per cent, out of which 14 per cent are men and 27.6 per cent are women.

Youth in Chennai

Chennai – being a vibrant economy based on the automobile, software industry, hardware manufacturing, etc. – provides ample opportunities for the city's youth. Around 32 per cent of the population is youth as per the Directorate of Youth Welfare Tamil Nadu. This substantial and vital part of the population is key in taking charge against climate change. Their higher awareness, proactive attitude, and willingness to bring about change are key to tackling climate change. In this context, it is of utmost importance that the youth are informed and facilitated to actively engage in climate actions.


Source: Chennai Smart Cities Limited

The current initiatives of the GoTN to ensure youth involvement in green climate action include the "Tamil Nadu Green Fellowship Programme," launched by the Chief Minister of Tamil Nadu under the Environment, Climate Change, and Forests Department. It aims to encourage and engage passionate young people meaningfully in the governance and administration of environmental policy design and implementation. The fellows will monitor and evaluate the outcome, communicate the impacts of policies, and deliver better services.

In addition to this, youth engagement is being encouraged through a variety of formal and informal structures such as the National Service Scheme (NSS), National Cadet Corps (NCC), Nehru Yuva Kendra (NYK), youth associations, special awareness programmes on selected aspects based on international, national, state, and local declarations. Programmes organized with the engagement of youth in general and students in particular – whether it is cycling, marathon, or tree plantation – have a strong correlation with green climate outcomes. In

9 Greater Chennai Corporation. Accessed on 26 August 2022, from https://chennaicorporation.gov.in/gcc/about-GCC/greater-chennai-corporation/brief-note-about-GCC/

10 Chennai Master Plan, 2026.

11 World Bank, 2021.

12 Confederation of Indian Industry.

13 FICCI, Chennai: Driven by Diversified Economic Base,2019.

14 Chennai Master Plan, 2026

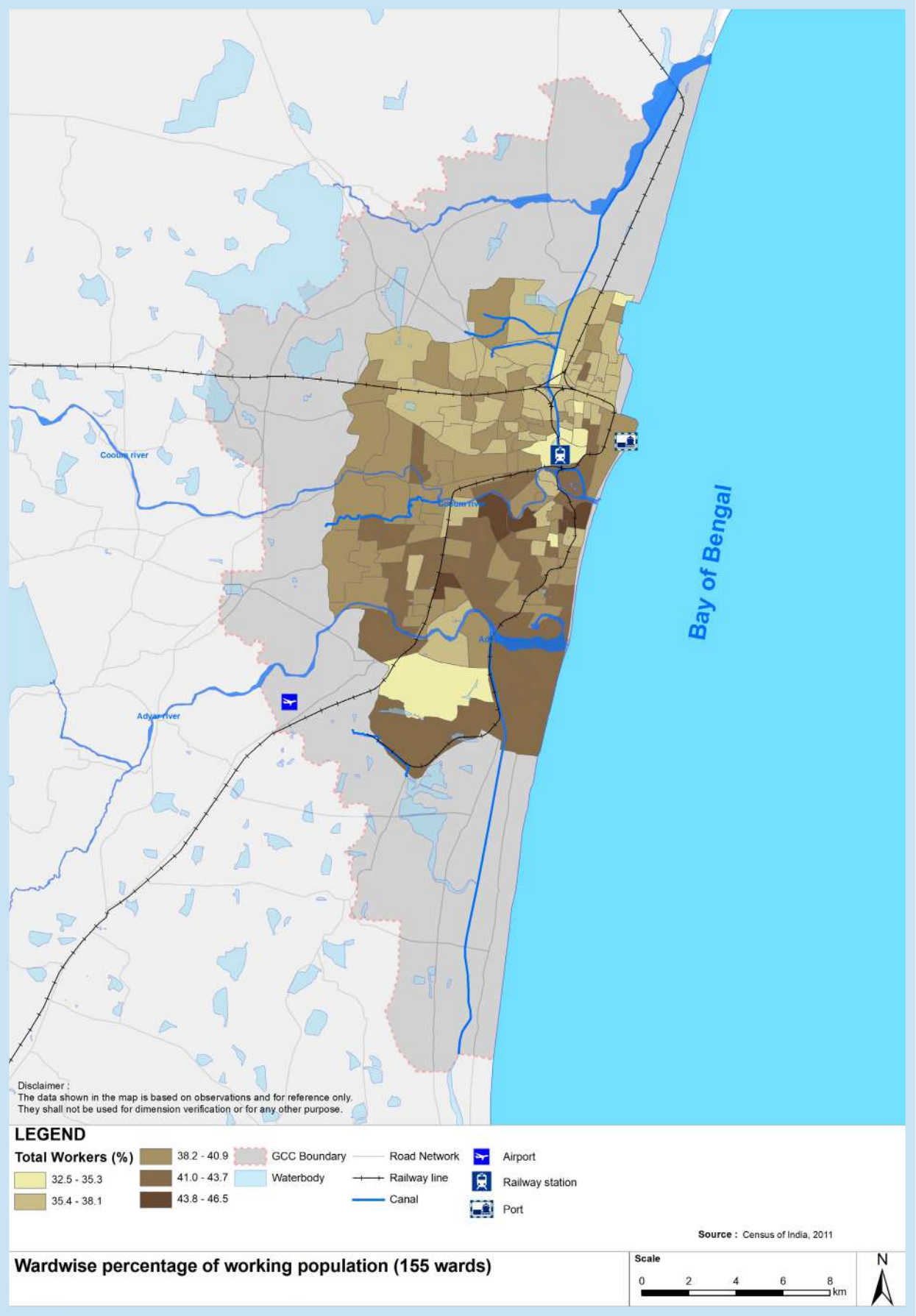


Figure 6: Ward-wise Percentage of working population

Ward-wise population data is only available for 155 wards as per Census 2011, as the GCC expanded in 2012.

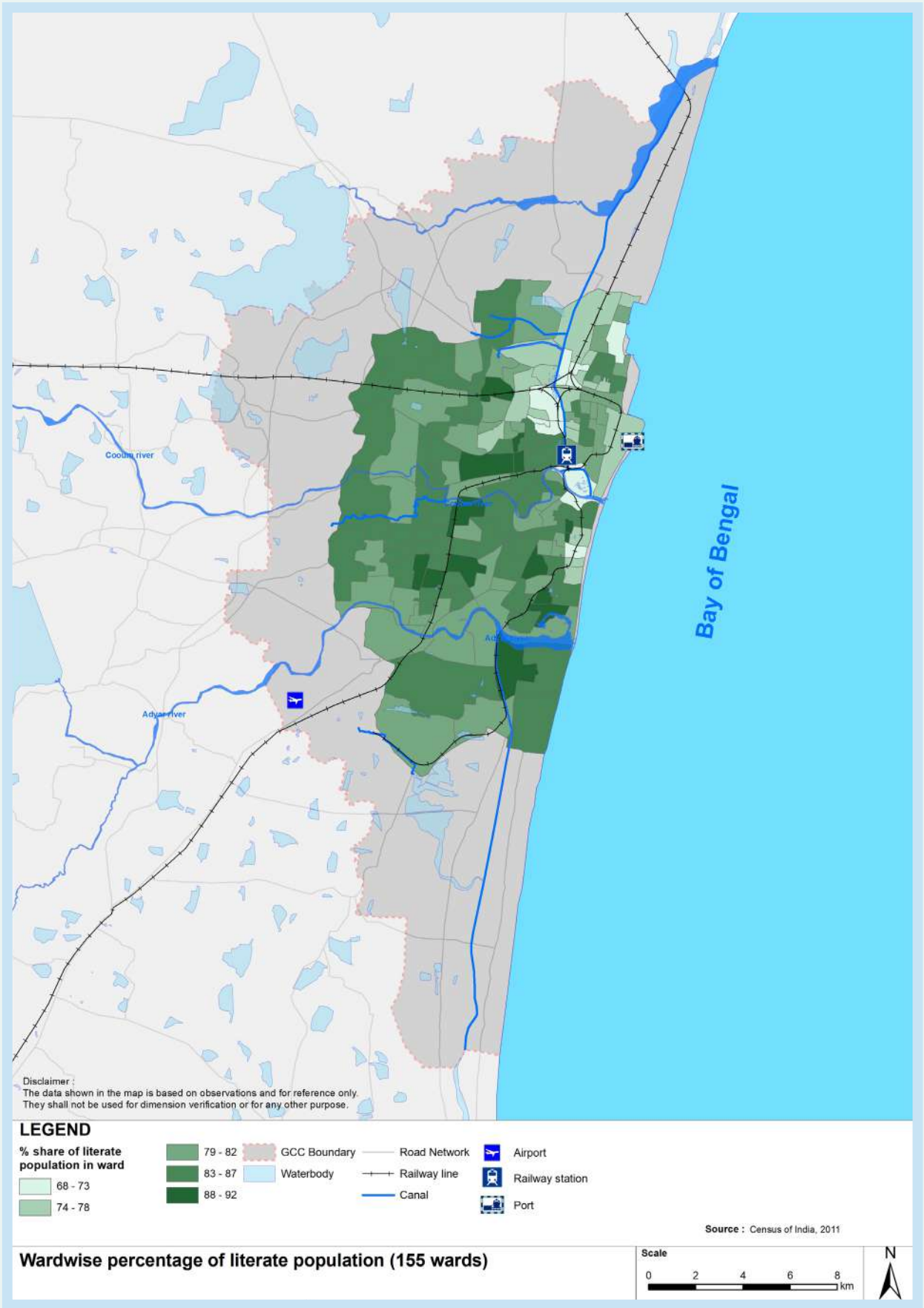


Figure 7: Ward-wise Percentage of Literate Population As Per Older GCC Boundary

Ward-wise population data is only available for 155 wards as per Census 2011, as the GCC expanded in 2012.

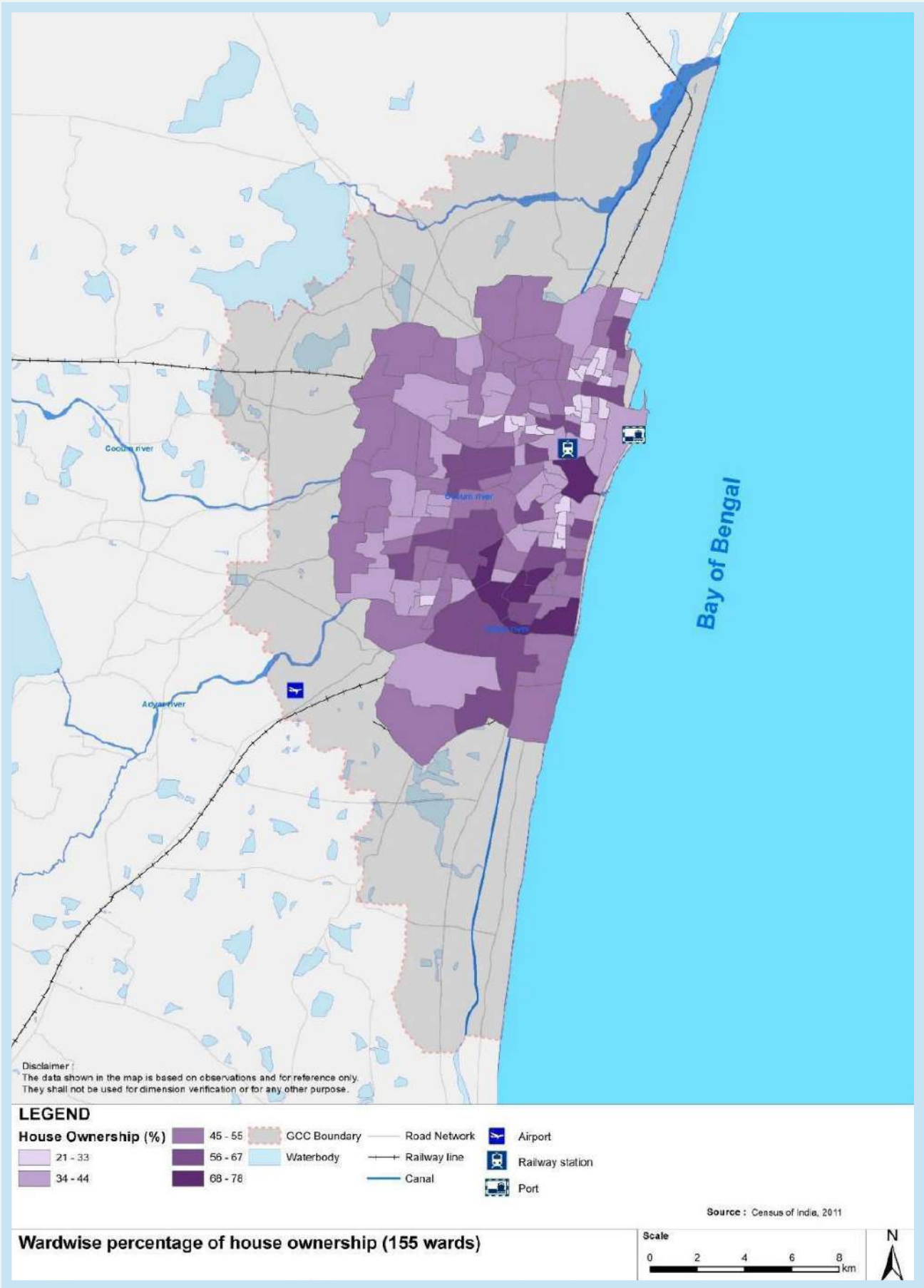


Figure 8: Ward-wise Percentage of House Ownership As Per Old GCC Boundary[18]

Ward-wise population data is only available for 155 wards as per Census 2011, as the GCC expanded in 2012.

Source: Chennai Smart Cities Limited

all these initiatives, climate change-related activities can be consciously promoted. As of 2021–22, about 390,700 volunteers are enrolled in the NSS across 43 universities and directorates in Tamil Nadu. The NSS Units in the institutions conduct programmes to raise awareness and develop personality and leadership qualities. Further, these programmes cover disaster management, environment enrichment, awareness about the reduction of plastic usage and road safety, social forestry projects, model forestry, and sapling plantation. Similarly, the NCC aims to create, inter-alia, a human resource collective of organised, trained, and motivated youth to provide leadership in all walks of life and are always available for the service of the nation. At present, the Tamil Nadu NCC Directorate has an enrolment of 552 colleges with 33,762 senior division/wing cadets, and 1,004 schools with 69,349 junior division/wing cadets – totalling 103,111 cadets.

Thus, there is a substantial scope for a fruitful and mutually beneficial partnership between the GCC and the State Directorate of Youth Welfare, in promoting climate change-linked objectives.

Vulnerable Population and Key Frontline Communities

Slum Dwellers of Chennai: Chennai has the fourth-highest population of slum dwellers among major cities in India, with about 820,000 people (18.6 per cent) living in slum conditions.[15] The Tamil Nadu Urban Habitat Development Board (TNUHDB) estimates that approximately 108,000

15 Chennai District Statistical Handbook (2016–17).

families from the economically weaker section live in *undeveloped slums*, of which about 67 per cent live in *objectionable slums*. Further, 37,000 families are estimated to be living in *unobjectionable areas*, and about 9,680 and 14,237 families live on the Adyar and Cooum riverbanks, respectively. Thus, a considerable portion of the city population is highly vulnerable to potential disasters, given the residential concentration in high-risk flood plains and low-lying areas. According to the Census 2011 data, there are 1.1 million households in the city, and the residential housing stock available is 1.15 million. About 427,000 families (with an average size of five members) live in small dwelling units with only one room. An earlier assessment also indicated the need to generate about 420,000 units for low-income groups by 2016.

To alleviate urban poverty, the state and the local governments are federating the urban poor, especially women, into Self-Help Groups (SHG), to encourage them to create savings and link them with formal credit. Such SHGs enable the layering of health and other messaging and create linkages with social and financial safety schemes. As of 2022, there are 14,072 SHGs in Chennai, with 209 Area-Level Federations and three City-Level Federations.[16]

Key Frontline Community: The effects of climate change disproportionately affect communities residing in vulnerable areas. The key frontline groups include women, children, disabled people, elderly people, people residing in informal communities, and low-income communities.

During floods, people residing in low-lying areas are likely to face extreme hazard impacts, resulting in the loss of livelihood, basic infrastructure loss, etc. These households may also face disruption in power, telecommunication services, rail, and road transport. As healthcare facilities, too, fall in risk zones, people residing in these areas may not be able to access healthcare facilities in times of crisis. In case of water scarcity and heat waves, households with limited access to piped water and vulnerable citizens (e.g., women and children) face socio-economic inequities. In times of water cuts, for example, poor households are unlikely to be able to afford water tankers, adding to the burden of the crisis. To address these inequities and vulnerabilities, the CCAP commits to strengthening livelihoods by providing equitable and affordable access to healthcare, basic infrastructure, housing, etc. It prioritizes improving access to healthcare facilities in risk zones, formulating strategies to tackle urban head-related risk, implementing actions towards conserving water resources, creating green spaces within the city, and executing climate actions in an inclusive and equitable manner.

Fisherfolk in Chennai: The livelihoods of the fisher families are intrinsically linked to the coast. The Chennai coast is dotted with several fishermen colonies – all along the length of about 19 km. Of the total 802,912 fisherfolk population enumerated across the 13 districts of Tamil Nadu, Chennai alone is home to about 8 per cent – accounting for 67,464 fisherfolk population constituting 15,176 fisher families.[17] Moreover, most of the community (95.2 per cent) falls in the Below Poverty Line category.

A majority of the 15,176 families have pucca houses (85 per cent), with only a small Percentage living in kutcha houses.[18] It is also found that many families possess lifesaving and/or electronic equipment, with 3,679 having lifesaving equipment and 4,993 having mobile phones. However, only 117 families have access to GPS facilities, and there is a need for greater reach of this facility among fisherfolks. About 14 per cent of the fisherfolk in Chennai are educated up to the primary level, 15 per cent up to the higher secondary level, and 3.6 per cent above the higher secondary level.[19]

Chennai has 14 fish-landing centres, where a total population of 25,851 is engaged in fisheries or other relevant occupations. Out of this, 56 per cent are active fishermen and 32 per cent are engaged in allied activities, such as marketing fish; making and repairing nets; cutting, processing, and peeling; and related labour. Out of the total population engaged in allied activities, 65 per cent are women, indicating a very high level of female engagement in the fishing industry. A high level of participation in cooperative efforts has also been noted among the fisherfolk, with 15,730 being members of fishery cooperatives and 5,337 other cooperatives.[20]

16 DAY-NULM MIS (2022).

17 Marine Fisheries Census 2010 for Tamil Nadu. Ministry of Agriculture, Government of India.

18 Marine Fisheries Census 2010 for Tamil Nadu. Ministry of Agriculture, Government of India.

19 Ibid.

20 Ibid.

Social Infrastructure Status

Chennai has a female and male literacy rate of 78.25 per cent and 84.25 per cent, respectively. The city's average literacy rate (81.27 per cent) is higher than the national average literacy rate (72.99 per cent). Currently, the GCC runs 281 schools (including primary, middle, and higher secondary schools) across Chennai.

The GCC is also responsible for managing urban primary health centres, urban community health centres, emergency obstetric centres, and medical and paramedical staff. It manages 138 urban

Source: iStock Photo

primary health centres, 14 urban community health centres, three emergency obstetric centres, and one communicable diseases hospital. On average, about 17,800 patients are treated daily in these facilities.[21] The city also has a network of 1,350 anganwadis, to provide childcare support to children below six years of age. Overall, with its well-equipped facilities, Chennai meets most of the health infrastructure requirements of its regional population.

Civil Society Engagement and Collaboration

The partnership between Chennai city and civil society has been institutionalized in several areas such as livelihood rehabilitation, housing reconstruction, and disaster mitigation. Civil society and community-based organizations, along with academic and research institutions, are being engaged at all levels to mainstream and converge emergency response and disaster risk reduction for government development plans, programmes, and processes. Some of the identified non-governmental/civil society organizations working towards climate action in Chennai city include Environmentalist Foundation of India, Care Earth Trust, Institute for Transportation and Development Policy, and 100 Resilient Cities. Further, the involvement of institutions such as the Indian Institute of Technology (IIT) Madras and Anna University, which have specialized centres dealing with climate change-related issues, are a huge advantage for the city.

1.3 Physical and Ecological Landscape

Physical Landscape

Topography: Chennai is a plain terrain low-lying area and has an almost-flat land surface, with contours ranging from 2–10 m (7–33 ft) above mean sea level and a few isolated hillocks. Its average elevation is around 6–7 m (20–23 ft), and its highest point is 60 m (196 ft). The average slope varies at 0.7 m (2.3 ft) per km, with some localities at just sea level or even below sea level. Chennai has a long coastline of about 43 km, starting from Kathivakkam in the north to Uthandi in the south (refer figure 9).

Geology: The city is classified into three regions based on geology: clayey region (T. Nagar, West Mambalam, Anna Nagar, Perambur, and Virugambakkam), sandy region (Thiruvanmiyur, Adyar, Kottivakkam, Santhome, George Town, Tondiarpet, and rest of coastal Chennai), and hard rock areas (Adambakkam and a part of Saidapet). The groundwater table across most of Chennai is at a depth of about 4–5 m. In clayey and hard rock areas, percolation of rainwater is slow, and the water retention/stagnation period is high.

Weather and Climate: Being a coastal city close to the thermal equator, the weather in Chennai is relatively consistent, with little variation in the seasonal temperatures. The city experiences three major seasons: summer, monsoon, and winter. Chennai has a largely tropical climate, with the maximum temperature ranging from 38°C to 42°C from April to June. During winter months, Chennai maintains an average maximum and minimum temperature of 24°C and 20 °C, respectively, as shown in Figure 12.

The Indian Meteorological Department has two rain recording stations and four automated warning systems in Chennai. The city experiences two monsoons annually: the southwest monsoon during June–September, and the northeast monsoon during October–December. The average rainfall recorded for the southwest monsoon and the northeast monsoon is 439 mm and 760 mm, respectively, with the latter contributing the major share of rainfall in the city.[22] Chennai's average annual rainfall is about 1,300 mm.

Ecological Landscape

The natural ecosystem of Chennai comprises three rivers (Kosasthalaiyar, Cooum, Adyar); five wetlands (Pallikaranai Marsh, Pulicat Lake, Kattupalli Island, Madhavaram and Manali Jheels, Adyar Estuary Creek); and six forest areas (Huzur Gardens; Vandalur;

21 GCC City Disaster Management Plan (2021).

22 Chennai City Disaster Management Plan, GCC, 2021.

23 https://www.worldweatheronline.com/chennai-weather-averages/tamil-nadu/in.aspx

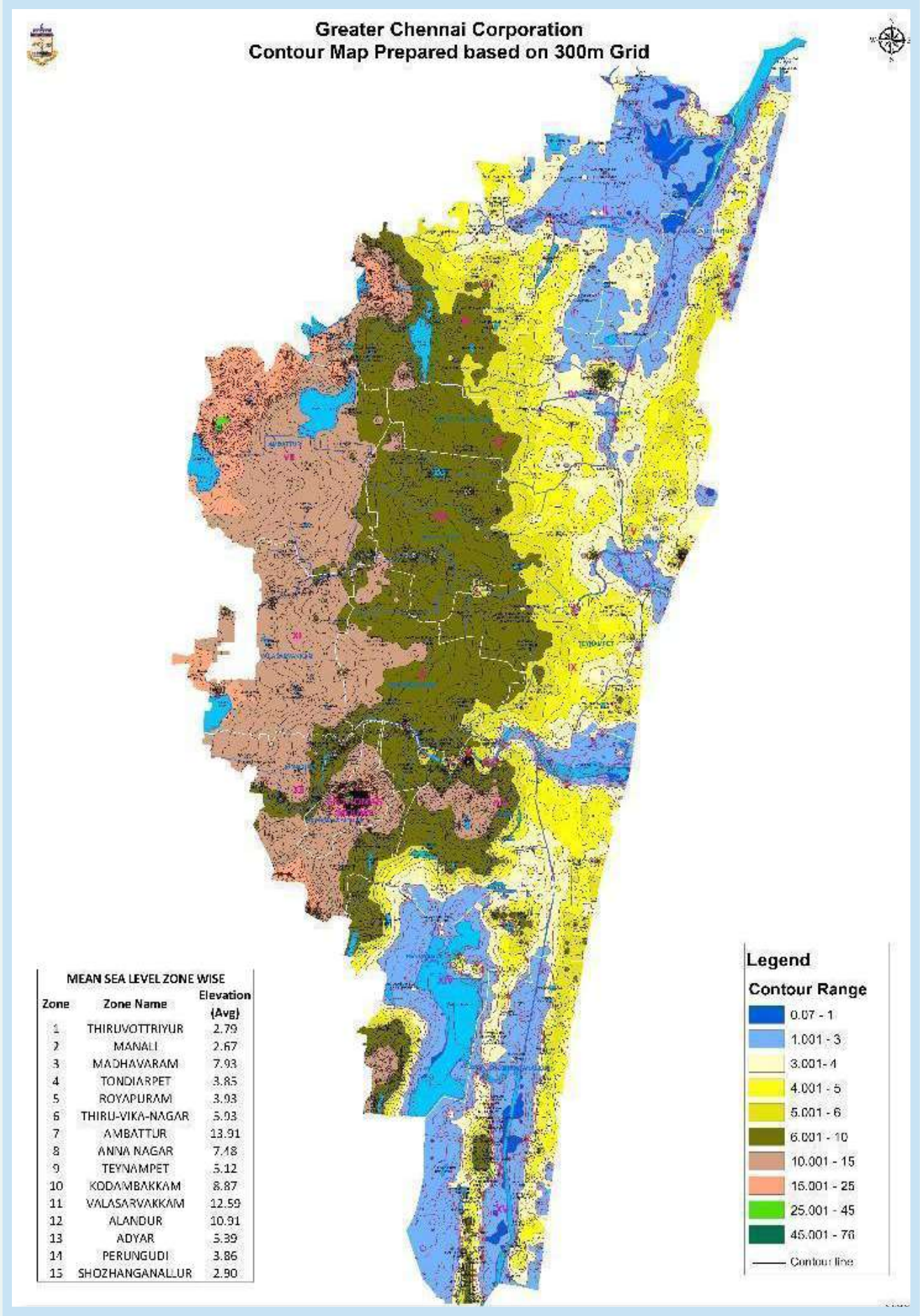


Figure 9: Contour Map of Chennai

Note: The contour range is in meters.

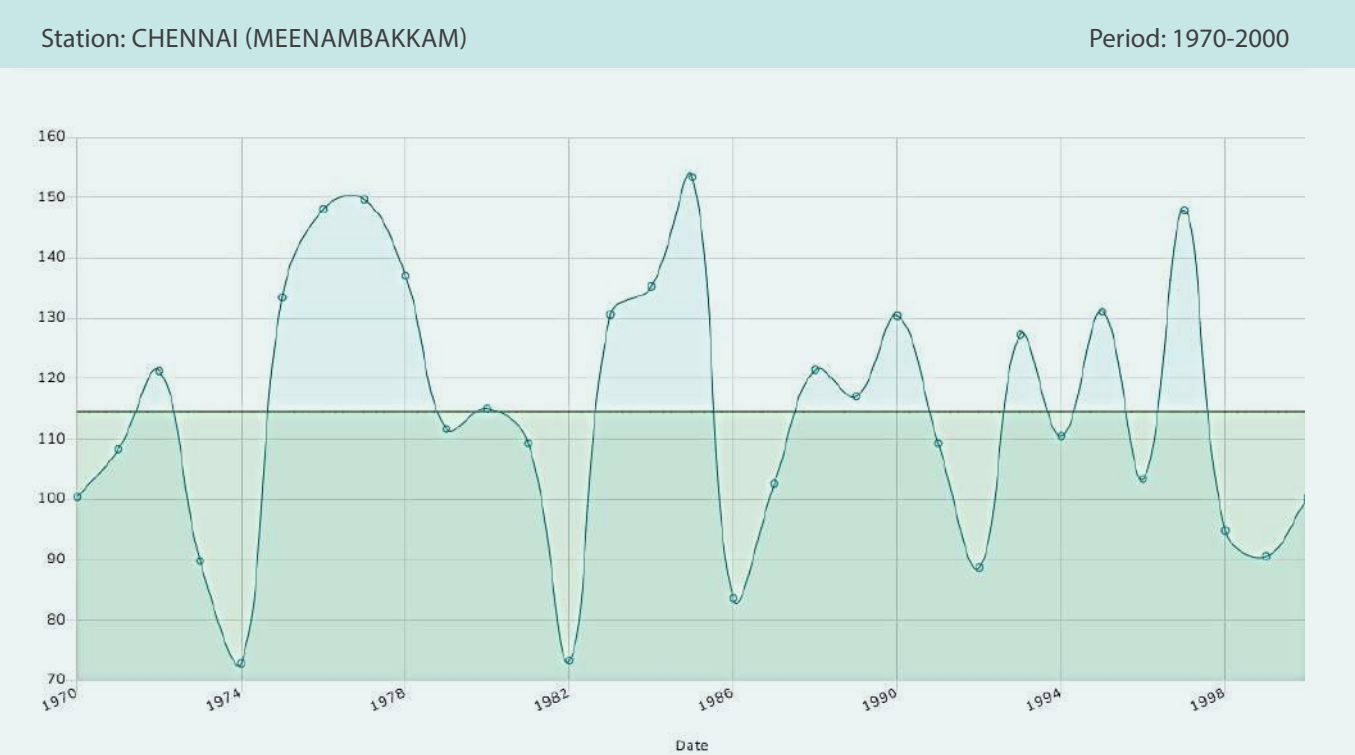


Figure 10: Annual Rainfall (1970–2000)

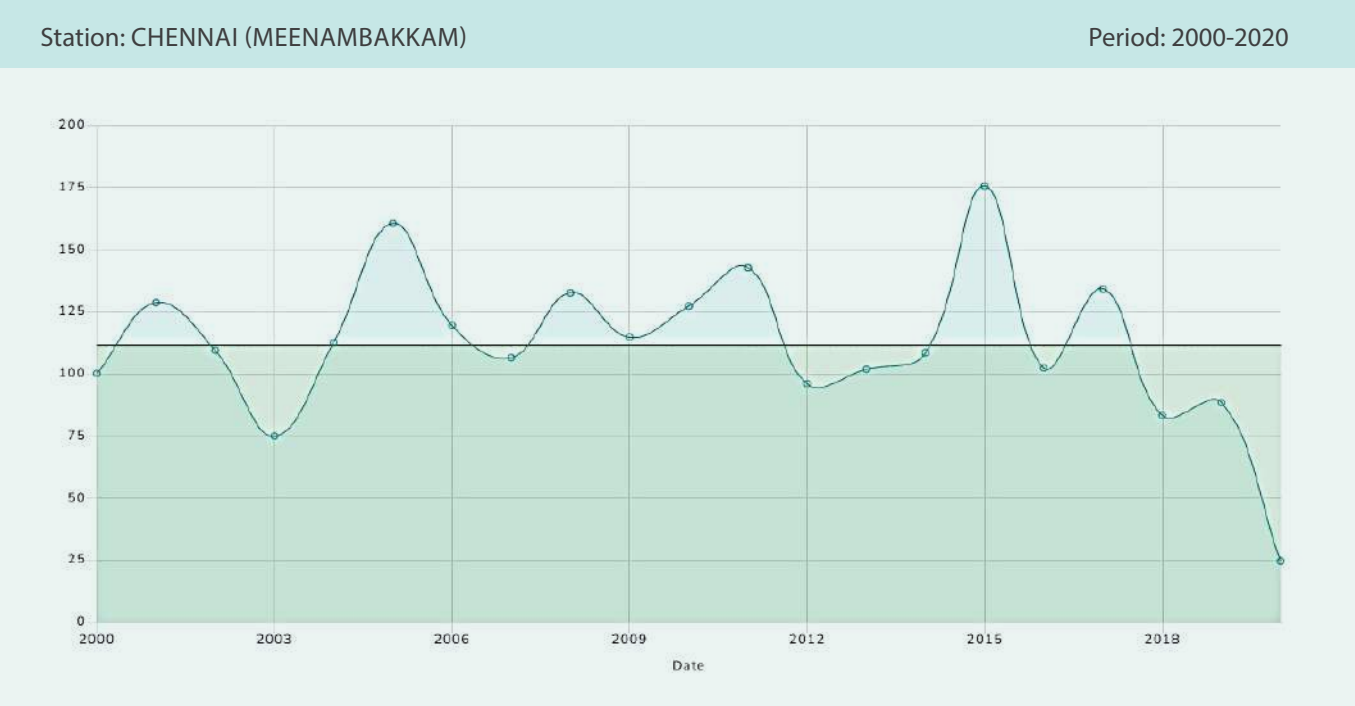


Figure 11: Annual Rainfall (2000–20)

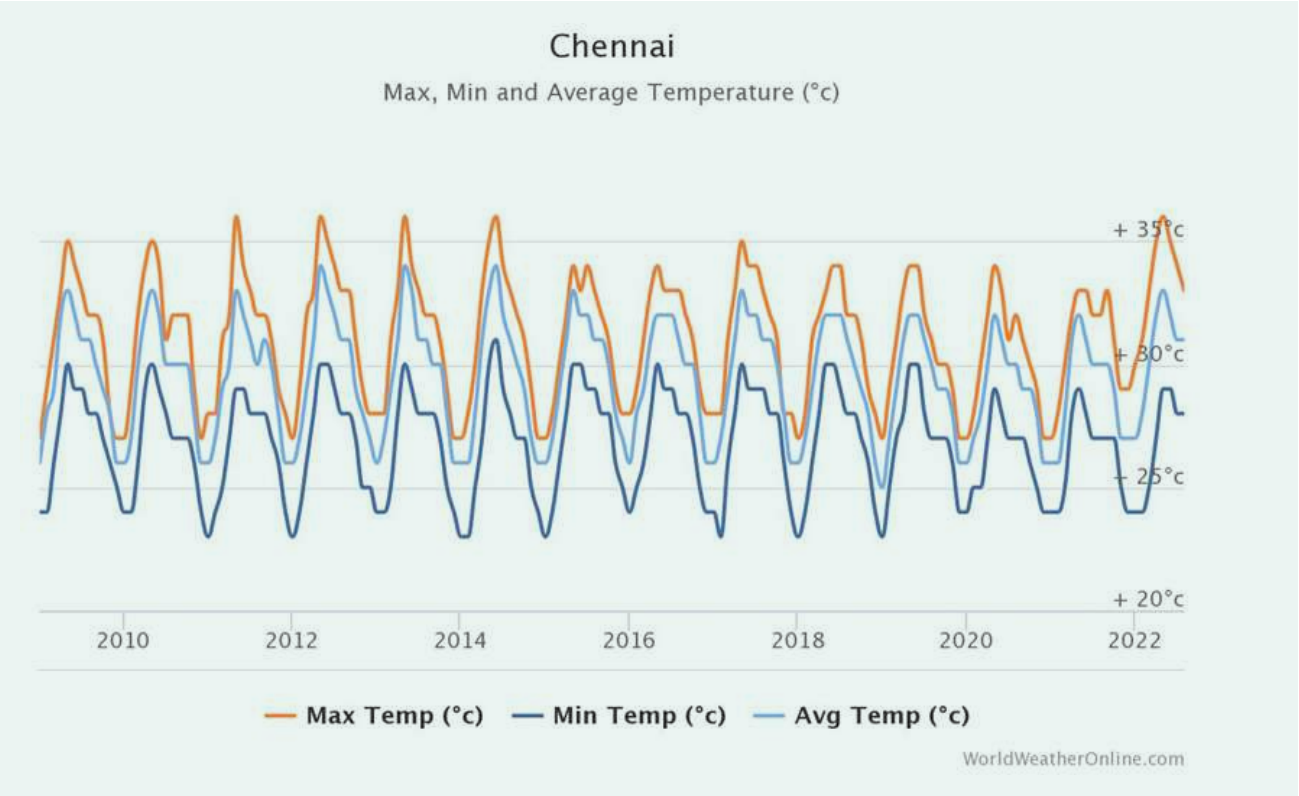


Figure 12: Temperature over the Years (2010-22)*

Guindy National Park; and the forests in IIT Madras, Madras Christian College, and the Theosophical Society). The Buckingham Canal, which was constructed as a navigation canal in 1806, runs parallel to the coast and links the two rivers, also plays an important role in the water map of the city.

In addition to the above major river systems, there are 31 minor canals running in the city, which play a crucial role in draining rainwater. The three major tanks in the CMA are Cholavaram, Red Hills, and Chembarambakkam; these also serve as the main source of water supply to Chennai. The Cholavaram Tank is a secondary storage tank and receives water from the Poondi reservoir, which lies outside the CMA region. Water from the Red Hills Tank is released into the Red Hills Surplus Channel, which then discharges into the Kosasthalaiyar River and then into the Bay of Bengal. The Chembarambakkam Tank in the southern part of CMA releases its surplus water into the Adyar River. These three major tanks play a crucial role in moderating the flow of floodwater in the rivers and, consequently, impact floods in Chennai and the CMA area. Further, several water bodies of varying sizes are located on the western fringes of the city. While Otteri Nullah, Kodungaiyur Drain, and Captain Cotton Canal drain into the Buckingham Canal, Veerangal Odai and Velachery Drain discharge into Pallikaranai Marsh. The Virugambakkam Drain discharges into the Cooum River. Figure 13 shows these ecological features within the GCC.

The Pallikaranai Marsh serves as a buffer for rainwater draining from the Perungudi, Velachery, Kilkattalai, Pallikaranai, and Narayanapuram lakes and a string of upstream lakes. Pallikaranai Marsh also holds significant importance as a natural habitat for more than 115 species of birds, 10 species of mammals, 21 species of reptiles, 10 species of amphibians, 46 species of fishes, 9 species of molluscans, 5 species of crustaceans, and 7 species of butterflies. About 114 species of plants are found in the wetland including 29 species of grass.[24] These plant species include some exotic floating vegetation, such as water hyacinth and water lettuce, which are less extensive now and highly localized. It is also home to some of the most endangered

24 Forest Department makes first move to get Pallikaranai marsh declared Ramsar site, The Hindu, August 2011

* https://www.worldweatheronline.com/chennai-weather-averages/tamil-nadu/in.aspx

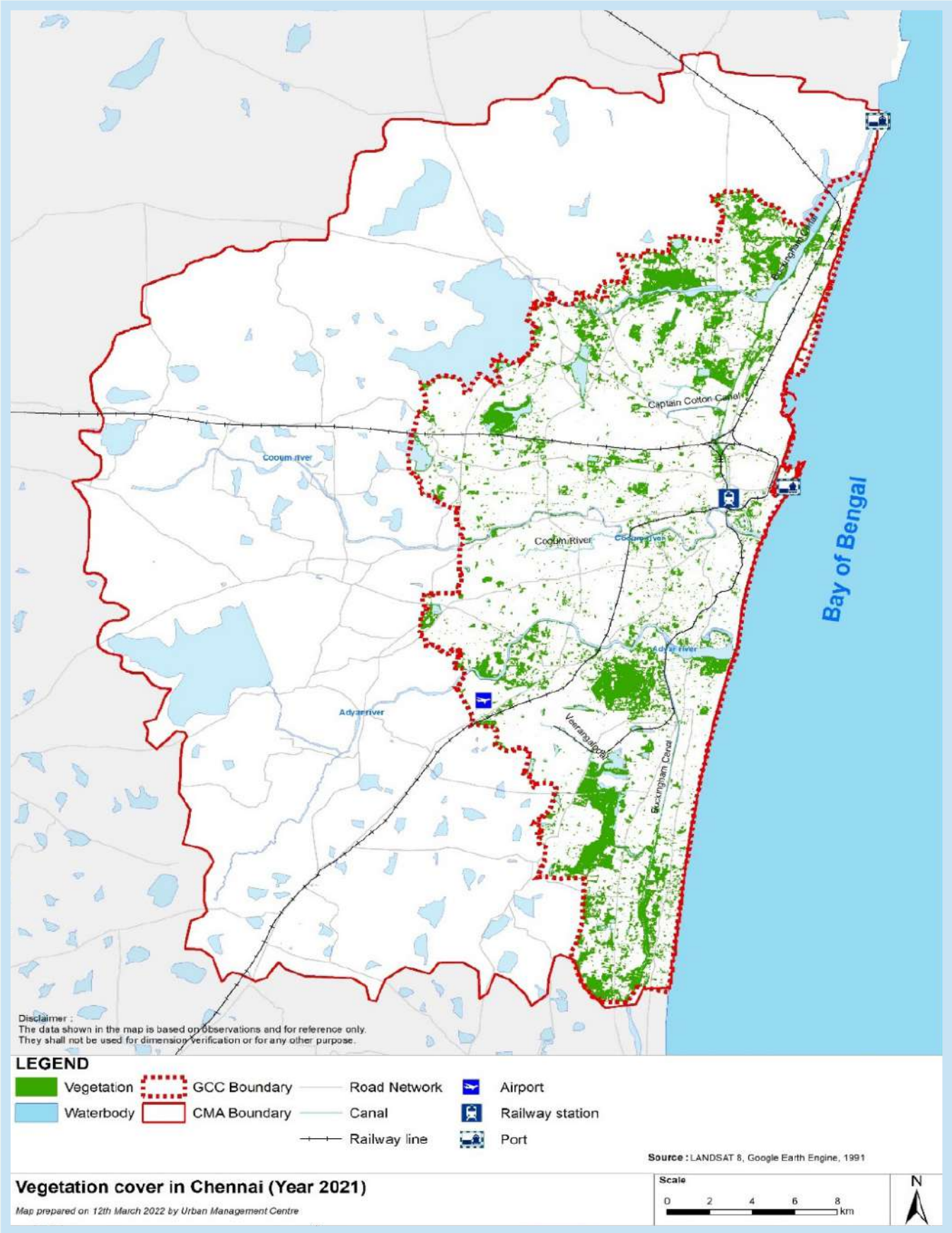


Figure 13: Ecological features in Chennai

reptiles such as Russell's viper and birds such as the glossy ibis, grey-headed lapwings,[25] and pheasant-tailed jacana. The Pallikaranai Marsh is declared a Ramsar site[26] by the Department of Environment, Climate Change, and Forest.

In addition to the six forest areas, the GCC maintains 525 parks over an area of 1.36 sq. km, and 763 Open Space Reservation (OSR) landmasses, measuring about 16.05 sq. km. The Parks Department of the GCC has planted over one lakh plantations at 35 locations, for the creation of urban dense forests, using the Miyawaki method. However, a report by Care Earth Trust, 2018, highlighted that the green cover in Chennai had decreased by nearly 22 per cent over the past two decades, with an increase in the built-up area. As of 2021, the GCC has a total vegetation cover of 74.3 sq. km and 18.95 sq. km under water bodies.[27] The current per capita green space in Chennai is 8.75 sq.m. per person, comparatively less than the WHO standards of 9.5 sq.m. per person.

Biodiversity in Chennai

Tamil Nadu wild plant diversity includes a vast number of Bryophytes, Lichens, Fungi, Algae, and Bacteria. The faunal diversity of Tamil Nadu includes 165 identified freshwater fishes, 76 amphibians, 127 reptiles, 545 birds, and 187 mammals[28]. Forest management in Tamil Nadu is focused on the conservation of biodiversity, the forefront of protecting its wildlife, and has a very good network of Protected Areas. Guindy National Park is a protected area of Chennai. There are over 14 species of mammals including blackbucks, chittals, spotted deers, jackals, small Indian civets, common palm civet, bonnet macaque, hyena, pangolin, hedgehog, common mongoose, and three-striped palm squirrel[29] and a wide variety of snakes, geckos, star tortoises and over 130 species of birds such as The park has over 150 species of birds including grey partridge, crow pheasant, parrot, quail, paradise flycatcher, black-winged kite, honey buzzard, pariah kite, golden-backed woodpecker, yellow-wattled lapwing, red-wattled lapwing, blue-faced malkoha, shrikes, Asian koel, minivets, munias, parakeet, tailor bird, robin, drongo, and stone curlew., and over 60 species of butterflies and spiders each, a wealth of different invertebrates—grasshoppers, ants, termites, crabs, snails, slugs, scorpions, mites,

Source: Chennai Smart Cities Limited

25 Rare grey-headed lapwing spotted in Pallikaranai marsh, The Times of India, February, 2011

26 Ramsar Sites are the wetlands which are declared to be protected as part of Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat.

27 As per Landsat 8, USGS Image Processed by UMC (2021).

28 Tamil Nadu Action Plan for Climate Change (TNSAPCC), 2015

29 Guindy National Park, Tamil Nadu Forest Department, Retrieved on 16th January 2013

earthworms, millipedes, and the like. Apart from this, the olive ridley turtles also nest on the beaches of Chennai from mid-december to April[30].

1.4 Current Climate Actions across the City

All state and local government-level stakeholders have taken some initiatives toward GHG emissions reduction as well as climate adaptation (details of these initiatives are covered in the subsequent sections.) While many of these climate actions are largely disjointed, lack granularity, and fail to adequately cover the wide spectrum of possible actions, they are contributing to building adaptation to climate-induced changes, viz., strengthening flood management situations.

The Chennai Preliminary Resilience Assessment and the Chennai Resilience Strategy, prepared by 100 resilient cities, in partnership with the GCC, have helped build a basic understanding of the climate risks associated with Chennai and the strategies that can help the city build resilience. To this end, all recommendations made are aimed at providing social and environmental benefits, while also driving development-resilience linkages, with a focus on leadership and strategy, economy and society, infrastructure and environment, and health and wellbeing.

The city of Chennai has witnessed several natural calamities in the last three decades, with frequent occurrences of floods, cyclones, and droughts. While the Bay of Bengal and the Arabian Sea generate only 7 per cent of the world's cyclones (i.e., five to six tropical cyclones per year), their impact is relatively high and devastating, especially when they strike the coasts near cities. This is compounded by Chennai being located in High-Risk Seismic Zone III as per Bureau of Indian Standards 1893 criteria for earthquake-resistant design of structures IS 1893 (Part 1): 2002.

The CDMA follows the Sendai Framework for strengthening disaster risk governance and managing disaster risk. The GCC has formed a Relief Committee to monitor the thrust areas for disaster mitigation. The Control Room (DEOC) at the GCC acts as a communication centre in the city, for the dissemination of information received from the State Emergency Operation Centre (SEOC). The Control Room operates round the clock during disaster times, collaborating with associated departments/ institutions for the dissemination of information; search and rescue; and relief and rehabilitation. The District Disaster Management Authority (DDMA) constituted under the Chairpersonship of Commissioner, GCC, acts as the district planning, coordinating, and implementing body for disaster management and takes all measures in accordance with the guidelines laid down by the SDMA.

Currently, the GoTN is in the process of adopting an Incident Response System (IRS) that will be implemented across the state to streamline and unify stakeholder efforts and ensure immediate response during disasters. The Disaster Management Perspective Plan, 2021 focuses on increasing resilience and preventing the emergence of disasters by strengthening scientific and technical capabilities and encourages coordination between governmental departments, NGOs, and other institutes to reduce and manage disaster risks.

To assess the effectiveness of implementing the 2026 Master Plan prepared by the CMDA, the CAG's report on "Performance Audit-Flood Management and Response in Chennai, 2015" addresses the issues of encroachment, which hinders the free flow of rainwater, economic development, and the execution of flood-management programmes.

The Comprehensive Mobility Plan prepared in 2019 for the CMA focuses on planning for people-centric mobility in the city. It aims to ensure extensive community engagement of various stakeholders around disaster preparedness and response; relief and rehabilitation; and coordination with Central Agencies and Armed Forces.

A Relief Committee under the chairpersonship of the Commissioner GCC has been formed with the participation of the District Collector - Chennai, CMWSSB, Police (Traffic), Highways and Rural works, PWD-Chennai and Environ area along with the MRTS and Fire Services Department as and when necessary. The Relief Committee monitors major thrust areas for disaster mitigation, including regular eviction of encroachments to maintain the free flow of rainwater; identification of vulnerable roads, subways, and level crossings within the GCC limit that are likely to be inundated during heavy rains; identification of roads and areas that are prone to inundation/traffic congestion during heavy rains; monitoring of all major drainage channels and waterways such as the Adayar and Cooum Rivers, Buckingham Canal, and Otteri Nullah; and identification of new drainage systems and interlinking existing drainage systems for the

30 Chennai's favourite annual visitors, The Hindu, August 2022

efficient discharge of rainwater.

The Tamil Nadu State Action Plan for Climate Change (TNSAPCC), in alignment with National Action Plan for Climate Change (NAPCC), has identified seven focus sectors for promoting awareness about climate change, adaptation, mitigation, and natural resource conservation while pursuing overall development in the city. These are

(1) Sustainable Agriculture,
(2) Water Resources Management,
(3) Forest and Biodiversity,
(4) Coastal Area Management,
(5) Sustainable Habitat,
(6) Energy Efficiency, Renewable Energy, and Solar Mission, and
(7) Knowledge Management.

The major strategies identified for the Energy Efficiency Sector include a) moving towards renewable energy through the increasing capacity for solar power generation and hydroelectricity in the state, b) adopting enhanced energy efficient appliances and technologies, and c) incorporating ECBC and energy audits for all buildings. For the Water Resource Management Sector, strategies identified include rainwater harvesting, interlinking of river and water bodies and catchment area management, desilting and maintaining drains and canals, and strengthening the stormwater drainage infrastructure. The Sustainable Habitat Sector has proposed adaptation strategies to provide improved housing and resettlement to the vulnerable population, the expansion of the public transport network to develop an efficient and integrated transportation system, and the adoption of electric vehicles to reduce GHG emissions. Strategies identified for Plantation and Urban Greening aim to reduce the effects of urban heat islands and increase carbon sequestration. To strengthen Health System Management, the Tamil Nadu State Action Plan for Climate Change and Human Health (TNSAPCCHH) has recommended developing climate-resilient health systems, which will incorporate actions on health and aim to reduce morbidity, mortality, injuries, and other vulnerabilities resulting from climate variability and extreme weathers.

Source: Chennai Smart Cities Limited

Source: Urban Management Centre

CHAPTER

2

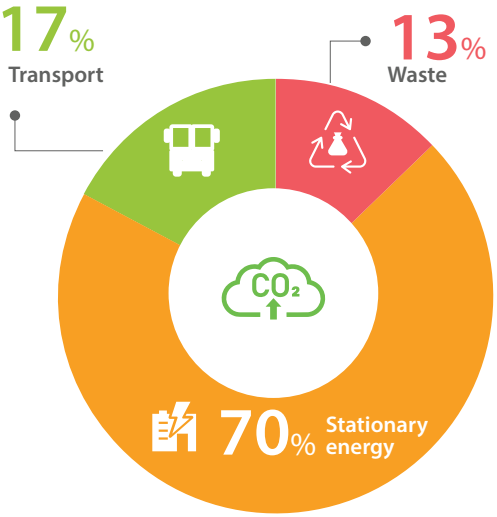
Towards a Resilient and Pro-active Chennai

2.1 Why does Chennai need a Climate Action Plan

Chennai is the fourth-largest city in India and an important commercial hub to the state of Tamil Nadu. Chennai and it's over 8 million population have over the years been increasingly prone to the effects of climate change and have witnessed numerous disasters due to excessive rainfall events, increased frequency of cyclones and storms, and rising temperatures.

India is a signatory to the Paris Agreement, and as such, has pledged to achieve net-zero by 2070 at the recent 2021 United Nations Climate Change Conference (COP26).[31] Chennai city and the state of Tamil Nadu are committed to implement climate actions to reduce the risks of climate change. Both the city and the state have undertaken several climate initiatives in line with meeting the highest targets set under the Paris Agreement with the overall objective to limit the average global temperature increase to below 1.5°C.

An analysis of GHG emissions within Chennai has shown that the major sectoral contributors are Stationary Energy (Electricity & Buildings) at



70 per cent, Transport (Private & Public) at 17 per cent, and Waste (Solid Waste & Wastewater) at 13 per cent. While Cities contribute significantly to environmental degradation and GHG emissions they also present unique opportunities to foster sustainability, efficiency, inclusivity, and committed actions. The impact of climate change is disproportionately high on vulnerable groups of society. This calls for efforts to be made toward

31 COP26: Unpacking India's Major New Climate Targets, WRI India (2021).

Source: Chennai Smart Cities Limited

inclusive, equitable, and fair climate policies. To this end, the implementation of the Chennai Climate Action Plan (CCAP) offers an opportunity to not only reduce the city's contribution to GHG emissions but also ensure climate justice for all.

The vision identified by Chennai under the CCAP is to achieve Carbon Neutrality and Water Balance by 2050. The CCAP serves as a roadmap for the GCC and other stakeholders to take streamlined actions and monitor them continuously to ensure a dynamic process. The intent is to embed climate-change thinking in the institutional culture of the GCC and the city. By taking a holistic view of the current scenario and policies, the CCAP makes recommendations for the short, medium, and long term – to bring about positive changes in compliance with India's overall climate goals and commitments, as well as the UN Sustainable Development Goals (SDGs).

The implementation of the actions identified under the CCAP will help the city realize its vision of Carbon Neutrality and Water Balance therein also systematically addressing climate risks. Further reducing loss of life and damages to property and livelihoods. Implementation of the CCAP will help create green jobs, create access to liveable and walkable neighbourhoods, improvement of service delivery, and enhancement of the city's coping capacity against climate change thus improving the quality of life for the citizens of Chennai.

Key Reasons That Chennai Requires a CAP

Resilience

To help the city be more resilient to climate change induced impacts, reduced fatalities, and loss of livelihoods in extreme weather events.

Quality of life

To improve quality of life for its citizens, especially for the poor and other vulnerable sections

Committment

To realize the city's commitment to address climate change.

Actions

To enable actions for enhancing skills and livelihood opportunities in key sectors.

Source: Chennai Smart Cities Limited

2.2 Chennai's Climate Vision

Chennai is committed towards becoming "**மீள்திறனும் முற்காப்பும் உடைய சென்னை**", which means a "Resilient and Proactive Chennai" by achieving the goals of 'carbon neutrality' and 'water balance' by 2050.

In the built environment, key mitigation emissions reduction opportunities are found in energy efficiency (e.g., stricter building standards/codes) and renewables (e.g., rooftop solar PV). Transport emissions can be reduced through a modal shift from private to public transport and the use of cleaner fuels (e.g., electric and hybrid vehicles). Emissions from waste can be reduced by diverting solid waste from dumpsites and ensuring 100 per cent processing (e.g., through recycling and composting).

To enhance climate resilience and adapt to climate change impacts, the city will focus on strategies for implementing flood and water-scarcity management, conserving natural ecosystems, building resilience through improving disaster risk-reduction measures, developing climate-proof housing and infrastructure, and enhancing the health and wellbeing of communities.

To realize its vision, the CCAP presents a roadmap

மீள்திறனும் முற்காப்பும் உடைய சென்னை

Resilient and Proactive Chennai

GOALS BY **2050**

1 CARBON NEUTRALITY

2 WATER BALANCE

What is Carbon Neutrality?

Carbon neutrality means achieving net zero carbon dioxide emissions at a global scale through the balance of residual carbon dioxide emissions with the same amount of carbon dioxide removal. To achieve carbo1n neutrality, Chennai aims to reduce carbon emissions from energy generation, buildings, transportation, and waste by supporting activities that are not carbon intensive. Carbon emissions are the main reason behind the increase in global temperature, which is responsible for floods, storms, heat waves, droughts, and sea-level rise.

What is Water Balance?

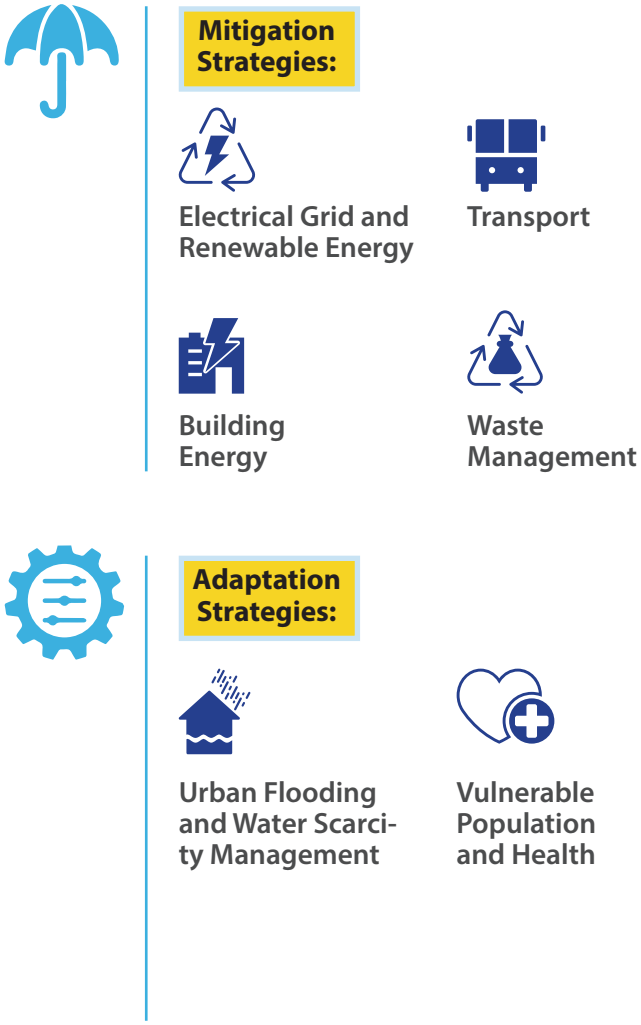
Erratic weather patterns resulting from climate change have made Chennai vulnerable to the contrasting effects of flooding and droughts. It has created a situation of water abundance and water scarcity within the same geography at different time periods.

Achieving water balance implies that Chennai promotes sustainable water supply, particularly in the context of extreme climate-related water events (i.e., droughts and floods) and the increasing demand for water that is associated with a rapidly growing and developing city.

Achieving water balance will help reduce the impact of climate change and erratic rainfall patterns in Chennai, while also using innovative water management strategies to improve storage and reduce usage, demand, and losses. This is critical to increasing resilience to droughts, water variability, and scarcity.

Figure 14: Vision and Goals

to the city, with clearly identified mitigation and adaptation strategies in the short, medium, and long term, focusing on six key sectors:



The adaptation strategy focuses on increasing coping capacity towards climate risks, especially for disadvantaged and vulnerable groups. The city's mitigation strategy is adopted to reduce emissions. GCC along with concerned stakeholders is setting targets to reduce citywide GHG emissions by 1 per cent by 2030, 40 per cent by 2040 compared to 2018 levels, as well as achieve net zero by 2050. These targets align with Deadline 2020 and the Paris Agreement, demonstrating Chennai's vision to create a cleaner, greener, and healthier city that aspires to meet the highest goals of the Paris Agreement.

Each of these sectors has a set of actions that will help Chennai reach its climate goals. These actions are built around three principles:

1. Inclusivity and Equity: The CCAP aims to reduce the impact of climate change on the urban poor and most vulnerable residents of Chennai. It has adopted "Inclusive Climate Action Planning" guidelines[32] to integrate inclusivity and equity throughout the climate action planning process. Intensive stakeholder consultations have been carried out with various government departments at the state, regional, and city levels – with technical experts from academia, CSOs/NGOs, and the public at large – for the preparation of the CCAP. The inclusion of frontline groups such as slum dwellers, fisherfolk population, women, children, elderly, and disabled has been prioritized during action identification. Further, the CCAP ensures inclusivity and equity by integrating co-benefits for the city's residents, such as improving urban health and quality of life, increasing livelihood opportunities, and facilitating better access to information and social infrastructure.

2. Focused Acceleration: To ensure that the GHG reduction targets are achieved, sectors and subsectors that hold the biggest opportunity for Chennai to reduce its carbon emissions have been prioritized.

3. Alignment with State, National, and Global Priorities: At the state level, the CCAP is closely aligned with the Tamil Nadu State Action Plan for Climate Change (TNSAPCC), prepared by the Department of Environment, Climate Change, and Forest (DoECC) in 2014. The six sectors identified under the CCAP are aligned with the State Action Plan on areas of coastal area management, strategic knowledge for climate change, energy efficiency, and sustainable habitat.

At the national level, the CCAP aligns with India's commitment to the Nationally Determined Contributions (NDCs) of the United Nation Framework for Climate Change (UNFCC). The six sectors of the action plans align with relevant national programmes and policies, such as the National Action Plan for Climate Change (NAPCC), the Swachh Bharat Mission, and the Smart Cities Mission, thus ensuring continuity and coherence across outcome indicators and targets. This also implies converging budgetary allocations under these national and state programmes.

32 https://www.c40knowledgehub.org/s/article/Inclusive-Planning-Executive-Guide?language=en_US

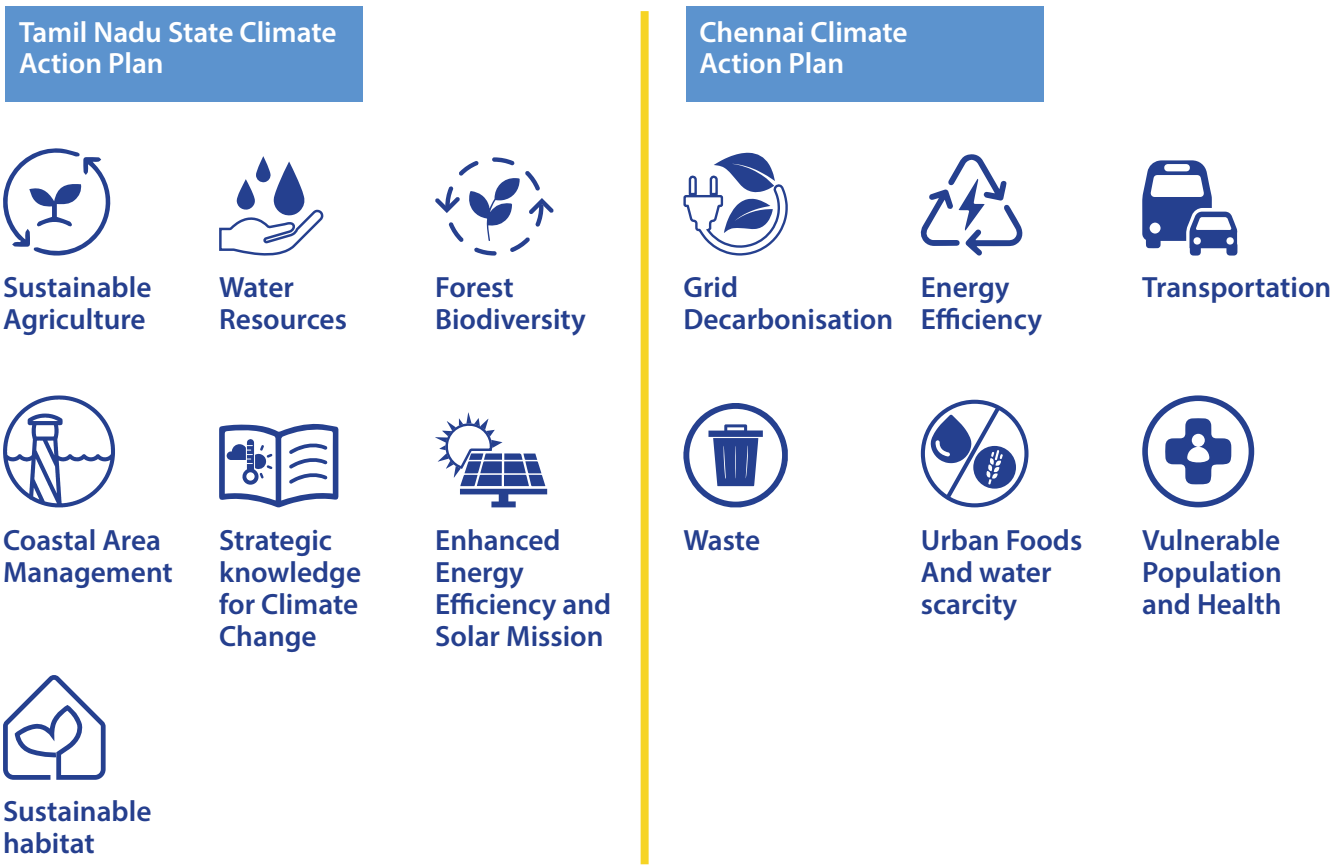


Figure 15: Alignment of CCAP with the TNSAPCC

At the global level, the CCAP aligns with 11 of the 17 UN Sustainable Development Goals (SDGs): SDG 3 (Good Health and Well Being), SDG 6 (Clean water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Actions), SDG 14 (Life below Water), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals). The alignment with SDGs city's wider socio-economic development which is supported by CCAP.

These principles represent non-negotiables, against which all decisions and projects must be measured, and which are in line with the GCC's commitment to ensuring a high quality of life for all its residents. Further, every climate action is supported by four pillars – representing the foundational approach through which plans can be carried out effectively. Timelines for each action have been proposed for the short (by 2030), medium (by 2040), and long-term (by 2050). These timelines are based on the opportunity for accelerated GHG emissions and alignment with timelines of national and state programmes.

Figure 16: Principles and Pillars of the CAP


PANDIAN COFFEE
RAW - ROAST - POWDER
FOR SALES & HIRE

Source: Urban Management Centre

CHAPTER

3

Process of Preparing the Chennai CAP

Since 2015, the Greater Chennai Corporation (GCC) has been in alignment with several state authorities in addressing environmental issues. Already in 2012, the GCC had ensured that its buildings were being powered through rooftop solar installations; in 2020, with support from ITDP, GCC initiated a massive "Chennai's Streets for People" initiative that has been instrumental in transforming over hundred kilometres of the city's streets for more accessible and equitable mobility. For the past two decades, GCC has led efforts toward household-level rainwater harvesting systems. As of 2021, it has also taken initiatives for the "Mitigation and Management of Flood Risk" by constituting an advisory committee.

Chennai became a member of C40 Cities in 2016, ratifying its commitment to halve its fair share of carbon emissions by 2030 and achieve net-zero emissions by 2050. One of the first efforts in preparing a plan was to compile the inventory of GHG emissions from the city of Chennai. The inventory for the year 2015–16 was compiled initially in 2018.

The task of updating the inventory for 2015–16 and 2018–19 began in December 2021. The preparation of the Chennai Climate Action Plan (CCAP) has been based on principles of inclusivity, consultations, and participation with a wide range of stakeholders. The various components of the CCAP preparation are summarized below:

STAGE 1

Project Inception

Climate Risk identified, discussed to enchance understanding

STAGE 2

Strategic Climate Action Planning Appraisal

Identificaiton of existing city targets, plans, policies and gaps that needs to be addressed

STAGE 3

Climate Change Risk Assessment

- Data collection
- Hazard assessment
- Stakeholder Consultation

STAGE 4

Greenhouse Gas Emissions Baseline Inventory

Calculating & Reporting GHG emissions of the city

STAGE 5

Pathways

Projecting Future Emissions

STAGE 6

Action Identification

Climate Mitigation & Adaptation actions identified and planned to be implemented in Chennai

Figure 17 CCAP Methodology

STAGE 1

Project Inception

Climate Risk identified, discussed to enchance understanding

Chennai Smart City Limited was designated as the anchor organisation for the CCAP preparation process. The project kickoff was held between the Greater Chennai Corporation (GCC), Department of Environment, Climate Change and Forest (MoECCF), GoTN and C40 cities in September 2021.

STAGE 2

Strategic Climate Action Planning Appraisal

Identificaiton of existing city targets, plans, policies and gaps that needs to be addressed

The appraisal was aimed at identifying the existing city climate targets, plans, policies, data, programmes, and actions compatible with the CAP Framework; the gaps that need to be addressed; and the approaches that can be taken to fill the gaps efficiently and effectively. Being the priority stakeholders, DC (Work), the GCC, and Chennai Smart Cities Limited lent their support to the stakeholder-mapping exercise. The exercise helped in identifying major stakeholders from various departments of the GCC; CSCL; Department of Environment, Climate Change, and Forest (Government of Tamil Nadu); state-level institutions, such as TANGEDCO, TEDA, TNUHDB; regional authorities such as CMDA, CMWSSB, CMRL, suburban railways, MTC; and experts from academic institutions, including IIT Madras and Anna University; stakeholders from CSO/NGOs such as Care Earth Trust; and technical experts from ADB, WB, WRI, TARU, 100RC, and ITDP. A series of consultative meetings were conducted with concerned stakeholders.

STAGE 3

Climate Change Risk Assessment

- Data collection
- Hazard assessment
- Stakeholder Consultation

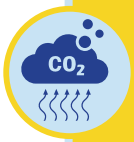
Data was collected from the relevant departments, and a Climate Change Risk Assessment (CCRA) was conducted. This helped identify the probability, intensity, and timescale of key current and future climate hazards in the city, and where these hazards are prevalent or likely to manifest. A climate impact assessment was also conducted to evaluate the potential impact of those climate hazard events on people, the environment, the economy, assets, and services. The CCRA was conducted via a review of relevant documents on climate change and development, one-on-one consultations with relevant departments, and desk-based research. This stage highlighted the four distinct risks that Chennai faces – **floods and storms, heat, drought, and the risk of permanent inundation due to sea-level rise**. The CCRA also explored the likelihood of future climate hazards, and their potential impact on the city and its communities, which will help decision-makers prioritize climate actions and channel investments toward climate change adaptation. Further, a stakeholder consultation workshop was held for the CCRA, to ensure representation from a range of key stakeholders from the city.

STAGE 4

Greenhouse Gas Emissions Baseline Inventory

Calculating & Reporting GHG emissions of the city

Creating this inventory was aimed at prioritizing actions, setting goals and targets, and measuring the progress on reducing emissions. The City Inventory Reporting and Information System (CIRIS) tool by C40 was used for this, which is an Excel-based tool for managing, calculating, and reporting city greenhouse gas emissions.[2] This tool is based on Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) standard. Data was collected from primarily three sources: i) Stationary Energy (buildings), ii) transportation and iii) solid and liquid waste. For this baseline emission estimate, 2018–19 was taken as the base year, in compliance with the GPC accounting protocols for cities. Chennai emitted a total of 14.38 million tons of CO2e in the year 2018-19. On average, a Chennai resident contributed to 1.9 tons of CO2e per capita of emissions in the year. This is comparable with other cities in South Asia of this size.



STAGE 5

Pathways

Projecting Future Emissions

The Pathways Model of C40 helped build a better understanding of the impact of existing and planned strategies that the city has already identified. It models GHG emissions over time and allows users to input climate actions to estimate how they would impact the city's emissions by 2050. The Existing and Planned (E&P) Scenario uses current city, regional, and national actions, policies, and programmes – to demonstrate the emissions reduction trajectory for Chennai before the implementation of the climate action plan. The Pathways Model provides insights into the significant gap in the current carbon emissions and the desired goal of carbon neutrality. Based on the gap identified in the E&P Scenario, appropriate actions are identified, along with clarity on their role in reducing carbon emissions.

STAGE 6

Action Identification

Climate Mitigation & Adaptation actions identified and planned to be implemented in Chennai

The three principles discussed in Chapter 6 were taken into consideration for Action Identification. This stage focused on the collation of the climate mitigation and adaptation actions identified and being (planned to be) implemented in Chennai. Inclusivity and equity are integrated into the CAP actions by ensuring co-benefits to frontline groups, i.e., slum dwellers, fisherfolk population, women, children, elderly, and disabled during prioritizing the climate actions. Actions have been prioritized into short, medium and long term actions through consultations with stakeholders and further co-benefits, targets are attached to them.

2 C40 Cities, https://resourcecentre.c40.org/resources/reporting-ghg-emissions-inventories, accessed on 27 August 2022.

Source: iStock Photo

Stakeholder Consultations

The city of Chennai adopted an inclusive and participatory approach to the development of the CCAP, to ensure fairness and accessibility in the design and delivery of urban climate policies, programmes, and services. The nodal officers of the GCC and stakeholder departments were identified with support from DC(Works), GCC.

Each stage (mentioned above) in the preparation of the CCAP was concluded with consultations with relevant stakeholders. More than 200 meetings and group consultations were conducted. Further, one-on-one stakeholder consultations helped in the formulation of major strategies for CAP actions. The workshops, conducted over several months, included:

- Climate Action Plan introductory workshop (December 2021)
- Vulnerability Assessment workshop (April 2022)
- Mitigation and Adaptation Action identification consultations (June 2022)
- Consultations with DC (Works) & CEO, Smart cities on actions identified for Chennai Climate Action Plan (July 2022)
- Consultations with ACS, DoECCF on actions identified for Chennai Climate Action Plan (July 2022)
- Consultations with Technical Experts on actions identified for Chennai Climate Action Plan (August 2022)
- Consultations with Commissioner, GCC on actions identified for Chennai Climate Action Plan (August 2022)

At the outset, a detailed institutional mapping was undertaken to identify stakeholders who play a critical role in the decision-making, implementation, and monitoring of sectors contributing to the GHG emissions as well as building the city's resilience. Stakeholders included state government parastatals, departments within the GCC, academic institutions, and NGOs (international and national).

Post this, the discussion on the CCAP began with one-on-one meetings with all concerned departments. The first round of stakeholder consultations was held in December 2021, with the objective of presenting the Strategic Appraisal. The stakeholders present in this consultation were mainly department heads from the GCC, heads of other government institutions, and technical experts who had already worked on environmental and climate-related projects in Chennai (see Annexure 8.4). Representation from various departments of the GCC, CSCL, and regional government institutes such as MTC, CMRL, CMDA, CMWSSB, and technical experts such as TARU, ITDP, and Environmentalist Foundation of India helped in collating details of past and current policies/projects in the city. This facilitated a thorough assessment of the city's role and capacity in implementing climate actions, identification of gaps in actions, and policy, technical, and administrative barriers in the current climate.

The findings from the strategic appraisal are appended in Annexure 8.5. The stakeholder consultation on strategic appraisal helped identify actions that can bridge these gaps and overcome these barriers, as well as policies that can be leveraged.

The second stakeholder consultation workshop for the CCRA was conducted in April 2022. The objective was to present a synopsis of the salient features of sectoral GHG inventory assessment and the gauged climate risks, with reference to vulnerable and disadvantaged communities, to seek the views and impressions towards validation of inventory and assessed risks. This helped bring all the stakeholders to a common understanding and receive their inputs as well as the data points to enrich the assessment. Representatives from various departments of the GCC, other government institutions, technical experts, and NGOs actively participated in the consultation. Disadvantaged communities were represented by the Tamil Nadu Urban Habitat Development Board (TNUHDB) since it works for the betterment of disadvantaged communities and the improvement of the living conditions of poor families (see Annexure 8.4). The inputs received from stakeholders helped scrutinize and validate the methodologies used for preparing the GHG inventory and making projections regarding climate risks and their impacts. The meeting also focused on prioritising sectors that have the maximum GHG potential and climate resilience-building potential; the role of the city; and the need for alignment with national and state action plans and commitments.

In June 2022, a series of one-on-one stakeholder consultation workshops were conducted to identify relevant climate actions. The impact of Existing & Planned (E&P) Strategies and Ambitious Strategies on sectoral emissions and the role of the concerned department were discussed at length. Similarly, the impact of climate-induced disasters on the city's residents, including vulnerable populations and infrastructure, was discussed. Discussions also brought out several co-benefits, which helped in prioritising actions such as improving urban health and quality of life, increasing livelihood opportunities, and facilitating better access to information and social infrastructure. Suggestions

Figure 18: Glimpses of Stakeholder Consultations Conducted during Preparation of the CCAP

were sought from different departments on how they could contribute to the adaptation and mitigation strategies.

Detailed sectoral notes were shared with all department heads, to solicit feedback on the E&P Strategies by respective departments. These meetings helped build consensus and firm up the sectoral visions, to identify climate actions for each of the six sectors (see Annexure 8.4). The actions for GHG mitigation were prioritized based on the following criteria:

- their potential for GHG reduction and/ or building resilience of the residents and systems;
- alignment with ongoing national/state-supported programmes;

Key Stakeholder Consultations & Interactions

Figure 19: Summary of Stakeholder Consultations & Interactions during the Preparation of the CCAP

- institutional capacities to deliver;
- financial feasibility of the said actions; and
- Co-benefits for its residents such as improving urban health and quality of life, increasing livelihood opportunities, and facilitating better access to information and social infrastructure.

In August 2022, a multi-stakeholder consultation workshop, chaired by the GCC, was organized. Technical experts from WRI, ITDP, World Bank, Asian Development Bank, 100RC (Resilient Chennai), TARU, Care Earth Trust, Citizen Action Group, Anna University, Poovulagin Nanbargal (Friends of Earth), Citizen Action Group (CAG), Nature Conservancy Centre and many more were present (see Table 35 in Chapter 8.4). The objective was to discuss the various decarbonization trajectories and actions required to help achieve the GHG reduction targets in the short, medium, and long term.

The draft of the action plan for the CCAP was shared, and feedback was solicited from all present. After incorporating relevant feedback and suggestions from academia and sector experts, the draft CCAP was again discussed with the Municipal Commissioner, GCC; Deputy Commissioner (Works), GCC; and CEO (Chennai Smart Cities Limited). At the state level, a detailed presentation was made for the Additional Chief Secretary, Department of Environment, Climate Change, and Forests (GoTN), who leads the state in the implementation of the state climate action plan. Following further inputs, the actions required to be taken by different departments for the E&P, Ambitious, and Extended Scenarios were finalized, along with a tentative governance structure for the implementation of the CCAP. Thereafter, the draft climate actions proposed in the CCAP were uploaded on the official website of the GCC and Chennai Smart Cities Limited – to inform citizens as well as to elicit suggestions from them. The suggestions received during these consultations were considered during the finalisation of the CCAP.

Meeting with Chennai Metro Rail Limited

Meeting with SWD Deptt,GCC

Meeting with TEDA

Meeting with IOCL

Meeting with CMDA

Meeting with CMWSSB

Meeting with TANGEDCO

Meeting with SWM Deptt, GCC

Source: Urban Management Centre

Figure 20: One-on-One Stakeholder Consultations in Chennai

CHAPTER

4

Source: iStock Photo

Chennai's Climate Risks and Vulnerabilities

The Climate Change Risk Assessment (CCRA) sought to understand the likelihood of future climate hazards and the potential impacts of these hazards on cities and their inhabitants. The hazard prioritisation was done by identifying the most significant climate hazard faced by Chennai as per past trends and considering the frequency and intensity of hazards.[33] It supports prioritising the actions and investments for adapting to climate events. The major hazards that Chennai faces are increased precipitation, drought, extreme weather events, torrential downpours, flash floods, surface floods, pluvial floods, cyclones, river flooding, creek flooding, storm surge, sea-level rise (SLR), and coastal floods. According to India's Climate Vulnerability Index, floods and cyclones pose the maximum risk for Chennai.[34] Lately, the city has also been facing increased instances of water scarcity, heat stress, and other heat-related diseases. The average change of maximum and minimum temperatures in Chennai is also expected to increase by 2.9°C and 3.3°C, respectively, by the end of the century,[35] which will exacerbate the difficulties faced due to increasing heat. Additionally, the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR6) regional factsheet for Asia states that the relative sea level around the continent is expected to rise to 134 cm by 2100s, with rapid coastal area loss and shoreline retreat. Figure 18 captures the various climatic hazards for Chennai.

The CCAP has adopted C40 Cities' CCRA framework to assess the climate risks and vulnerabilities in the city. To this end, it screened parameters related to past climatic trends and future projections, based on global models and assessment reports such as IPCC, UNFCCC, as well as national-, state-, and city-level plans. The spatial analysis was carried out using GIS and remote-sensing technologies, to identify areas that are highly vulnerable to extreme climate events.

Monitored weather data and publications were used to map decadal, inter-annual, and temporal (monthly, daily, and hourly) trends; presently associated impacts; and project potential future trends in precipitation, temperature, and SLR. The C-FLOWS[36] data was used to visualize zone-level

33 As part of rapid CCRA, a summary of prioritized key risks per hazard theme is given in the annexure 8.2.

34 Mohanty & Wadhwan, Mapping India's Climate Vulnerability, 2021.

35 http://www.tnenvis.nic.in/WriteReadData/UserFiles/file/1_CHENNAI_TEMPERATURE.pdf

36 C-FLOWS (Chennai Flood Warning System) is an integrated web-based GIS decision-support tool for relief and mitigation operations, especially during flooding, developed by National Centre for Coastal Research (NCCR).

Floods and Storms

- Flash floods/ surface floods
- Delayed and irregular monsoon
- Coastal floods
- Severe winds

Heat and Water Scarcity

- Heatwave/ urban heat island
- Reduction in rainfall
- water scarcity
- Reduction in water bodies

Sea Level Rise

- Sea water intrusion
- Surface water pollution
- Ground water pollution

Figure 21: Climatic Hazards in Chennai Based on Past and Future Trends

flood risks and identify potential vulnerabilities as well as compromised access to infrastructure and services. Socio-economic sensitivities were mapped using plans developed by the GCC for "Slum Free Cities 2014."[37] Further, GCC's services and amenities data was visualized spatially, to identify underserved areas with poorer adaptive capacities. Finally, these different datasets were correlated to present the interlinkages between climate risks, socio-economic sensitivities, compromised access to infrastructure and services, and vulnerability to communities.

4.1 Chennai's Climate Hazard Assessment

Climate Hazard Assessment is done to identify the short-term and long-term climatic events that have the potential to cause damage to humans and natural systems. The assessment identifies the probability, intensity, and timescale of the key hazards in a city, taking into account the city's historic trends and present situation, as well as future scenarios based on available scientific evidence through 2050 and beyond.[38]

37 Slum Free Cities (2014). TNHUDB.

38 Climate Change Risks Assessment Framework (May 2018). C40 Cities.

4.1.1 Urban Flooding in Chennai

Rainfall in Chennai has caused a series of disasters in recent times in the city. Over the past decade, the city has witnessed historic downpours that brought it to a standstill and caused loss of lives and damage to property.

Rainfall trends show that Chennai has been receiving short but intense rainfall spells. During 1970–2000, the Chennai district recorded an average annual rainfall of 1,298 mm,[39,40] with mean OND/post-monsoon[41] rainfall accounting for much of Chennai's annual precipitation. As per Tamil Nadu State Disaster Management Authority and the Meteorological Department, the district received about 2,830 mm of average annual rainfall in 2021, i.e., 62 per cent more rain than its average.[42] The trend shows increasing rainfall over a lesser number of days per year. Thus, while rainfall in the post-monsoon months increased, it decreased in the monsoon months.[43] Moreover, rains in the district have become more intense, with an increase in the number of days that experience extreme rainfall events, which then lead to pluvial and fluvial floods, failure of rain-fed crops, reduced groundwater recharge, and enhanced soil erosion. Over the past 100 years, Chennai has received rainfall above its average in the years 1918, 1985, 2005, 2015, and 2021 – leading to the city being submerged and facing massive floods. According to the IPCC AR6, El Niño had induced extreme precipitation, due to which severe rainfall events were observed in Chennai in December 2015.[44]

Among the top 20 districts across India that have maximum exposure to extreme flood events, the Chennai district ranks sixth. Its vulnerability

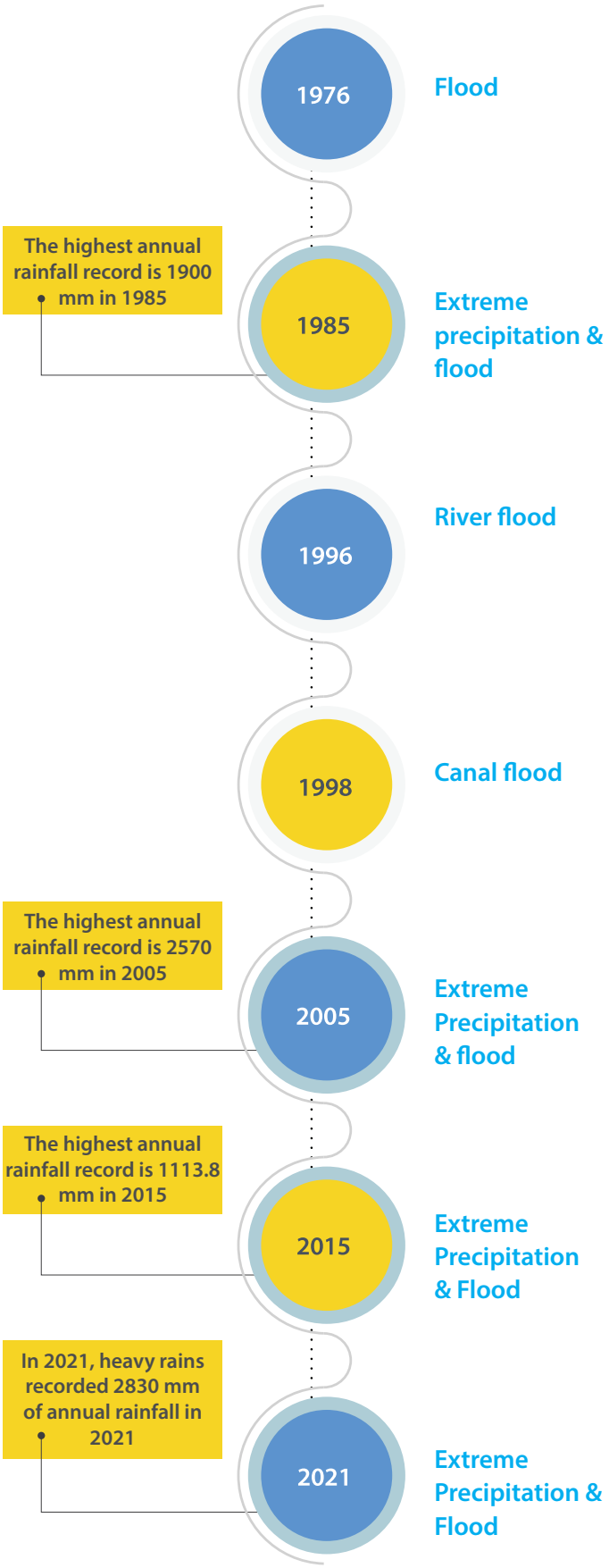


Figure 22: History of Floods and Extreme Precipitation Events in Chennai

39 This is higher than the average rainfall of Tamil Nadu.

40 RAINFALL PROJECTIONS FOR CHENNAI, TNSCCC & Anna University, 2018.

41 Post monsoon rainfall in Chennai occurs in October, November, and December months.

42 K. Lakshmi. (20 November 2021). Chennai has received 62% more rains this year compared to previous years, study finds. *The Hindu*. https://www.thehindu.com/news/cities/chennai/chennai-has-received-62-more-rains-this-year-compared-to-previous-years-study-finds/article37594189.ece

43 District wise climate change information for the state of Tamil Nadu. http://www.tnenvis.nic.in/WriteReadData/UserFiles/file/1_CHENNAI_RAINFALL.pdf

44 Climate Change 2021, The Physical Science Basis, IPCC AR6, August 2021

45 Water Stagnation Areas as mapped by Storm Water Drainage Department, GCC.

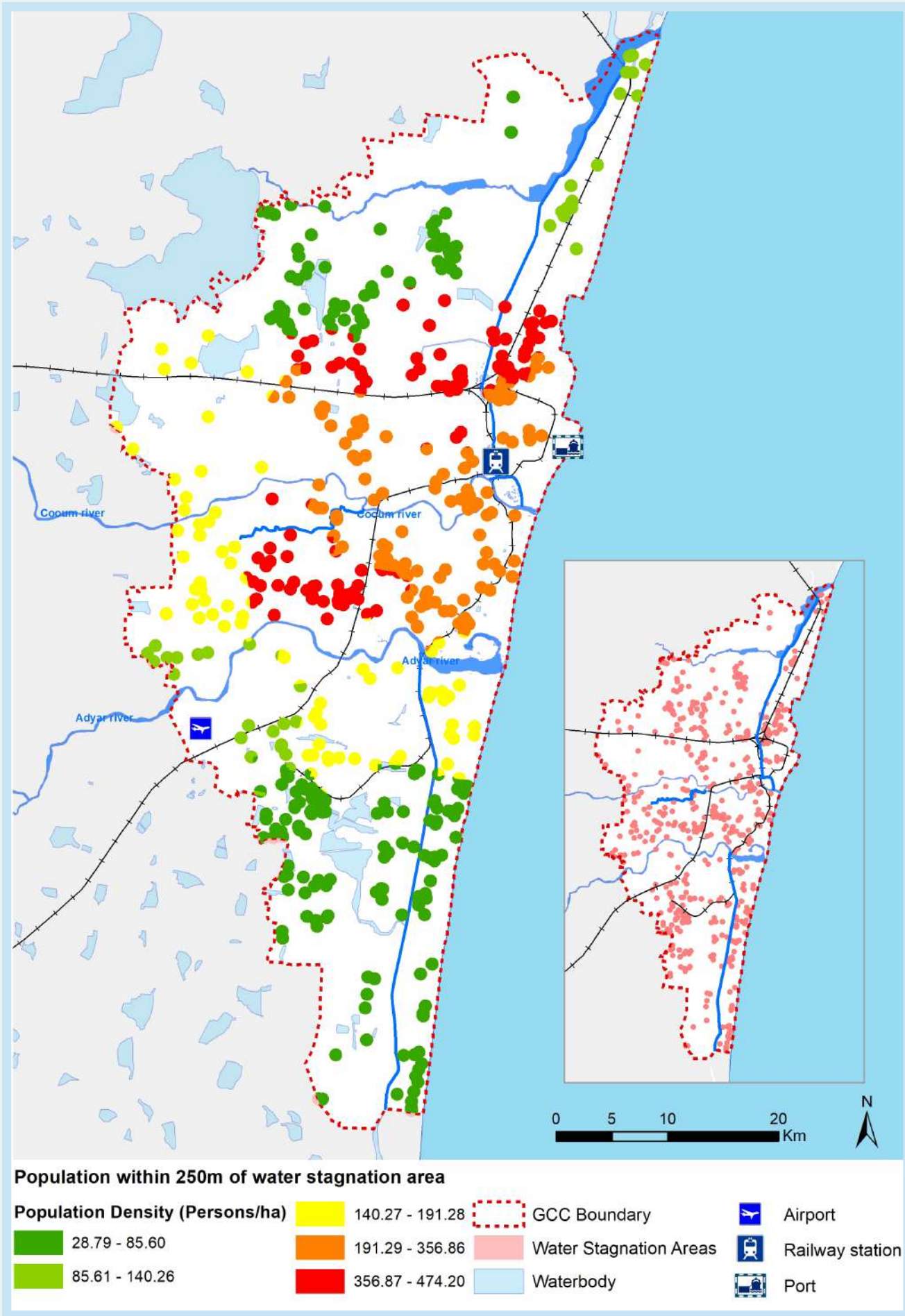


Figure 23: Population Affected by Water Stagnation Areas within the GCC*

* Water Stagnation Areas as mapped by Storm Water Drainage Department, GCC.

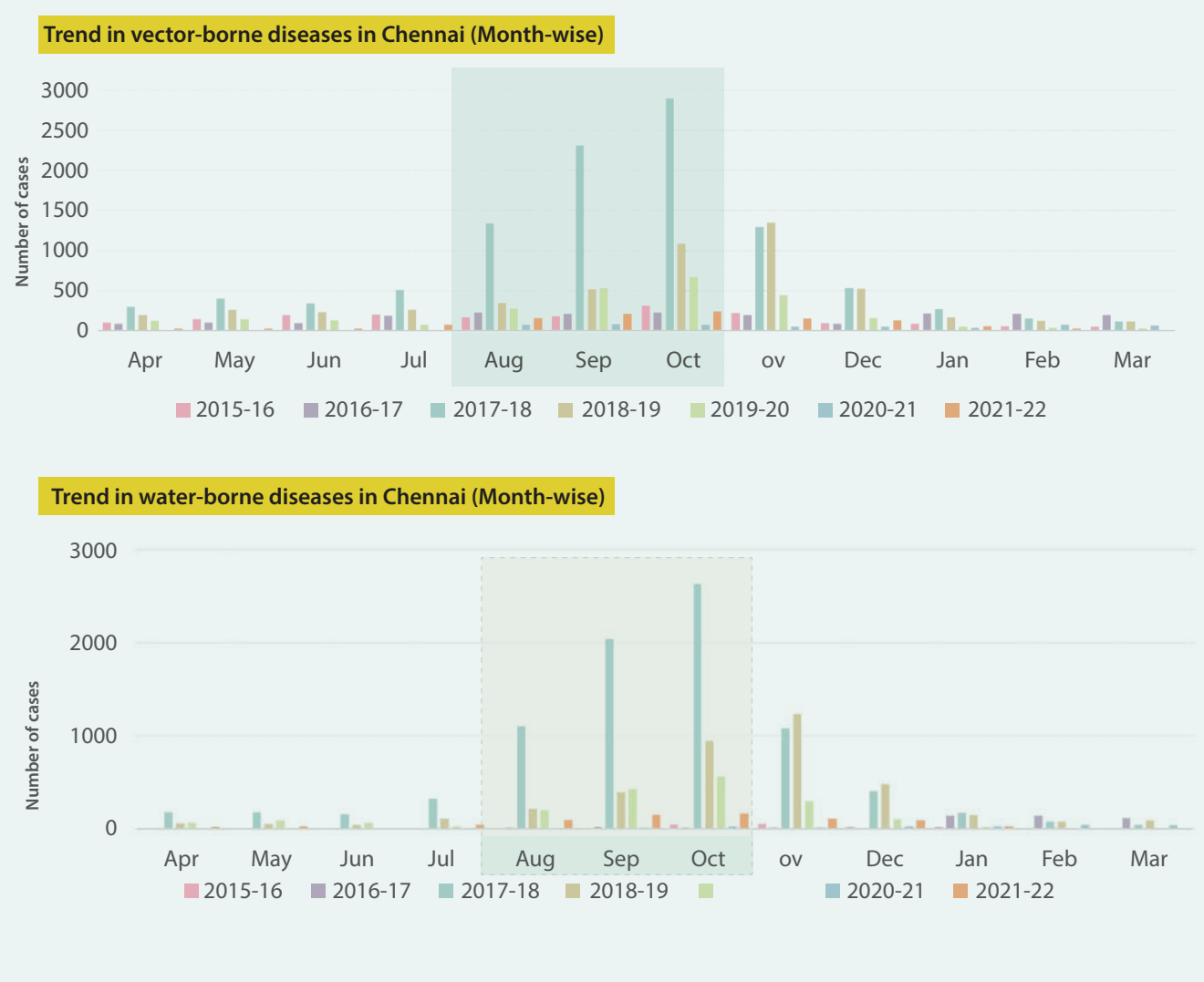


Figure 24: Trend of Diseases in Chennai

index is 0.894 on a scale of low to high vulnerability, ranging from 0.01 to 1.00.

The city of Chennai has a history of experiencing floods five to six times during monsoon months, due to high-intensity rainfall occurring, particularly in the low-lying areas near the Cooum and Adyar Rivers as well as the creeks and areas near the Pallikaranai Marshlands. The Storm-Water Department of the GCC, responsible for cataloguing the data on "water stagnation areas," has identified 562 such locations across the city. Assuming that the resultant waterlogging will impact areas within a 100-metre radius from each of these 562 locations, almost 16.7 per cent of the total GCC area and 20 per cent (i.e., ~16 lakhs) of the city's population will be severely affected.

Of the 15 zones of the GCC, 50 water-stagnation areas each have been identified in Zone 4 (Tondiarpet), Zone 9 (Teynampet), Zone 10 (Kodambakkam), and Zone 14 (Perungudi). Approximately 36 per cent of the 1,202 slums in the GCC fall within these areas. Moreover, Zone 4 also houses the maximum slum population in the city. The GCC's Health Department data from seven years points to a six times increase in vector-borne and water-borne diseases during monsoon months, compared to non-monsoon months.

Water stagnation and flooding are attributed largely to rapid urbanisation, increased concretization, alteration in the natural topography,

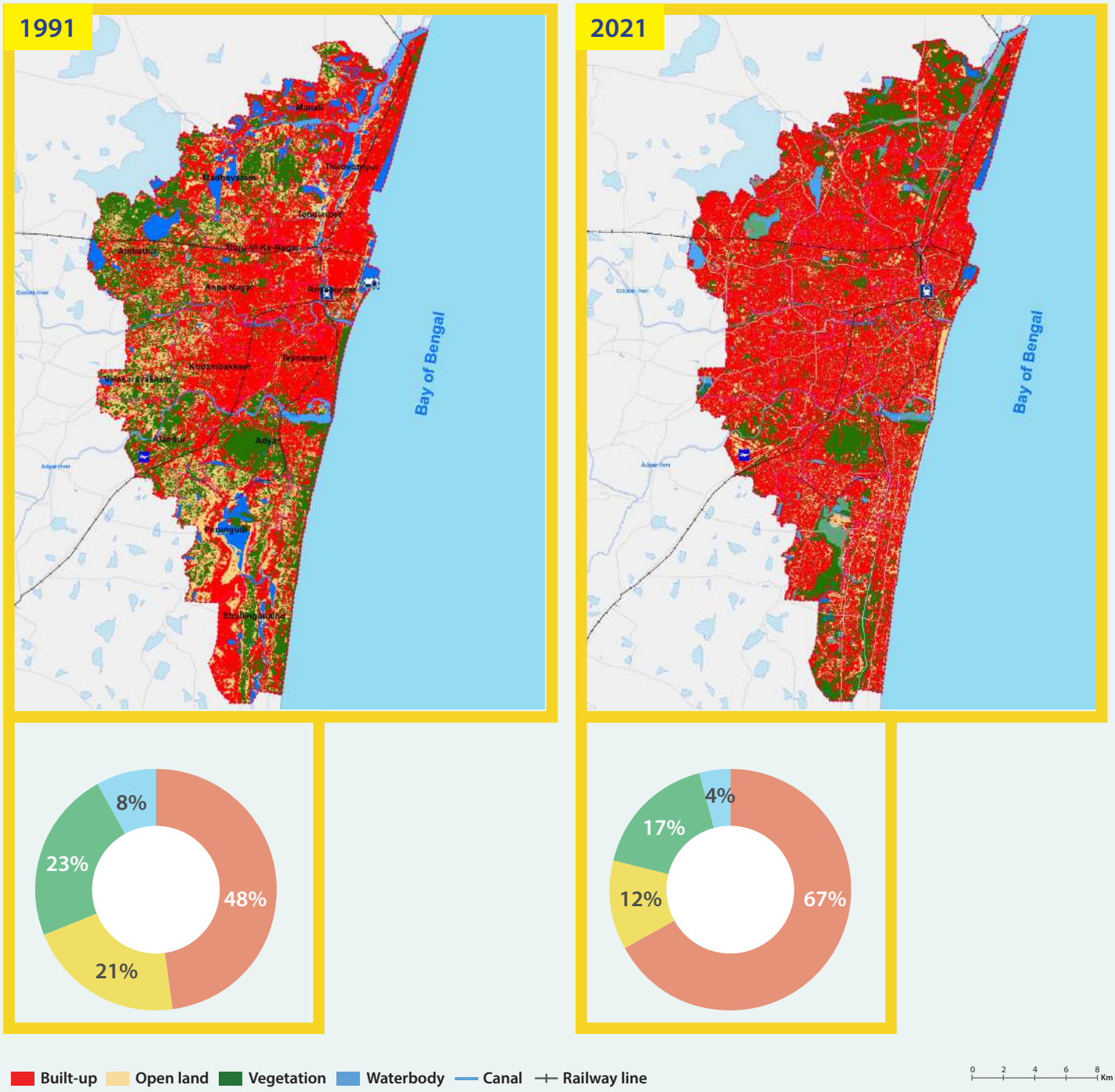


Figure 25: Land use and Landcover Change from 1991 to 2021*

and urban encroachment over the lands in low-lying areas or dried-up waterbodies.[46] While provisions have been made for implementing new infrastructure and policies on rainwater harvesting, along with regulatory mechanisms such as the GDCR, challenges persist—both in enforcement and adoption.

Over the years, as Chennai has densified, vast areas of the surrounding floodplains, along with its lakes, ponds, and wetlands have decreased. From 1991 to 2021, the area of waterbodies within the GCC limit shrank rapidly from 28.7 sq. km to 5.7 sq. km, while the area under open spaces shrank from 21 per cent of the total area to a mere 12 per cent. Open

46 Prathip Moses (2022). State task force for flood prevention/mitigation.

* LANDSAT 8, Google Earth Engine. May 1991 & May 2021. Image processed by UMC.

Figure 26: Nungambakkam Tank in Current T. Nagar Area of Chennai

Source: Roumeau et al. 2015.

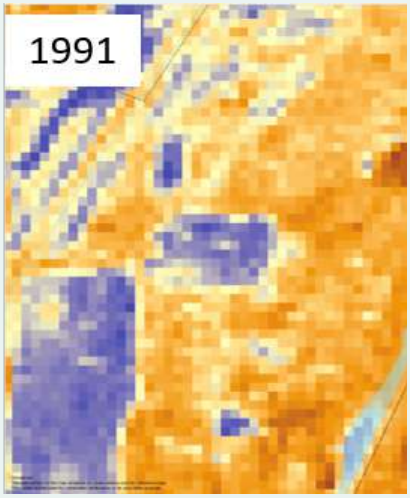


Figure 27: Waterbody in Thiruvottiyur Zone Near Buckingham Canal

Source: LANDSAT 8, May 1991 and Google Earth Imagery, 2021.

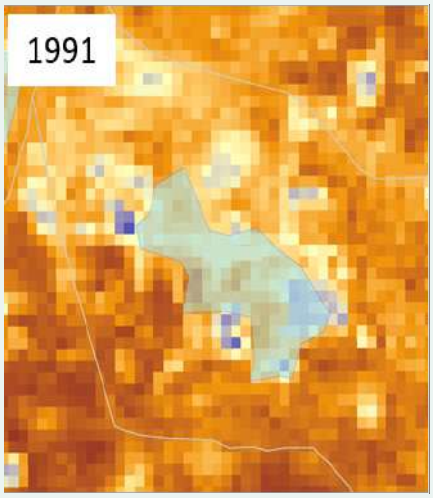


Figure 28: Waterbody in Thiruvottiyur Zone Near Buckingham Canal

Source: LANDSAT 8, May 1991 and Google Earth Imagery, 2021.

spaces act as sponges when the city experiences heavy rainfall and a drastic reduction in such spaces contributes to floods.

Due to rapid urbanisation, Chennai has seen a reduction in its marshland. The marshlands of Chennai play a major role in holding water and enabling groundwater recharge. Indeed, over the last decade, the industrial corridor has expanded rapidly, covering almost 230 sq.km. of the Pallikaranai Marshlands.47 Figure 26, Figure 27 and Figure 28 show how natural water bodies have been encroached on and built upon over the last few decades. For example, Chennai's lakes, which offered a natural-flood discharge channel and drained spill-overs, have been encroached, thus blocking the flow of water.

As evident, most urban floods are a manifestation of haphazard development, plans that pay no regard to the city's natural topography, and weak enforcement mechanisms.

Future Risks of Urban Flooding in Chennai

The IPCC AR6 predicts that South Asia will witness increased annual and summer monsoon precipitation during the 21st century, with enhanced inter-annual variability.

Chennai faces a very high risk of flooding, which calls

47 How Chennai, one of the world's wettest major cities, ran out of water,.*The Economic Times*, 2021.

Table 2: Flood Intensity and Affected Population in Future Years

Flood Intensity	Rainfall Intensity (in mm per hour)	Land Area projected to be inundated within GCC (sq. km)	Year 2021 (Lakhs)	Year 2031 (Lakhs)	Year 2041 (Lakhs)	Year 2051 (lakhs)
Total Projected Population*			84	109	141	182
At return period of 5 Years	200	128.84 (29.1%)	23.4	33	42	55
At return period of 10 Years	300	139.70 (31.6%)	26	36	46	59
At return period of 25 Years	380	203.49 (46.0%)	39	52	67	87
At return period of 50 Years	420	240.88 (54.5%)	46	62	79	103
At return period of 100 Years	470	250.13 (56.5%)	50	64	82	106

**Projected population derived from City Solid Waste Action Plan provided by the SWM department, GCC, 2021.*

What are Representative Concentration Pathways (RCP)?

RCPs are scenarios that describe alternative trajectories for carbon dioxide emissions and the resulting atmospheric concentration, from 2000 to 2100. The RCPs describe four different scenarios based on different assumptions about population, economic growth, energy consumption and sources, and land use over this century. RCP 8.5 refers to the concentration of carbon that delivers global warming at an average of 8.5 watts per sq. mt across the planet.

for concerted mitigation and adaptation strategies to reduce the damage and impact caused by it. The city's annual rainfall projections for the periods 2010–40 (2020s), 2040–70 (2050s), and 2070–2100 (2080s) indicate a general decrease in precipitation by 0.1 per cent, 5.0 per cent, and 1.0 per cent, respectively, compared to the baseline from 1970–2000. However, extreme events are likely to increase, e.g., one-day maximum precipitation, contributing to the risks of major pluvial and fluvial flood events. As per Representative Concentration Pathways 8.5 (RCP 8.5[48]), it is estimated that 29 per cent of the GCC area may get inundated every five years, affecting a population of around 23.5 lakhs. Similarly, at return periods[49] of 10, 25, 50, 100, and 200 years, 31.6 per cent, 46 per cent, 54.5 per cent, 56.5 per cent, and 62.4 per cent of the city area, respectively, may get inundated (see Table 28 in Chapter 8.3). This, combined with increasing population densities, puts a larger proportion of people at risk.

4.1.2 Sea-Level Rise

Global assessments identify Asia as the region most exposed to SLR in terms of the number of people living in low-elevation coastal zones and the number of people exposed to flooding from 1-in-100-year storm surge events.[50] India is estimated to have one of the largest total coastal populations exposed to SLR.[51] On the coast of Tamil Nadu, SLR ranges from 0.29 ± 0.56 mm/year, with an average recorded SLR of 1.70 mm/year over the 20th century and 1.80 mm/year during 1952–2003. Currently, the major affected

48 https://medium.com/@davidfurphy/what-on-earth-is-an-rcp-bbb206ddee26 on 15 September 2022.

49 A return period is the time over which it is likely that a particular magnitude flood will occur, e.g., a 50–year flood is defined as a flood that can occur on average once every 50 years.

50 Climate Change 2022: Impacts, Adaptation and Vulnerability, Working Group 2 contribution to the IPCC AR6, 2022

51 Climate Change 2022: Impacts, Adaptation and Vulnerability, Working Group 2 contribution to the IPCC AR6, 2022

areas due to SLR in Chennai are ECR road, Perungudi in southern GCC, and Manali and Thiruvottiyur in the northern GCC area. Further, river and coastal flooding disturb the natural ecosystem of the riverbeds and coastline, damaging the riverine and coastal biodiversity. For example, Pallikaranai Marshlands in the south of Chennai experience seawater intrusion due to excessive withdrawal of water.

SLR is mainly caused by two factors related to global warming: the additional water from the melting of glaciers and the expansion of the seawater as it warms. There are varying assessments estimating the rise in sea level and the extent of its impact. These variations are primarily attributed to the criteria followed and the assumptions used. Notwithstanding such variations in projections regarding the extent of SLR, shoreline retreat, and rise in population, which may be affected by these impacts, what is clear is that the SLR is real, gradual, consistent, and determined by many uncontrollable variables.

While the exact quantitative prediction of SLR can vary based on the assumptions made for estimating SLR, it is expected to affect the coastline in Chennai in a number of serious ways, including inundation, flood, and storm damage associated with severe cyclones and surges, erosion, saltwater intrusion, and wetland loss. The IPCC AR6 regional factsheet for Asia states that the relative sea level around Asia has increased faster than the global average in the 20th century, with rapid coastal area loss and shoreline retreat.

Chennai also faces a longer duration of water stagnation during heavy rainfall days, at times of high tide. Research shows that the coastal waves and tides along the shoreline deposit sediments in the sinkholes, which are the mouths of the Adyar and Cooum Rivers. This deposition of sediments decreases the mouth size of the rivers and reduces their depth as well. It blocks the mouth of the river and prevents the exchange of water between rivers and sea. This leads to an increased risk of flooding in the city during heavy rains as well as coastal flooding during high tides.[52]

In this context, it is important to prepare for the eventualities through appropriate mitigation and adaptation measures.

Future Risks of Sea-Level Rise

Chennai is one of the cities among the 20 largest coastal cities with the highest flood losses by 2050.[53] According to the Fifth Assessment Report of the IPCC, global sea levels would rise less than a metre, or about a metre, by the end of the century. An assessment of SLR along Chennai's coastline projected 7.1 cm (2025) to 36.87 cm (2100) from RCP 2.6, with the inundation potential being 101.2 m to 508.4 m for respective periods. The corresponding figures for RCP 8.5 are 7.38 cm (2025) to 77.88 cm (2100), with corresponding inundation being 107.2 m to 1070.5 m. Based on the Brunn Rule and the available SLR data, it is estimated that close to 1.6 km of the horizontal area along the coastline is expected to be inundated by 2100. This will probably submerge almost 71.6 sq. km of the GCC area by 2100, some of it permanently (see Figure 26).

The IPCC A6 Atlas (IPCC, 2021) indicates that there is high confidence that the sea levels in India will increase and also increase coastal floods, coastal erosion, and marine heatwaves. The mid-century (2040–70) projection for SLR is 33.95 cm as per the low-emission climate scenario (RCP 4.5) and 85.5 cm as per RCP 8.5. The mid-century (2040–70) projection for SLR as per the climate scenario RCP 8.5 is 38.58 cm, and the end-century (2070–100) projection is 134.29 cm. Figure 26 shows the areas within the GCC that will get permanently inundated due to SLR, as per the high-emission scenario. About 2 per cent of the GCC area by mid-century and 16 per cent of the GCC area by the end of the century is expected to get permanently inundated.

Going forward, Chennai is expected to face frequent coastal flooding, river flooding, and saltwater intrusion in the freshwater aquifers due to SLR. Saltwater intrusion in freshwater sources – such as rivers, lakes, and groundwater – leads to reduced freshwater quantities and, consequently, water scarcity and higher cost of freshwater. This, in turn, exacerbates Chennai's drought problem. At the same time, rising sea levels drive the displacement of populations residing near riverbeds and damage to major infrastructure near the coastline (such as ports), resulting in spill-over social and economic impacts. In 2100, it is expected that around one million residents living on the coast of Chennai – many of whom are low-income groups, including fisherfolk – will be displaced due to SLR. As per the current slum population in Chennai, 215 slum settlements are also likely to get affected.

52 Erosion and Accretion across the Chennai Shoreline, IIT-M, 2021.

53 Climate Change 2022: Impacts, Adaptation and Vulnerability, Working Group 2 contribution to the IPCC AR6, 2022

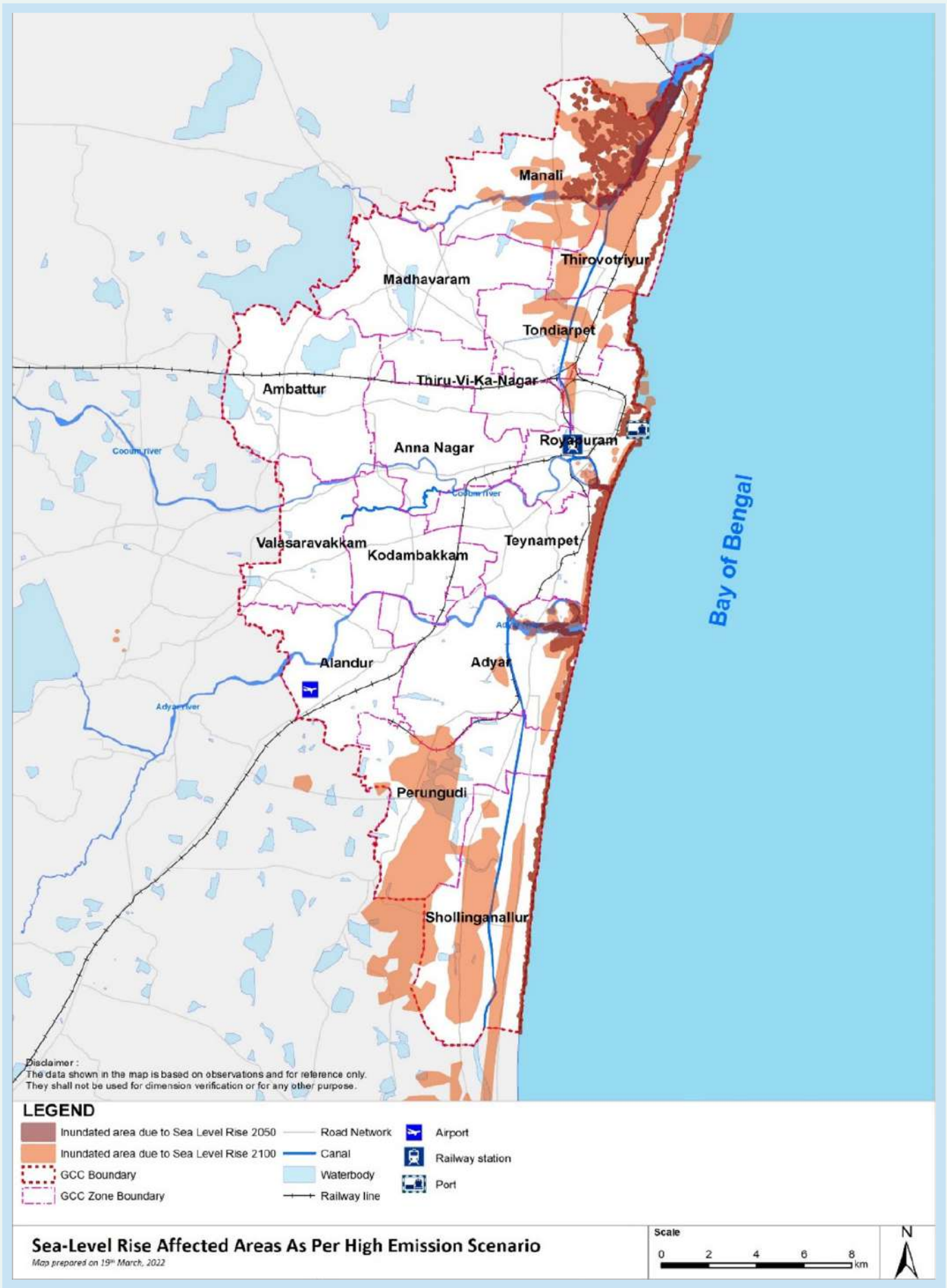


Figure 29: Sea-Level Rise Affected Areas As Per High Emission Scenario in Mid-Century and End-Century*

** Assessment on Shoreline retreat in response to SLR, National Centre for Coastal Research (NCCR), 2020*

4.1.3 Increasing Temperature and Heatwaves

Chennai has a tropical wet and dry climate. Its coastal–equatorial location prevents much annual variation in temperature, with the maximum variation experienced May and June, and the minimum variation in January. In 2015, the city recorded an average annual maximum temperature of 33.0°C, which was higher than the average annual temperature of Tamil Nadu.[54] In the same year, the minimum temperature recorded in the city was 24.5°C.[55] Over the last decade, Chennai has experienced an increase in the number of hot days, with a maximum temperature of more than 40°C and an increase in extreme heatwave events.

In addition to the atmospheric temperature changes, human activities (such as construction, concretization, and shrinking of green spaces and waterbodies leading to the trapping of heat) have caused an increase in the urban heat island (UHI). According to a study by Anna University, the temperature in these heat islands has been increasing by 1-2°C over the last decade.[56]

The highest recorded land surface temperature in Chennai is 43.2°C, while the lowest is 16°C. The temperature is observed to be significantly higher in areas where the land surface is covered by materials such as concrete, asphalt, metal, and sand, compared to areas with waterbodies and vegetation. The highest land surface temperature of 43.3°C has been recorded at the Chennai Airport, and the second highest at the waste disposal sites at the Perungudi and Kodungaiyur dump yards. Further, higher temperatures have been recorded in industrial areas such as SIDCO industrial estate and integral coach factory, while parks, gardens, forests, and waterbodies are comparatively cooler. Increased UHI effect demands more energy for cooling of space, which creates a rise in energy demands, ultimately contributing to an increase in GHG emissions.

The impact of increased heat is higher on urban poor communities, as they live in thermally uncomfortable built environments with higher densities, low vegetation cover, and limited choice of roofing materials. In Chennai, 27 per cent of the slum houses use asbestos sheets as a roofing material,[57] which heats much faster than cement roofs. Nocturnal UHI effect, which prolongs the time it takes for the city to cool off at night, too, has a higher impact on the urban poor, who have limited access to cooling equipment and electricity. Limited access to fresh water adds to this dilemma by increasing the risk of dehydration. The Rajiv Gandhi Government General Hospital reports 30 to 50 patients with heat-related symptoms between April and June each year.[58]

Finally, heat exhaustion also reduces economic productivity. In 2016, construction workers report 18-35 per cent less productivity in peak summer due to extreme heat stress.[59] Since extreme heat also impacts poultry and cattle, dairy-based businesses are affected along with the livelihoods of the communities dependent on them.

Future Risks Due to Increasing Temperature and Heatwaves

> By 2050, India has a 10 per cent likelihood of experiencing a lethal heat wave in climate-exposed regions, leading to reduced productivity due to loss of working hours.[60]

In Chennai, the projections of maximum temperatures for the periods 2010–40 (2020s), 2040–70 (2050s), and 2070–2100 (2080s), with reference to the baseline (1970–2000), indicate an increase of 0.9°C, 1.9°C, and 2.9°C, respectively.[61] Similarly, the projections of minimum temperatures for the same periods indicate an increase of 1.1°C, 2.2°C, and 3.3°C, respectively. The average change of maximum and minimum temperatures in Chennai is expected to increase by 2.9°C and 3.3°C, respectively, by the end of the century.

54 In 2015, the average annual temperature of the state of Tamil Nadu was about 32.4°C.

55 http://www.tnenvis.nic.in/WriteReadData/UserFiles/file/1_CHENNAI_TEMPERATURE.pdf

56 https://chennai.citizenmatters.in/chennai-heat-wave-action-plan-summer-climate-change-27368

57 TNSCB & DARASHAW, Slum Free Cities Plan of Action for Chennai, 2014.

58 K. Lakshmi, Chennai's scorching summers get hotter. The Hindu, https://www.thehindu.com/news/cities/ chennai/chennais-scorching-summers-get-hotter/article34292878.ece, 11 April, 2021.

59 Chinnadurai, Influence of occupational heat stress on labour productivity – a case study from Chennai, India, 2016.

60 McKinsey Global Institute, 2020.

61 http://www.tnenvis.nic.in/WriteReadData/UserFiles/file/1_CHENNAI_TEMPERATURE.pdf

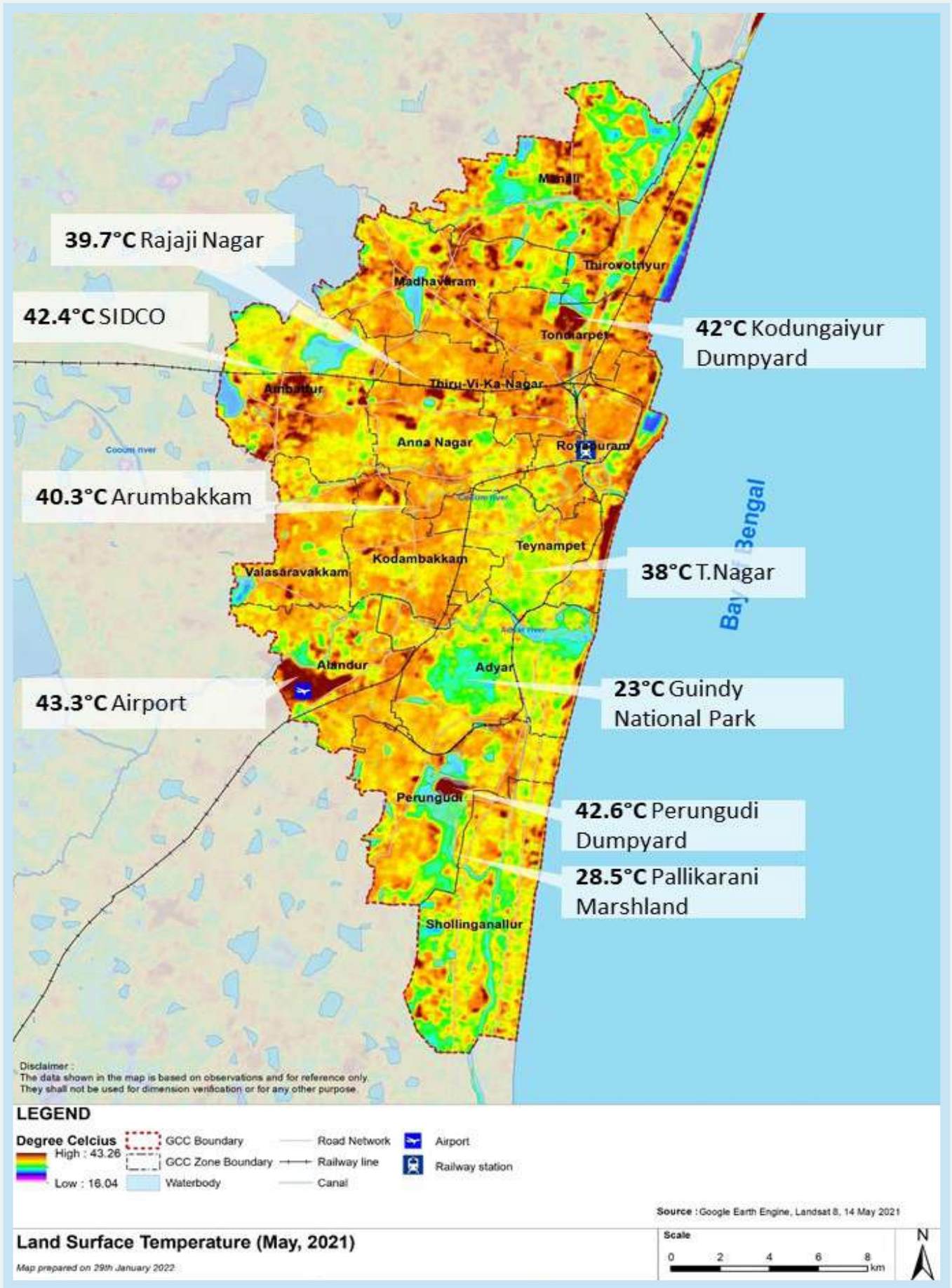


Figure 30: Land Surface Temperature in Chennai*

** LANDSAT 8, Google Earth Engine. May 2021. Image processed by UMC.*

4.1.4 Water Scarcity

Chennai's total water requirement is about 830 million litres a day. The city is dependent on four major reservoirs/lakes, namely, Poondi, Cholavaram, Red Hills, and Chembarambakkam for its daily water supply. These sources contribute to about 200 MLD of water. The reservoirs/lakes are rain-fed, and after filling up at the end of the Northeast monsoon (October–November), they supply water until the next monsoon season. Post the 2015 floods, the city experienced a deficit monsoon for the ensuing three years, leading to Chennai facing "Day Zero" in 2019 when all its four water reservoirs went dry. Households are also dependent on private groundwater wells. There are about 0.42 million groundwater wells in the city, and 66 per cent of the households have their own private wells.[62] Limited recharge, owing to the deficit monsoon as well as over-extraction of groundwater, has led to rapidly depleting water tables, deteriorating water quality, and increased risk of saline sea-water ingress.

Citizens had to depend on distant, unreliable public water pumps, and costly private water tankers.[63]

From 1991 to 2021, Chennai has seen a threefold increase in the built-up area (from 102 sq. km to 295 sq. km), while the vegetation cover has reduced from 23 per cent to 17 per cent (from 101.9 sq. km to 74.35 sq. km). Additionally, a significant decrease has also been observed in the area covered by water bodies, from 8 per cent to 4 per cent. A comparative analysis of the satellite imagery of Chennai from 1991 and 2021 shows that the area under waterbodies within GCC has decreased from 42.11 sq. km to 18.95 sq. km over the last three decades. Increasing temperature, reducing rainfall, and many other non-climatic parameters such as urbanisation have together led to marked water scarcity.

According to WHO standards, the green space per capita for healthy living is 9.5 m^2/person,[64] while Chennai currently stands at 8.75 m^2/person. Much of Chennai's land has been concretized due to urbanization, with few areas left with vegetation coverage. Built surfaces also reduce the percolation capacity of soil and have a direct impact on water resilience.[65]

As of 2021, the area under waterbodies in the GCC had decreased to less than half of that in 1991, from 42 sq. km to 18.95 sq. km (see Figure 28). Increased evaporation has led to the drying of waterbodies and has reduced their yield of water. Moreover, the rising UHI effect necessitates more energy for cooling of space – contributing to energy demands and, ultimately, to increased GHG emissions.

Chennai's current land surface temperature shows a negative relationship with vegetation (NDVI)[66] and waterbodies (NDWI),[67] with higher temperatures observed in areas with lower vegetation and waterbody cover (see Figure 29).

Although the water crisis impacts the rich and poor both, the impact is unequal. Slums and slum-like settlements suffer the most from acute water shortages. Sourcing water takes away not only a major share of their monthly incomes but also a large portion of their productive hours, which are spent on waiting for water. This further adds to the existing share of the burden that women carry in running their households.

Additionally, limited access to fresh water enhances the risk of dehydration. Extreme exposure to heat impacts citizens' health and causes increased cases of dehydration. The Rajiv Gandhi Government General Hospital reports 30 to 50 patients with heat-related symptoms every year between April 15 and June 15.[68]

Future Risks due to Water Scarcity

Chennai may face the risk of water scarcity in the future if its water resources are not managed well. Water scarcity will create social-economic imbalances across the city. The reduced reach of water may impact hygiene levels, adversely

62 Excreta Matters Report, 2012 as retrieved from https://drive.google.com/file/d/0B8NC6TnaIwLiSVNOQlI3MFg0TWM/view?resourcekey=0-MI91WsLHKGutIrzbMhAWDg on 14th September, 2022

63 https://www.downtoearth.org.in/blog/water/chennai-water-crisis-a-wake-up-call-for-indian-cities-66024

64 CET & INMAAS (2018). Preparation of Master Plan and DPR for Plantation Strategy in Greater Chennai Corporation.

65 https://ecologicalprocesses.springeropen.com/articles/10.1186/s13717-021-00341-1

66 Normalized Difference Vegetation Index (NDVI) shows vegetation cover. Built areas with negative values are prone to flooding and poor groundwater potential. Vegetation increases infiltration capacity. Positive values in NDVI are associated with more shrubs and forest coverage.

67 Normalized Difference Water Index (NDWI) predicts soil and wetness depth. Areas with low NDWI values denote a bare soil category.

68 https://www.thehindu.com/news/cities/chennai/chennais-scorching-summers-get-hotter/article34292878.ece

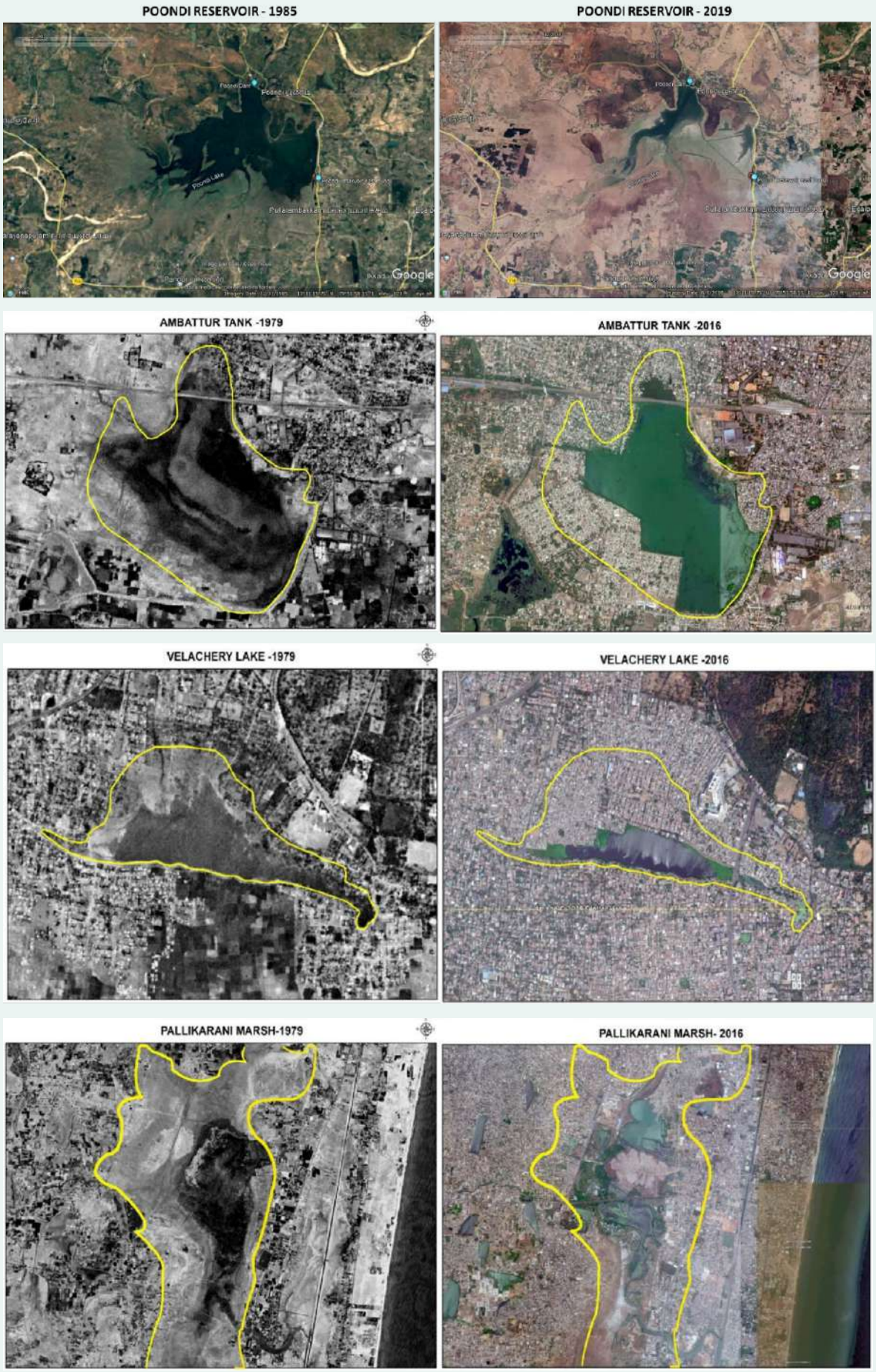
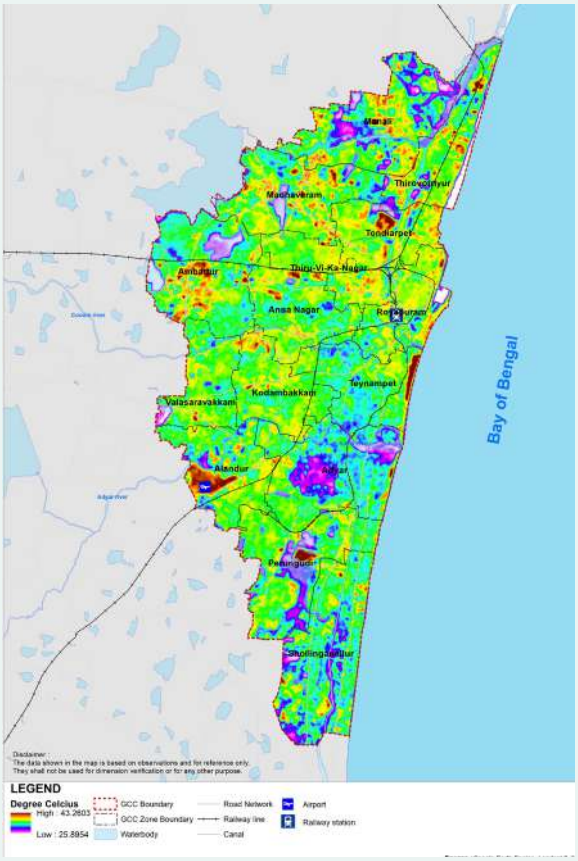


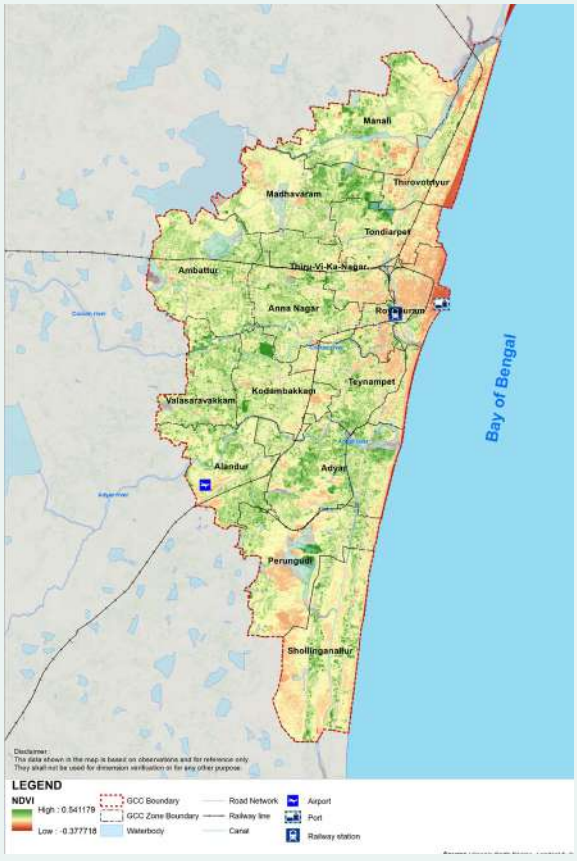
Figure 31: Disappearance/Shrinkage of Waterbodies within the GCC Area

Change in Land Surface Temperature

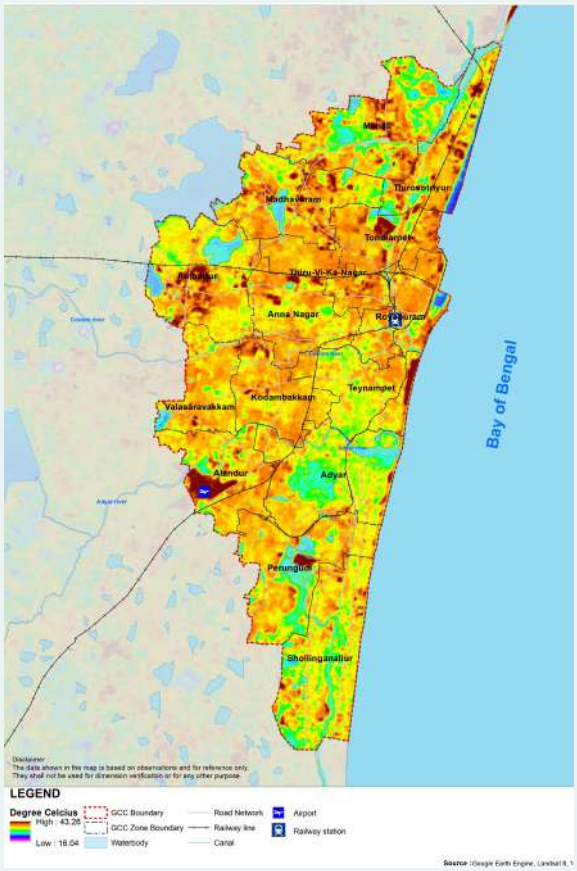
Change in Vegetation Cover

1991





2021



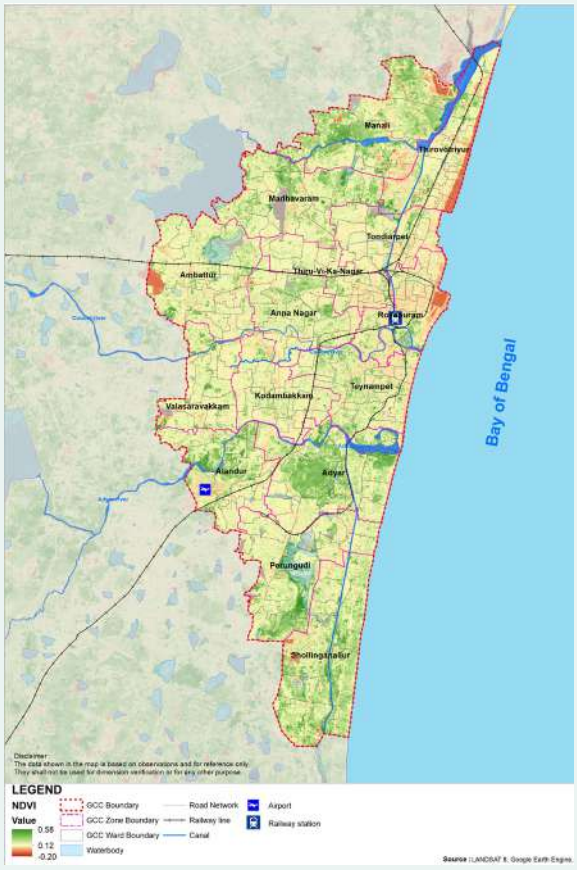
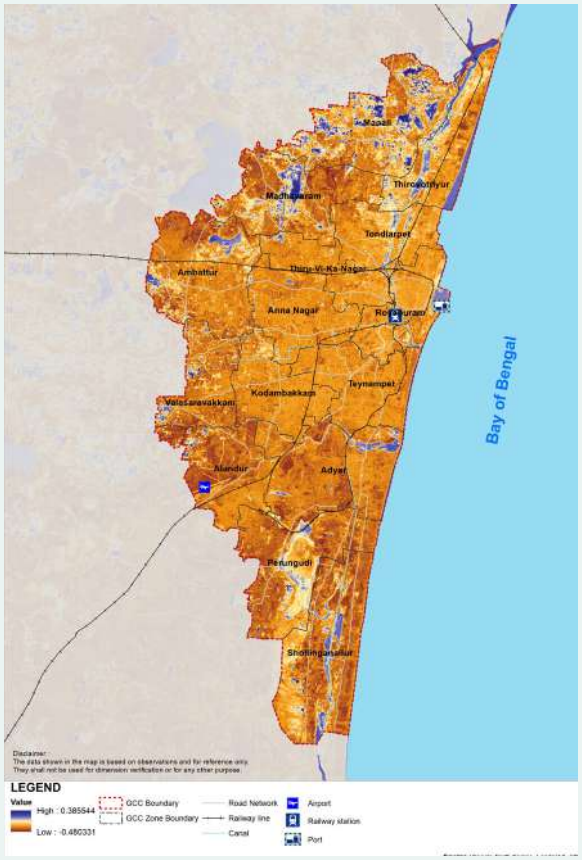
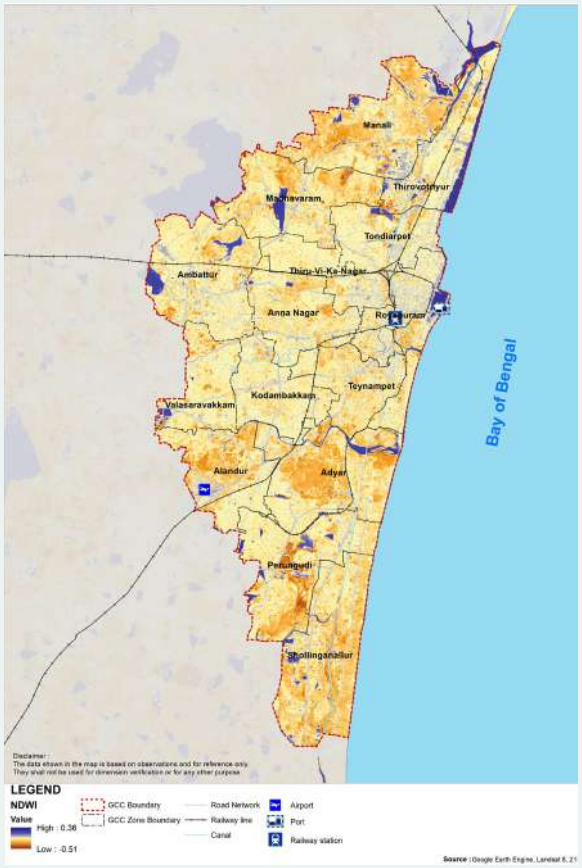


Figure 32: Correlation between Land Surface Temperature, Vegetation, and Waterbodies in 1991 and 2021

Change in Water Stream Cover





impacting the health of citizens. Additionally, damaged soil due to reduced levels of the water table and flash flooding events will directly impact the agricultural yield. Loss of agricultural yield will impact the economy and increase social inequality in the city.

4.1.5 Air Pollution

An air pollution assessment for Chennai was based on air quality data from five monitoring stations of the TNPCB located within the GCC area. A trend analysis was conducted for the concentration of particulate matter (PM 2.5 and PM10), along with an assessment within the framework of the Central Pollution Control Board (CPCB) permissible limits. The CPCB permissible limits for PM10 and PM2.5 are 60 (µg/m3) and 40 (µg/m3), respectively.

Trend analysis over the last five years for data across the monitoring stations shows an improvement in air quality and a reduction in the concentration of PM. PM levels fall within the CPCB permissible limits in all areas, except in Thyagaraja Nagar, where the concentration of PM10 is at 62 µg/m3. This is marginally higher than the permissible limit of 60 µg/m3. Thyagaraja Nagar's air pollution can be attributed to its location at the center of the city, which exposes it to higher levels of vehicular emissions and construction activities.

RSPM/PM10 monthly data for 2021 shows that the concentration was higher during the winter months of November, December, January, and February compared to the rest of the year. The T. Nagar and Kilpauk monitoring stations recorded the highest air pollution in the month of November. The Ambient Air Quality (AAQ) data from TNPCB shows how the air quality degrades in the month of November, due primarily to the festival of Diwali. On 4 November, the day of Diwali in 2021, the concentration of PM10 was recorded as 280 µg/m3 and PM 2.5 as 231µg/m3 in T. Nagar.[69] A similar pattern of increased air pollution is seen during the festivities of Bhogi (14 January 2021), when the concentration of PM10 is at 71 µg/m3 and PM2.5 at 96 µg/m3.

These outliers notwithstanding, the pollution levels in Chennai have remained largely under control, which can be attributed to its coastal location and the resultant sea breeze.

69 TNPCB (2021). Ambient air quality data during Deepavali festival from 28.10.2021 to 11.11.2021.

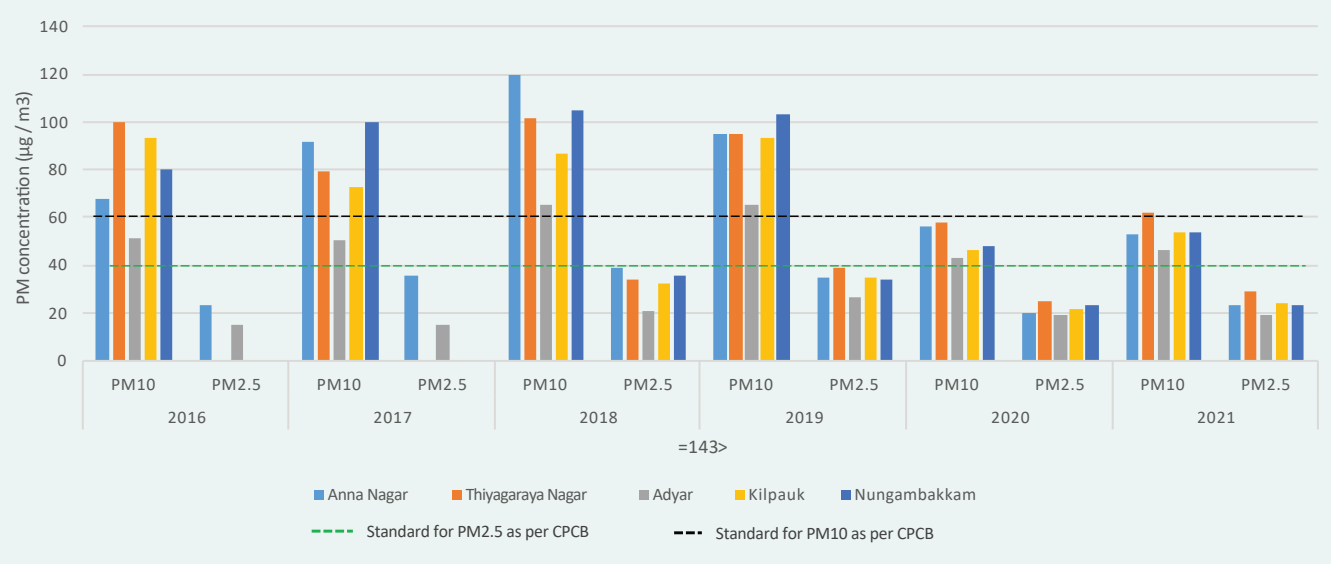


Figure 33: Concentration of PM10 and PM2.5 Overtime, at 6 Monitoring Stations in Chennai

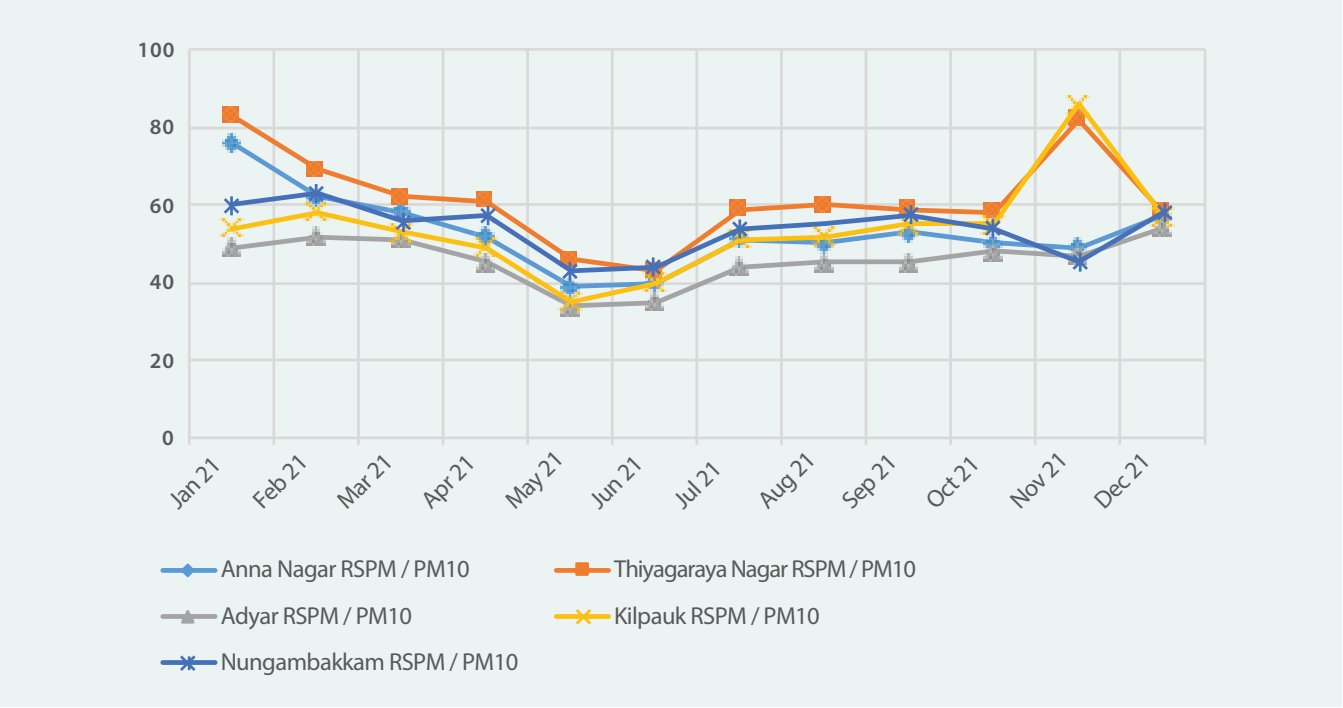


Figure 34: Concentration of PM10 in 2021

4.2 Chennai's Climate Change Hazard Impact Assessment

This section presents the potential impacts that these climatic hazards will have on the citizens of Chennai – especially the vulnerable communities, the social and physical infrastructure of the city, and municipal services. These projections have been based on the projected population growth and densities and considering the current location of slums and slum-like settlements and the social and physical infrastructure in the city.

The projected impacts also include the impact on people and systems in terms of the number of people affected, cost of damage, days of service lost, and impact on people's livelihood.[70]

4.2.1 Impact on Slums and Fisherfolk Population

Housing is crucial for the safety and well-being of an individual. Access to housing enables enhanced security from extreme events. The urban poor living in slums are particularly vulnerable to the impacts

70 C40 Cities. Climate Change Risk Assessment Framework. May 2018.

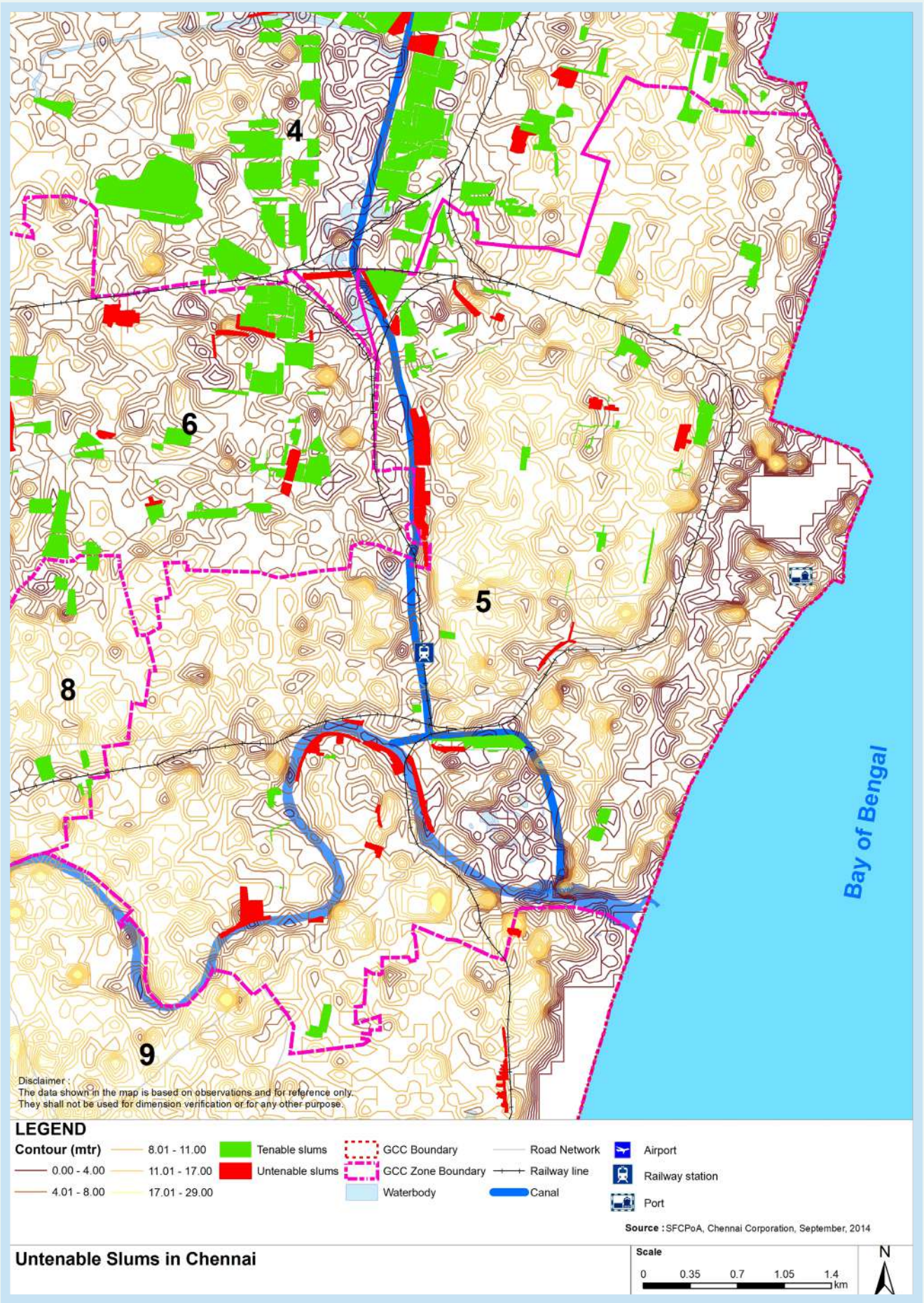


Figure 35: Untenable Slums in Central Chennai

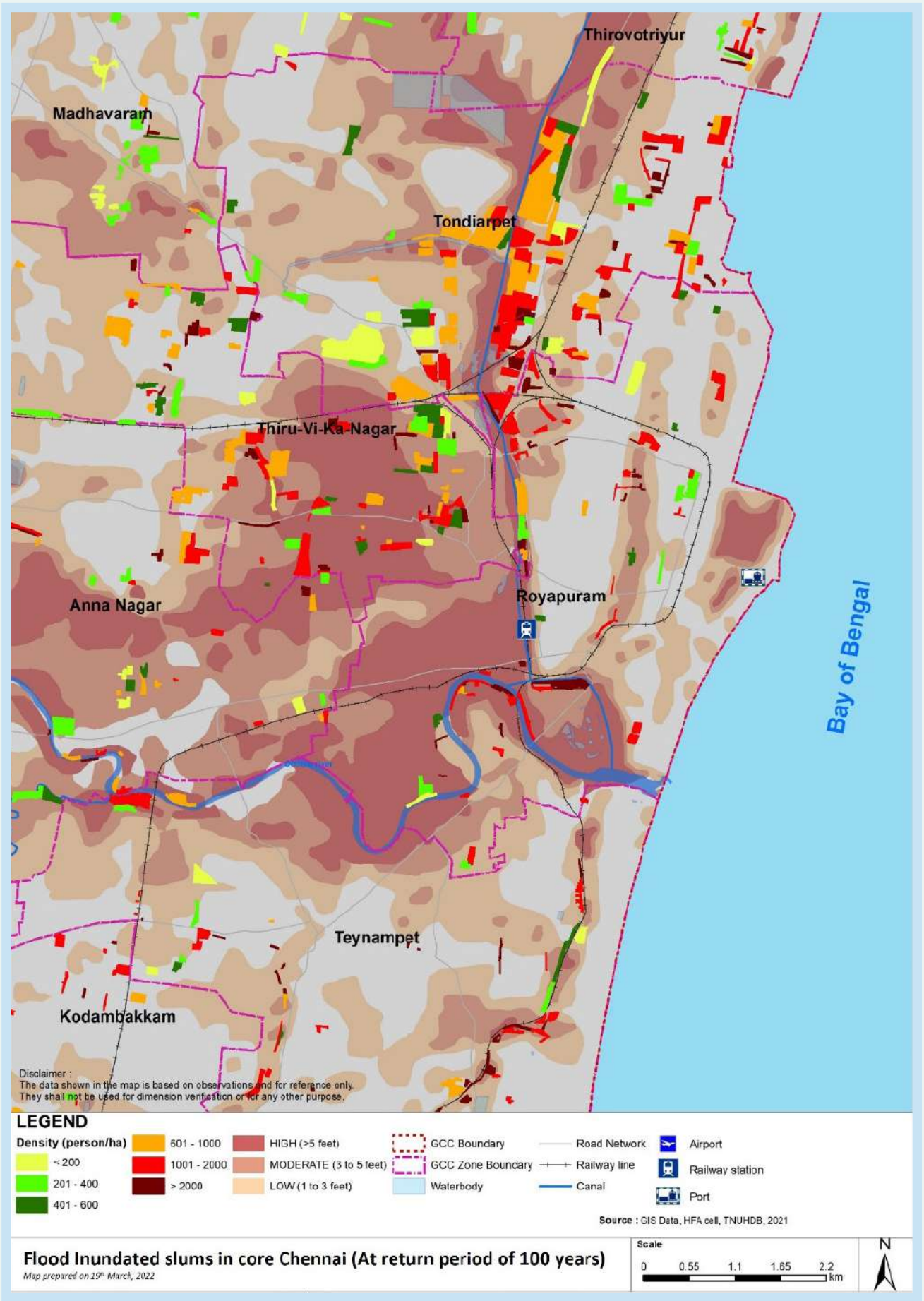


Figure 36: Existing Slums in Core City Area at Flood Risk at Return Period of 100 Years

of climate change and natural hazards since they occupy lands in low-lying areas; peripheral areas close to waterbodies, rivers, creeks; or other unsafe, unhygienic, or environmentally risky areas.

Generally, the urban poor live on the most vulnerable lands within cities, typically areas that are less desirable by others and are thus affordable. This makes them more vulnerable to the impacts of climate change. The impacts of floods are exacerbated by overcrowding and a lack of adequate infrastructure and services. Frequent waterlogging affects their livelihoods, health, and education and may push several of them back into years of recovery. Moreover, being cut off from work sites due to waterlogging compounded by a disease burden, the urban poor face severe livelihood losses.

In Chennai, 21 per cent of the slums (237 out of the 1,202 slums surveyed) house a population of approximately 2.5 lakhs and are in untenable areas. Half of these slum areas are built on beds of rivers and waterbodies[71] (see chapter 8.3.2). Currently, the average population density of slums (at 580 persons per hectare) is more than double that of the citywide density (at 215 persons per hectare).

According to data from the "Slum Free City Plan of Action for Chennai," 22 per cent of the slum households do not have access to individual household-level toilets and are dependent on public or community toilets. These shared facilities generally become inaccessible during flood events, adding to the plight of the residents. Lack of access to basic sanitation facilities (which increases the risks of water-borne and vector-borne diseases) and reduced availability of freshwater impacts both health and livelihoods.

It is estimated that at the return period of 100 years, Royapuram (Zone 5), Thiru-vi-ka Nagar (Zone 6), Anna Nagar (Zone 8), and Tondiarpet (Zone 4), which are located in the central part of the city, will be most affected by floods. These zones house a population of almost six lakhs. Additionally, 459 slums face similarly high risks of flood inundation once in every 100-years (see Table 29 Chapter 8). Out of these 257 slums, 95 are already categorized as "Untenable" by the GCC and require immediate attention. Other vulnerable slums include those that house larger populations in times of climatic events.

Untenable slums located on riverbanks, creeks, or nearby low-lying areas are also expected to face inundation due to SLR. About 215 out of the 1,202 slums surveyed within the GCC area collectively house a population of approximately 2.6 lakhs and are expected to get permanently inundated due to SLR (see Figure 34), including those located in

Source: iStock Photo

71 TNSCB & DARASHAW, Slum Free City Plan of Action for Chennai, 2014.

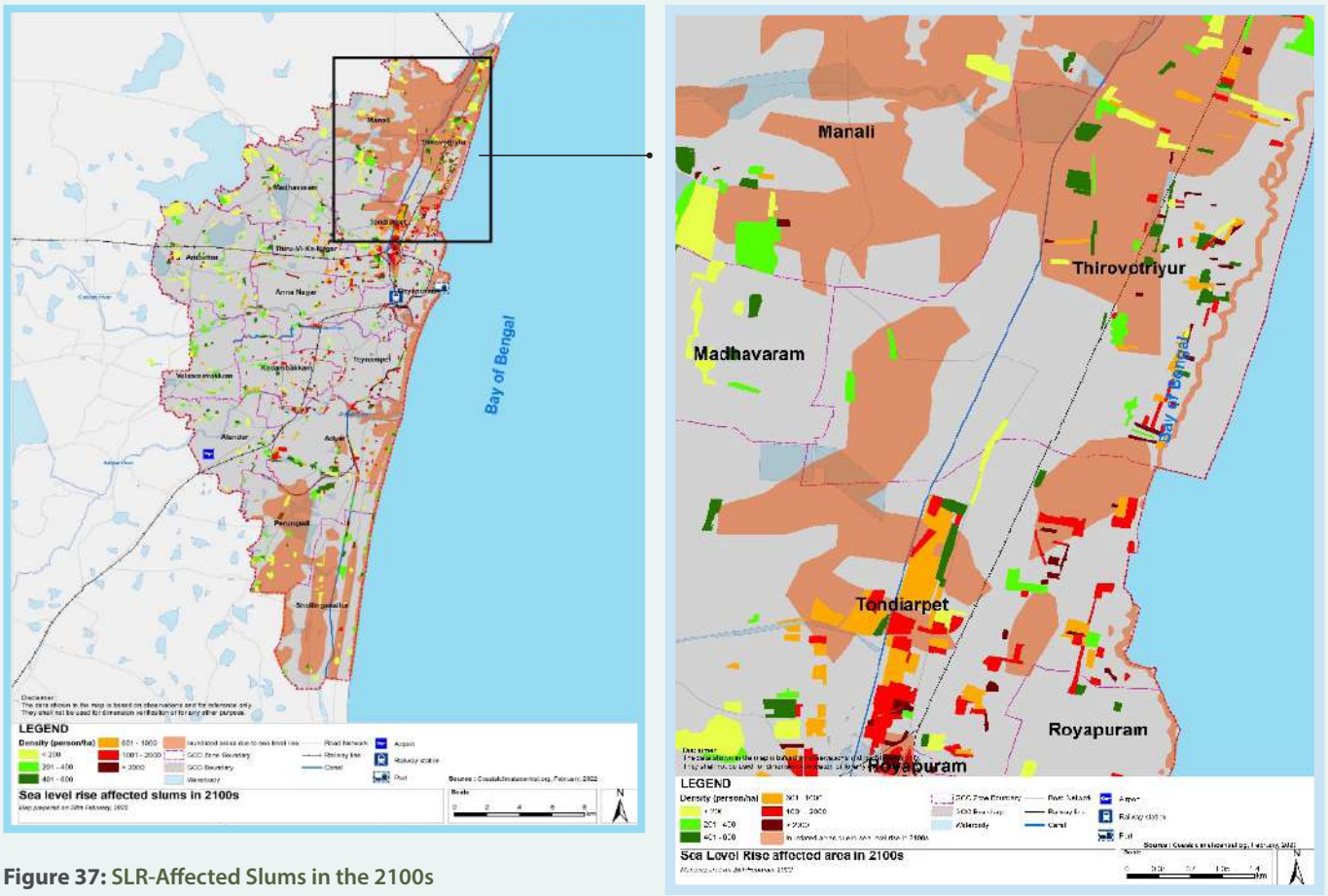


Figure 37: SLR-Affected Slums in the 2100s

the creek area in northern and southern Chennai. Among these, slums with a higher population density and those already categorized as untenable are more vulnerable.

As already noted, the 19-km long coast of Chennai district is dotted with several fisherfolk settlements. Since their livelihood is linked to a stable coastal environment favourable for fishing, the SLR is expected to impact their lives and livelihoods significantly. The impact is exacerbated by the fact that almost the entire fisherfolk community is assessed to belong to the Below Poverty Line category. Thus, the fisherfolk – in view of their linkage to the coast for their living (housing) as well as livelihood (employment source) – are among those most vulnerable to SLR.

The impact of UHI effect, as discussed above, is also more critical on the urban poor communities, driven by their inability to afford air conditioning; avoid strenuous activities; or avail of proper roofing material, shades, or protection. Since slums are densely built, have lower green cover and open spaces, and consist of houses built with materials that provide insufficient insulation from the heat, residents are exposed to extremely high temperatures during night time as well – often for an extended number of days.

Extreme exposure to heat also causes an increase in cases of dehydration and heat strokes, leading to a healthcare crisis. The situation is compounded by limited access to fresh water, since the residents are not able to afford private water tankers during times of water scarcity. The threat of seawater intrusion into freshwater sources further adds to the problem of water scarcity.

4.2.2 Impact on Public Transport

Access to transport is necessary for availing of basic necessities, such as livelihood, education, and health. Chennai has various modes of public transport, ranging from Suburban Railways and Metro Rails to City Bus Services. Including the completion of the Metro network planned for the next phase, 36.4 per cent of the GCC area is covered by public transport services, and around 47 per cent of the GCC population has access to public transport within a walkable distance of 400 m. Among slum population, too, 54 per cent have easy access to some mode of public transport.

The coverage of public transport is highest in Zone 9 (Teynampet), Zone 10 (Kodambakkam), and Zone 5 (Royapuram), while it is lowest in Zone 2 (Manali), Zone 1 (Thiruvottiyur), and Zone 11 (Valasaravakkam).

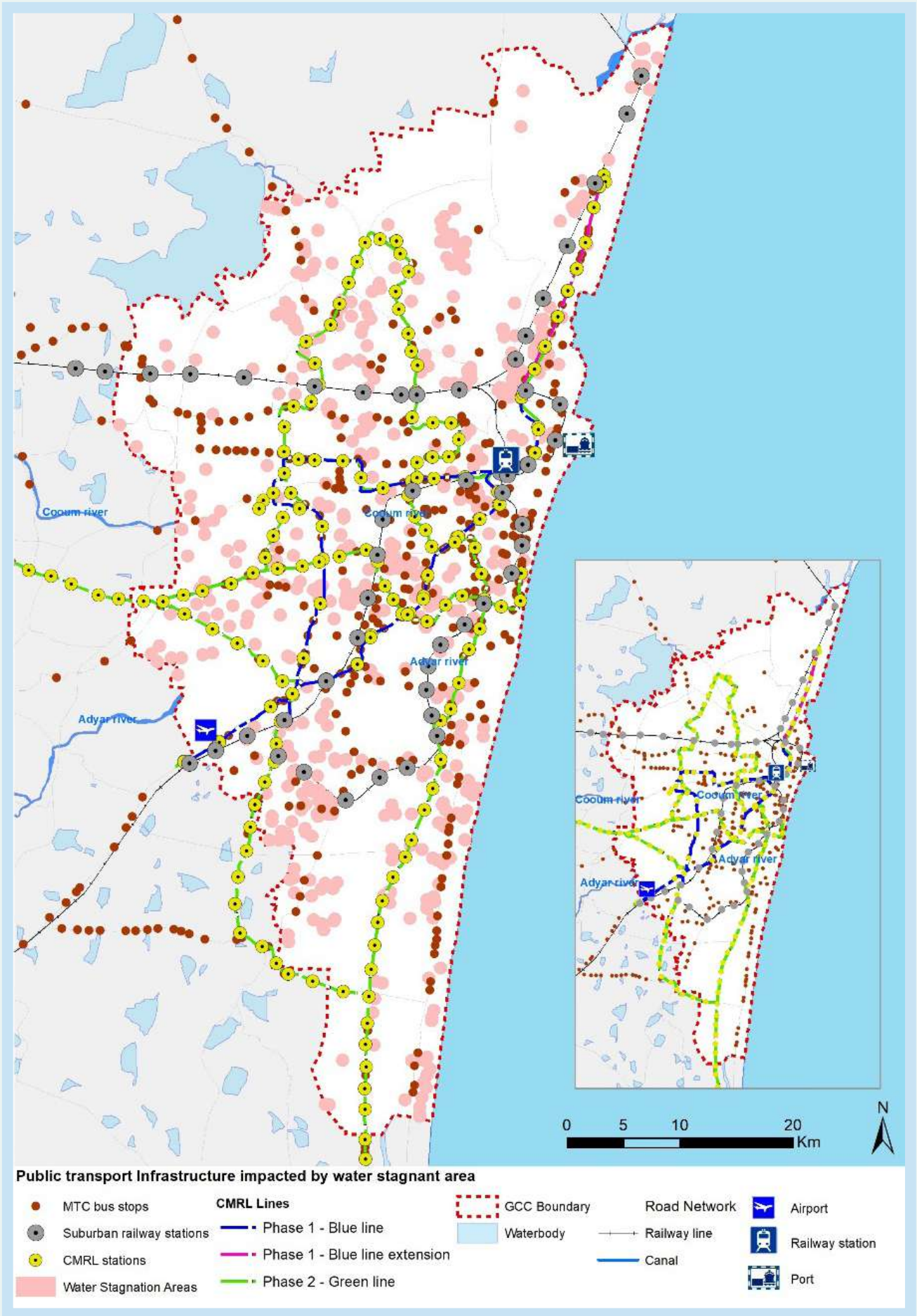


Figure 38: Accessibility to Public Transport Infrastructure Impacted by 562 Water-Stagnant Locations

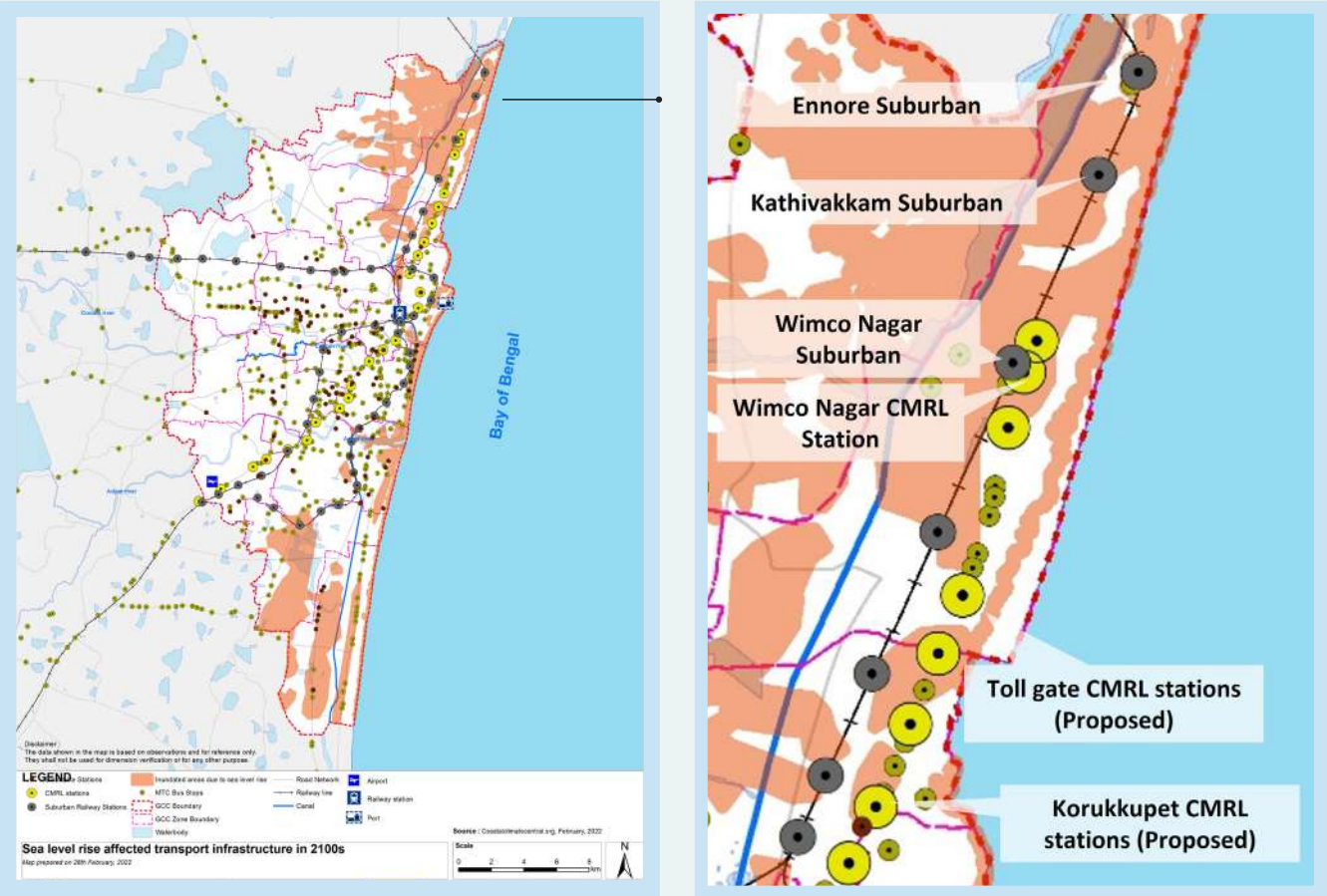


Figure 39: SLR-Impacted Transport Infrastructure in the 2100s

During floods, about 20.3 per cent of the population loses their access to public transport, since these transit points fall within water stagnation areas (see Figure 35).

Waterlogging during monsoons is common in Chennai and hinders citizens' access to public transport at least five to six times a year. Those dependent on public transport for their jobs, education, and health are deeply impacted due to the loss of working hours, productivity, income, access to school/colleges, and access to health facilities during emergencies.

Populations residing in slums are more vulnerable during these times, as they are often unable to afford alternate modes of transport. The projected flood risk analysis shows that 20.3 per cent of existing and proposed transport infrastructure in

Table 3 Impact of Floods and SLR on Public Transport Infrastructure

Risk of Flooding	No. of Flood-Inundated Transport Nodes at Return Period of 5 Years									
	Smart Bike Stations		MTC Bus Stops		Suburban Stations		Existing CMRL Stations		Prop. CMRL Stations	
High >5ft	6	6%	7	2%	0	0%	0	0%	0	0%
Moderate (3-5ft)	5	5%	9	3%	1	3%	1	4%	0	0%
Low (1-3ft)	21	20%	49	14%	12	35%	5	19%	28	17%

*Numbers given here for each category of risk zones are cumulative.

Permanent Inundation due to SLR	No. of SLR-Impacted Transport Nodes in the 2100s									
	3	2.8%	28	8%	4	12%	4	15%	12	7%

Chennai is likely to get inundated during floods once every five years. Similarly, the flood risks projected at return periods of 10 years, 25 years, 50 years, and 100 years indicate that 28 per cent, 47 per cent, 49 per cent, and 61 per cent of public transport infrastructure, respectively, are likely to get inundated (see 8.3.2). About 8 per cent of transport infrastructure is likely to get permanently inundated by the end of the century due to SLR (see Figure 36).

4.2.3 Impact on Physical Infrastructure

In addition to housing and transport infrastructure, other physical infrastructure is also made vulnerable

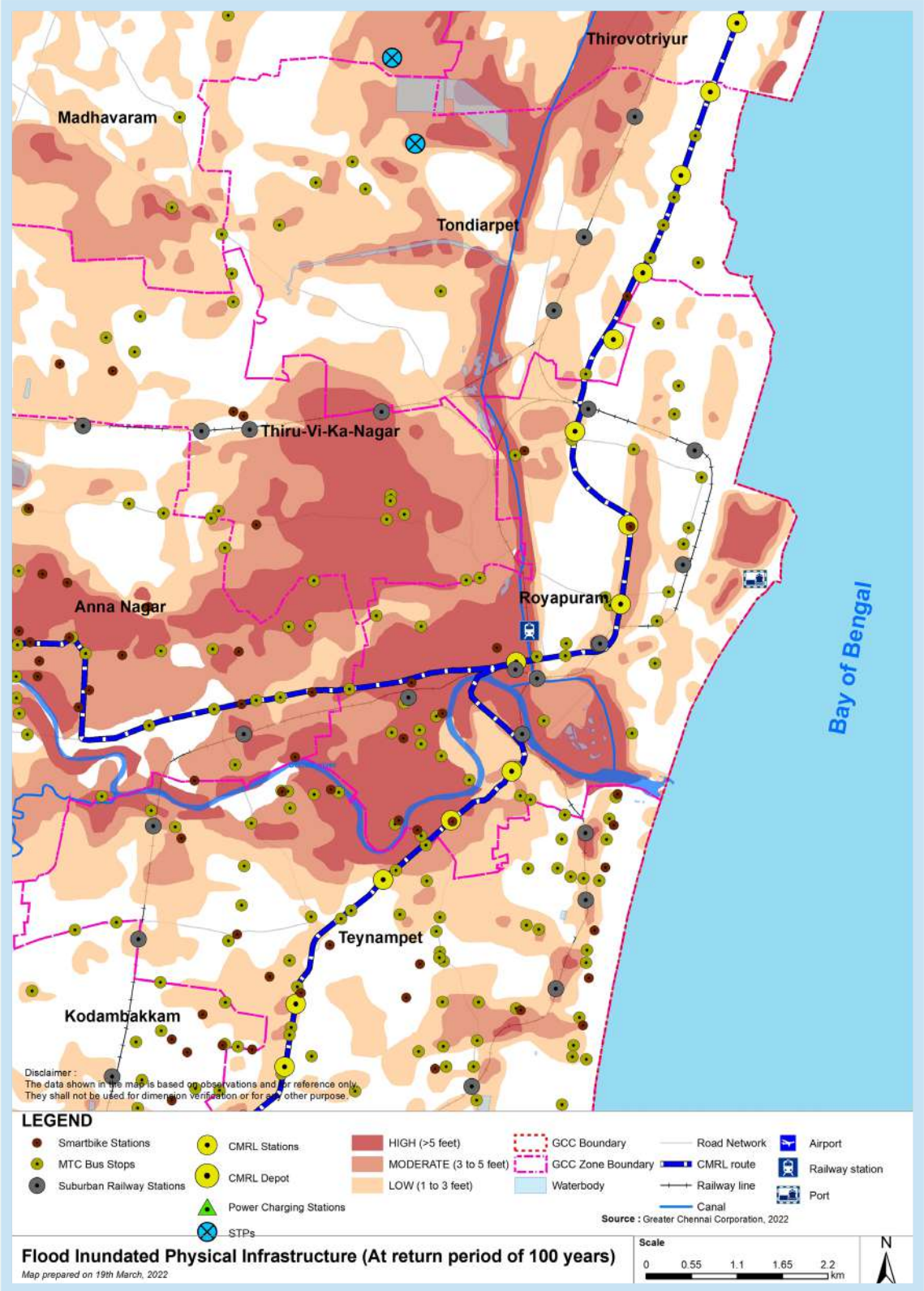


Figure 40: Existing Physical Infrastructure in Core City Area at Flood Risk at Return Period of 100 Years

to floods and storm, such as water, sanitation, and health infrastructure. Since water treatment plants are often located near rivers, floods may cause damage to machinery and contamination pipelines, which affect the dependent population due to service disruption.

Heavy rainfall and events of flash flooding can also damage sewerage infrastructure and cause overloading due to increased inflow of excess water in the system. The two STPs located in Kodungaiyur (Zone 4) have a total design capacity of 160 MLD and serve the northern part of the GCC area. The projected flood risk shows that at least two out of nine Sewage Treatment Plants (STPs) in Chennai are likely to be inundated once during floods every five years (see Table 4). Around 78 per cent of the existing STPs are vulnerable to flood inundation once in every 100 years.

Moreover, the larger the flood return period, the greater the risks. The inundation of STPs may also disrupt the functioning of the pumps and lead to backups in sewer lines, preventing sewage from reaching the pump station or plant. This can cause infiltration in leaky pipes and result in the overflow of untreated sewage, adversely affecting the health of the city.

Flood inundation can cause the failure of power plants, resulting in the loss of electricity. This not only has a serious impact on the general functioning of the city but also impedes recovery processes. Further, the risk of damage to power-charging infrastructure can discourage people from using electric vehicles and

Table 4 Impact of Flooding on Other Physical Infrastructure

Projected Risk of Flooding	No. of Flood-Inundated Physical Infrastructure at Return Period of 5 Years			
	Sewage Treatment Plants		Power Charging Infrastructure#	
High >5ft	2	22.2%	8	21.6%
Moderate (3-5ft)	2	22.2%	8	21.6%
Low (1-3ft)	2	22.2%	8	21.6%
Risk of Flooding	**No. of Flood-Inundated Physical Infrastructure at Return Period of 25 Years**			
High >5ft	5	55.6%	12	32.4%
Moderate (3-5ft)	4	44.4%	11	29.7%
Low (1-3ft)	4	44.4%	8	21.6%
Risk of Flooding	**No. of Flood-Inundated Physical Infrastructure at Return Period of 100 Years**			
High >5ft	7	77.8%	16	43.2%
Moderate (3-5ft)	6	66.7%	13	35.1%
Low (1-3ft)	4	44.4%	9	24.3%
	No. of SLR-Impacted Physical Infrastructure in the 2100s			
Permanent Inundation due to SLR	3	33%	3	8%

**Numbers given here for each category of risk zones are cumulative.*
#Power Charging Infrastructure means Public electric vehicle charging stations.

increase the pressure on fossil fuels, leading to a rise in GHG emissions.

Chennai's storm-water drains are currently under-capacitated and thus unable to manage extreme precipitation due to climate change, which became evident in the aftermath of the 2015 floods in the city. Consequently, multiple locations in the city experience waterlogging, which can persist for days. Civic authorities and residents have to rely on pumps and tankers for removing water from the streets.[72] To implement mitigation measures for the projected flood risks and the level of inundation estimated, it is important to develop a robust and collaboratively managed network of storm-water drains.

Source: Google Maps

72 https://chennai.citizenmatters.in/chennai-stormwater-drains-gcc-map-flooding-tnagar-ashok-nagar-36033


Source: iStock Photo

4.2.4 Impact on Health Infrastructure

Healthcare is an essential service, and access to it is especially critical during climatic events. Currently, only 24 per cent of Chennai's population has access to public health infrastructures within a walkable distance of 400 m, which includes only half of the slums located in the GCC area. The remaining population either depends on private clinics and hospitals, or travels larger distances to access public health infrastructure. The coverage of public health infrastructure is highest in Zone 6 (Thiru-vi-ka Nagar), Zone 4 (Tondiarpet), and Zone 10 (Kodambakkam), while it is lowest in Zone 2 (Manali), Zone 3 (Madhavaram) and Zone 14 (Perungudi).

The urban poor population has disproportionately limited access to healthcare. Especially during health emergencies, they are forced to choose between the exorbitant costs of private health facilities and the inordinately long response time of public health facilities. This, in turn, decreases their adaptive capacity to combat extreme climate events.

During floods, about 6 per cent of the population that otherwise has access to public health infrastructure, get cut off due to water stagnation. The projected flood risk analysis shows that 20 per cent of existing health infrastructure in Chennai is likely to get inundated in floods every five years, and 45 per cent and 56 per cent health every 25 and 100 years, respectively.

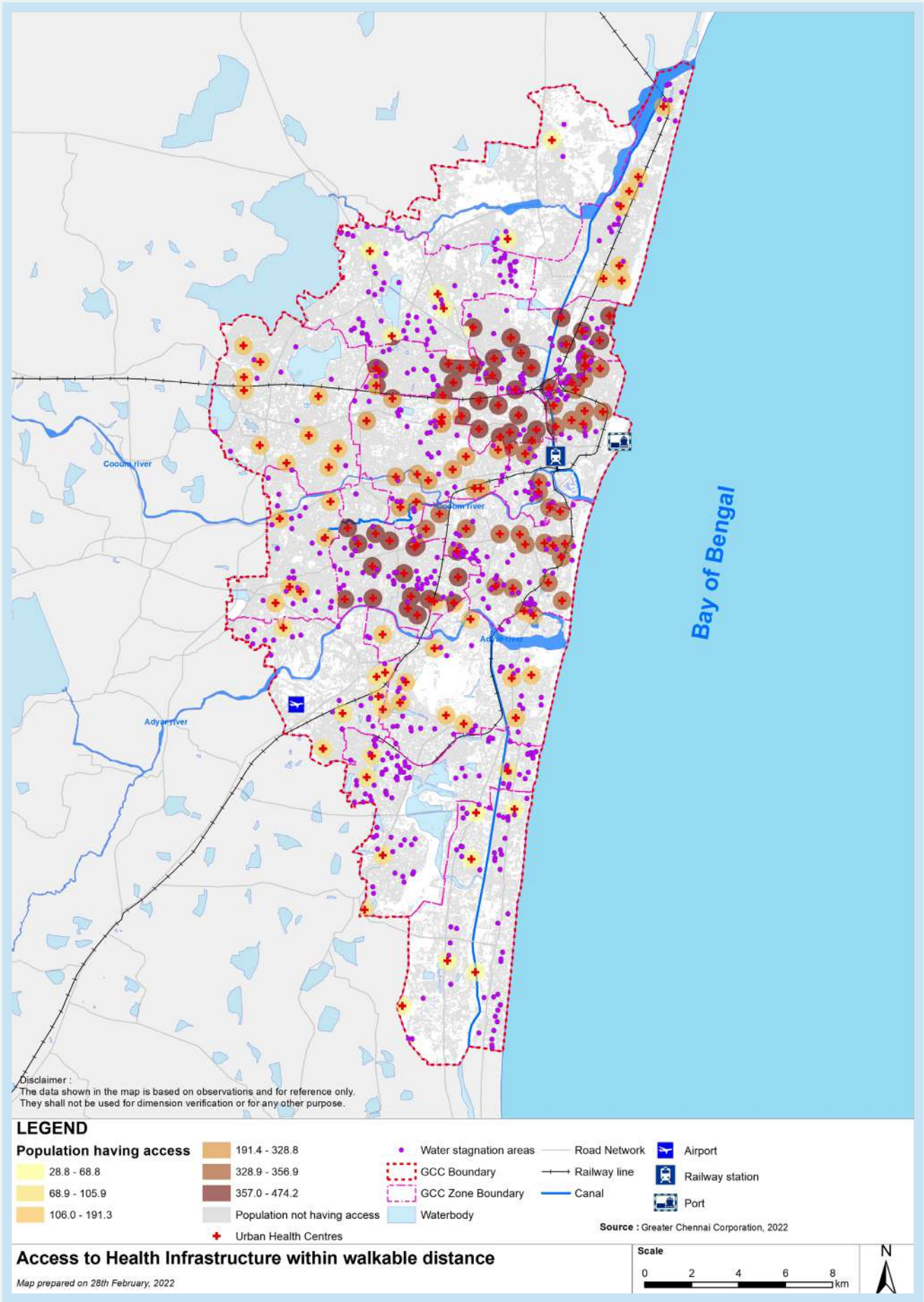


Figure 41: Access to Public Health Infrastructure within Walkable Distance

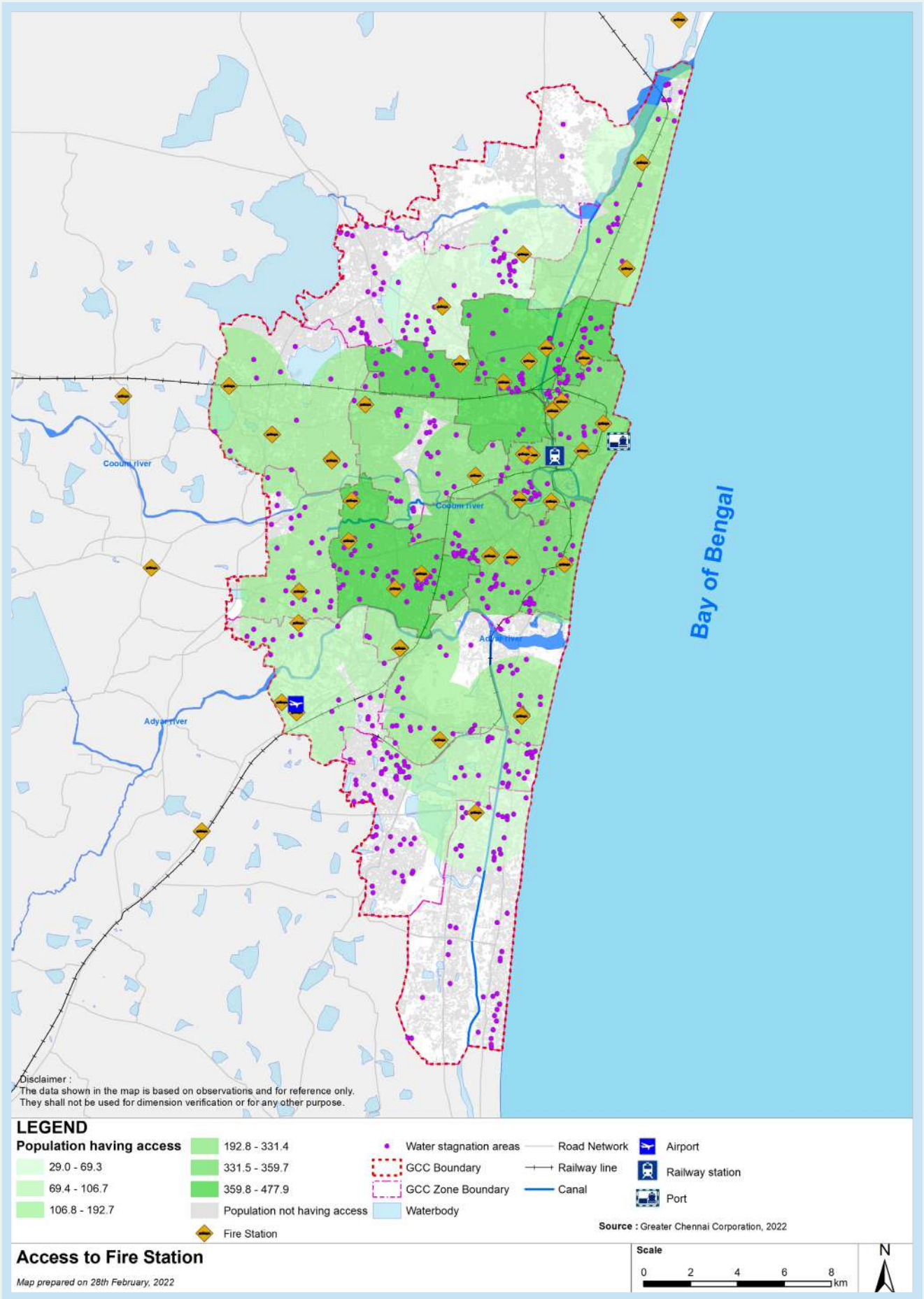


Figure 42: Coverage of Emergency Fire Service within a 5-Minute Response Time

Source: TNFRS/twitter.com

4.2.5 Impact on Emergency Fire Services

The Standing Fire Advisory Committee (SFAC), constituted by the Ministry of Home Affairs, recommends one fire station within a 2.5 km radius in urban areas, with a response time of 5–7 minutes. Chennai has a total of 50 fire stations, with a strong coverage of emergency fire services in the central part of the city. The fire and emergency services are able to respond within the stipulated response time of 5 minutes for about 87.3 per cent of the city's population, since the zones with the highest population density in the city are well covered.

However, the slums located in these zones remain relatively vulnerable, since the fire can spread quickly across informal housing and the locations are difficult

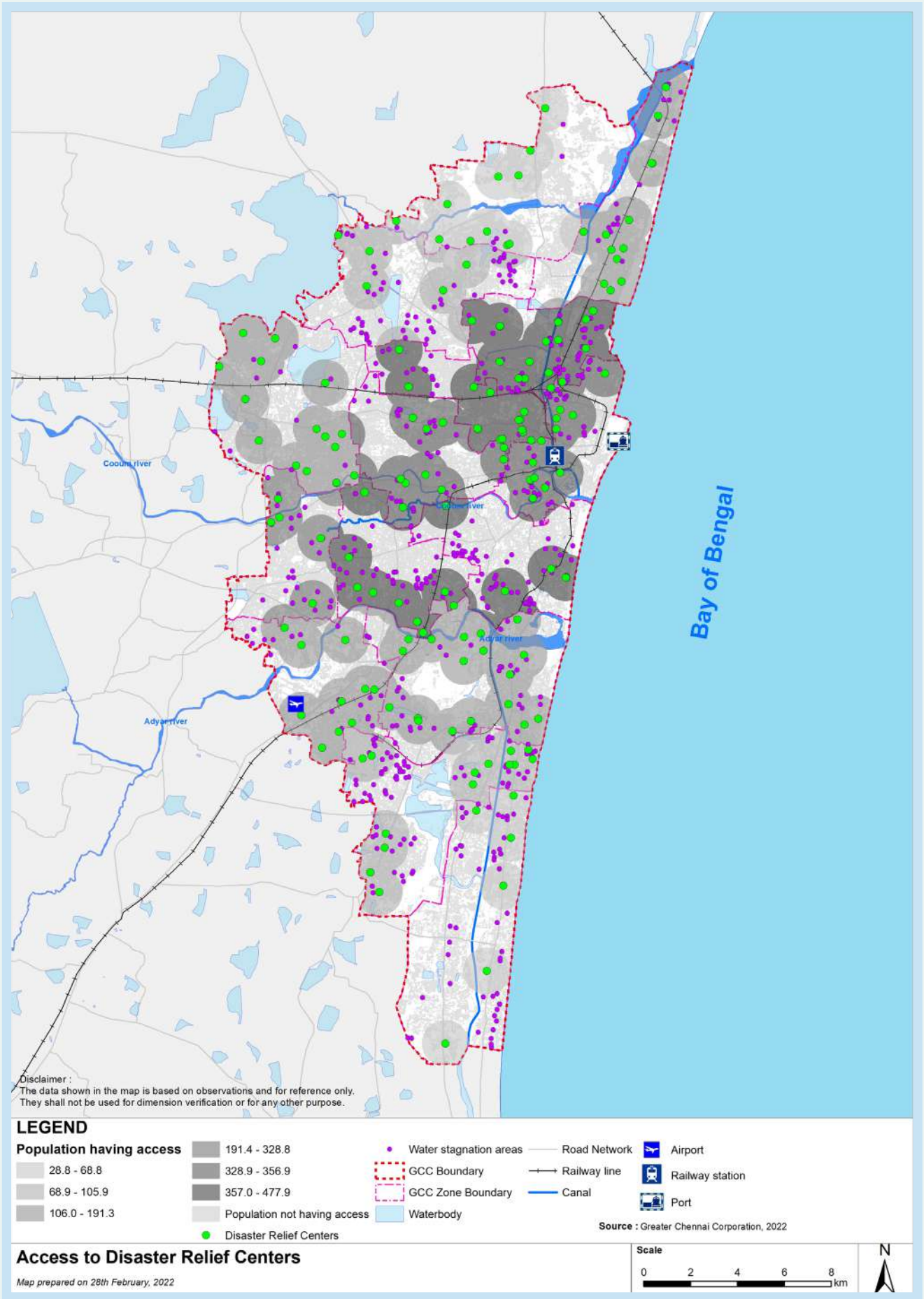


Figure 43: Access to Disaster Relief Centres within a Distance of 1 km

to access during rescue operations. Moreover, the coverage of fire services is relatively low in the newly developed southern zones of Sholinganallur (Zone 15) and Perungudi (Zone 14), and northern zones of Manali (Zone 2) and Madhavaram (Zone 3). This translates to higher response time and critical delays in emergency rescue and operations.

During flood events, the population with access to emergency fire services effectively decreases to 57.3 per cent due to waterlogged areas, a significant drop since most of the water-stagnant areas are located in high-density zones. The projected flood risk analysis shows that 18 per cent of existing fire stations in Chennai are likely to get inundated in floods every five years, and 42 per cent and 56 per cent every 25 and 100 years, respectively. The Guindy Fire Stations and Tamil Nadu Fire and Rescue Services, located in the Royapuram (Zone 5) near the Cooum River are the most vulnerable, since they are located in low-lying areas and are at risk of inundation every five years. Chapter 8.3.4 details the number of fire stations and the risk level due to floods for each.

4.2.6 Impact on Disaster Relief Centres

Disaster Relief Centres are vital for providing safety and support to vulnerable populations in cases of emergencies, and the proximity and access to these centres is, therefore, crucial. Approximately 66 per cent of Chennai's total population is located within a radius of 1 km from a disaster relief centre. However, this is projected to decline to 53 per cent during a flood event.

The projected flood risk analysis shows that 23 per cent of existing disaster relief centres in Chennai are likely to get inundated by floods every five years, and 35 per cent and 50 per cent every 25 and 100 years, respectively. See chapter 8.3.4 for details on the total number of disaster relief centres and their risk levels during floods.

Source: iStock Photo

Source: Urban Management Centre

CHAPTER

5

Chennai's Current & Future GHG Emissions

This Chennai city greenhouse gas (GHG) emissions inventory adopts a Global Protocol for Community-Scale Greenhouse Gas Inventories (GPC) BASIC standards (see Annexure 8.1) and is prepared for the geographic boundary of Greater Chennai Corporation for year 2018-19. The inventory was prepared as an evidence base to derive targets, strategies, and actions for the Chennai Climate Action Plan (CCAP). The process of preparation also involved updating the 2015–16 inventory to ensure that the data and methods used for collating both inventories are consistent with preserving the validity of comparison and provide a solid base for monitoring the progress of the city towards its emissions targets. The GHG inventory for Chennai includes an analysis of the emissions in Chennai.

Stationary Energy Sector (emissions from residential, commercial, institutional buildings, manufacturing and construction industries, and energy industries along with emissions from energy production outside the city boundaries but which is consumed within the city)

Transportation Sector (emissions from all vehicular trips from private, public, and intermediate transportation modes within the city boundary, and from such vehicular trips from the region to the city that are generated due to the city's economic and social offerings)

Waste Sector (emissions from solid and liquid waste generated within the city)

5.1 Chennai's Current GHG Emissions

To understand the emission profiles of Chennai, year 2018–19 was taken as the base year to capture the pre-COVID-19 scenario. Chennai has developed a sector-specific GHG emissions inventory for the base year, using the Global Protocol for Community-

Source: Urban Management Centre

Table 5 Comparison of GHG Emissions with Other Cities

Cities	Total GHG Emissions for Base Year 2018–19	
	Total Emissions *(million tons CO_2e)*	Per capita Emissions *(tons CO_2e per capita)*
Chennai	14.38	1.9
Mumbai*	25.09	2.0
Bangalore**	17.81	1.6
Kolkata***	25.04	1.5

Scale Greenhouse Gas Emission Inventories (GPC) (see Annexure 8.1). Overall, the city has contributed the equivalent of 14.38 million tons of CO_2e during the base year 2018–19. This represents 1.9 tons of CO_2 emissions per Chennai resident per year and approximates to 165 tons per $1 million of the city's GDP. This is comparable with similar-sized cities in India (see Table 5).

Under the GPC BASIC standards, these emissions are attributed to three sectors: Stationary Energy, Transportation, and Waste. In the base year 2018–19, the Stationary Energy Sector is responsible for 10.10 million tons of CO_2e, followed by the Transportation Sector at 2.37 million tons of CO_2e, and the Waste Sector at 1.90 million tons of CO_2e, comprising 71 per cent, 16 per cent, and 13 per cent of the city's total emissions, respectively.

Figure 41 shows the sectoral change in GHG emissions between 2015–16 and 2018–19. While there has been an absolute growth in the emissions during this period, the emission intensity of the city is already decreasing. For example, the per

* Carbon Footprints, 2018, http://citycarbonfootprints.info/. Retrieved on 29 August 2022

** Ibid.

*** Ibid.

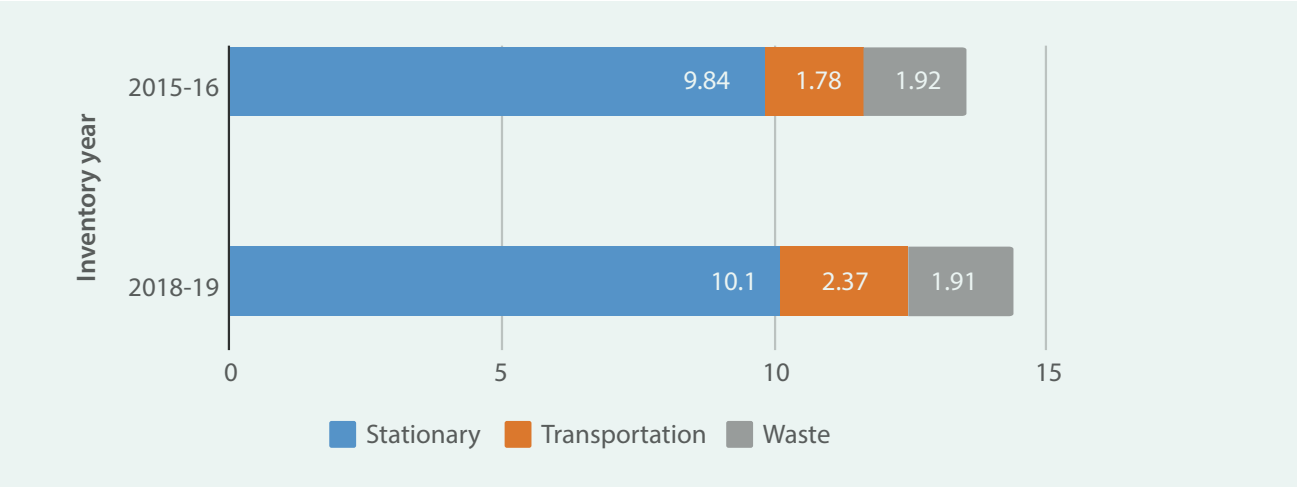


Figure 44: Change in Emissions from 2015-16 to 2018-19

capita emissions are marginally lower for 2018–19 (1.9 tonnes per capita), compared to the 2015–16 numbers (2.0 tons CO_2e per capita). Similarly, the per $1 million GDP emissions was 212 tons of CO_2e in 2015–16 and reduced to 200 tons of CO_2e in 2018–19. The Transport Sector has seen the largest increase in emissions of 25 per cent, from 2015-16 to 2018-19. This increase is largely attributable to a significant growth in the total number of trips made by private transport and a shift away from the bus service. As the city develops more inventories over time, such comparisons will yield more robust conclusions.

Stationary Energy

The Stationary Energy Sector generates emissions through the burning of fuels primarily to produce

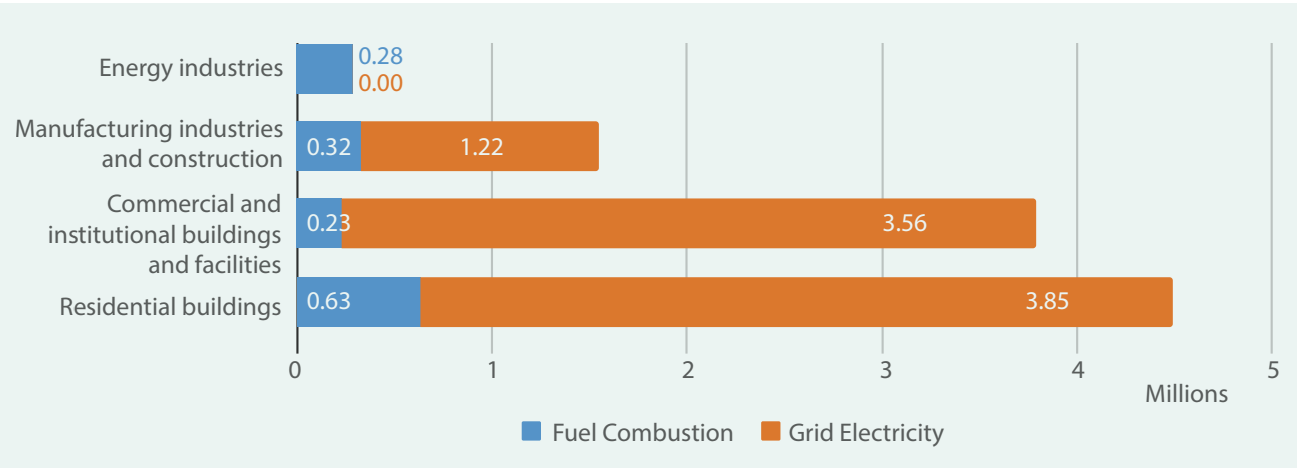


Figure 45: Stationary Energy Emissions by Subsector in tCO2e

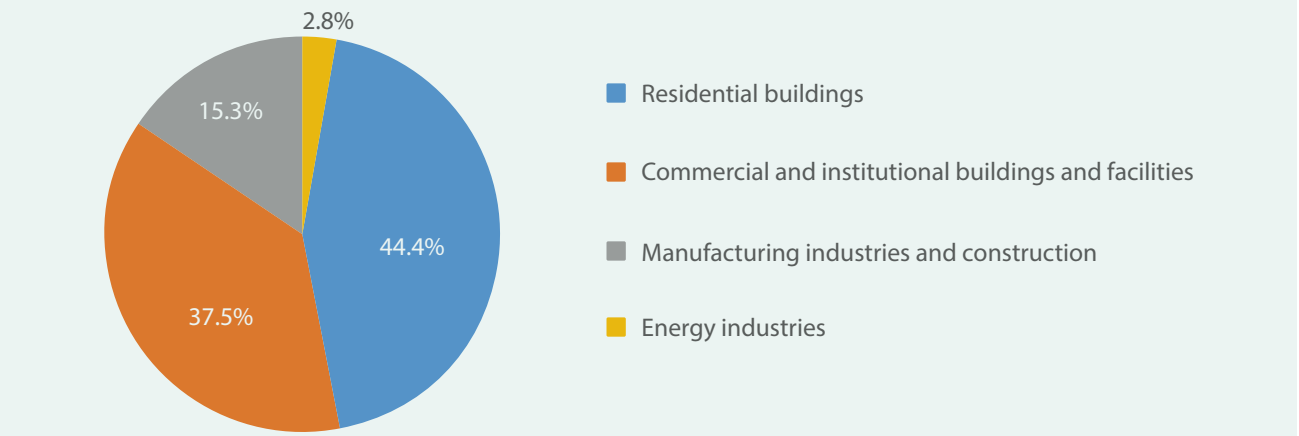


Figure 46: Share of Stationary Energy Emissions by Subsector (Percentage)

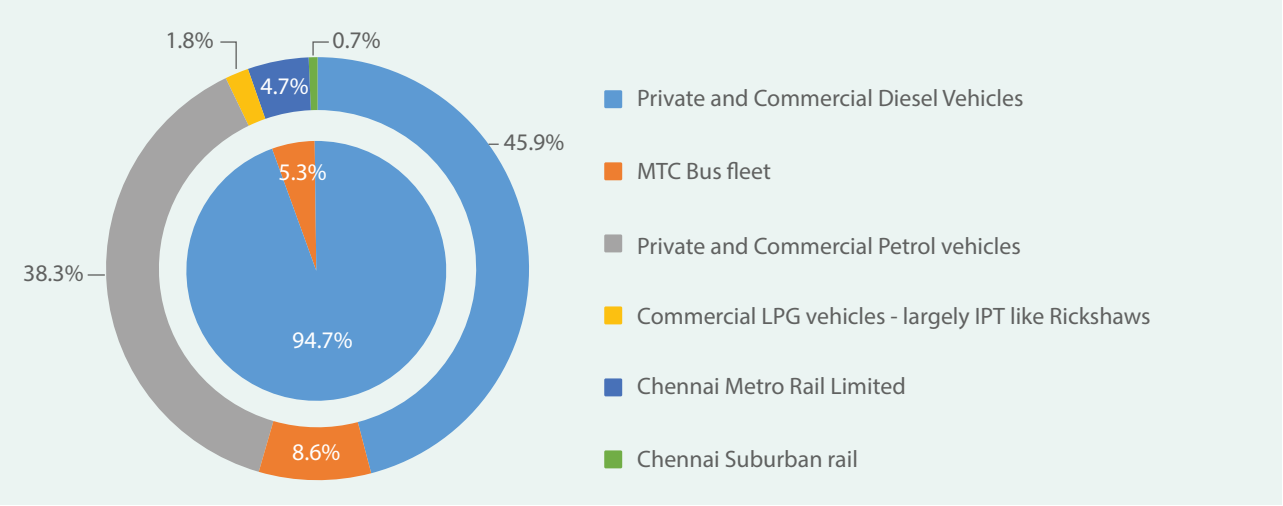


Figure 47: CO_2 Emissions from Transportation Sector

electricity or steam; electricity consumption; and technical losses in the transmission and distribution systems. The emissions from the Stationary Energy Sector are contributed by residential buildings, commercial and institutional buildings and facilities, and manufacturing industries and construction. Around 71 per cent of Chennai's total GHG emissions are contributed by residential, commercial, institutional buildings, manufacturing and construction industries, and energy industries along with emissions from electricity produced outside the city boundaries (but which is consumed within the city). Since these sources are the highest contributor to a city's emissions, they constitute the most important areas where stringent climate actions need to be identified and implemented.

These 71 per cent emissions include those generated from GRID energy at regional level as well as fuel combustion in buildings within the GCC. Of these emissions, 85 per cent come from electricity consumption in buildings and 15 per cent from fuel consumption (LPG consumed for cooking, fuel oils used by industries, and fuel consumed by the petroleum refining activities). This is mainly because the source of a significant amount of the electricity consumed is a predominantly *coal-based grid*. Owing to the city's hot climate, air conditioners and fans are the two appliances used extensively. About 60 per cent of the electricity used in Chennai is utilized for cooling alone. The cooling appliances that are used are not energy efficient. Similarly, only 45 per cent of the households in Chennai use energy-efficient lighting such as LEDs. Surveys also reveal that only 36 per cent of all households in Chennai are aware of the BEE's star label programme. Overall, combining the emissions from grid energy consumed and fuel combustion within buildings, 44 per cent is from residential buildings, with 38 per cent from commercial and institutional buildings. The remaining 18 per cent of the emissions are attributed to the manufacturing and energy industries in Chennai, including the petroleum refinery, which alone amounted for 3 per cent of the city's emissions in 2018–19.

Given the backdrop, four significant opportunities for decarbonization emerge. First, shifting manufacturing fuel use towards cleaner fuels. Second, accelerating grid decarbonization. Third, increasing the supply of distributed renewable energy. Fourth, increasing energy efficiency in buildings by using energy-efficient appliances. In the case of Chennai, since fuel use for heating is limited, the impacts of more renewable energy in the grid and adoption of energy efficient buildings will be immediate.

Transportation

The Transportation Sector comprises *on-road transportation and railways*, and contributes 16 per cent of Chennai's total GHG emissions. Within the GCC boundary, 95 per cent (~2.24 million tons CO_2e) of these emissions come from *on-road transportation,* since 66.4 per cent of total trips in Chennai are made using on-road motorized modes of transport, such as private and commercial vehicles, fuelled by fossil fuels. The entire Metropolitan Transport Corporation (MTC) bus fleet in Chennai is also dependent on diesel. Only 28 per cent of all trips in Chennai are made through non-motorized transport (cycling, walking) and 5.6 per cent through rail transport.

Rail transport, including Chennai Suburban Rail and Chennai Metro Rail, only contributes 5 per cent (~0.12 million tons CO2e) of the total emissions in the Transport Sector. The Suburban Rail Service

caters primarily to long-distance commuters and is the most efficient service in the city measured per passenger kilometre. The metro rail service only began full operations in 2018–19, and hence has not yet achieved the target ridership. The limited physical extent of services keeps the overall ridership – and hence, emissions – low.

Waste

The Waste Sector contributes 13 per cent (~1.9 million tons of CO_2e) of the total GHG emissions within the GCC. Of these, more than 94 per cent are linked to the disposal and treatment of solid waste in the city, and the remaining 6 per cent to the aerobic treatment of wastewater.

The lower segregation efficiency at household level and loopholes in the waste transportation system has been a major reason behind the inefficiency of processing units for solid waste. Out of the total solid waste collected in the city, only 20 per cent gets processed while the remaining 80 per cent is dumped across the dumpsites in Chennai. Moreover, only 26 per cent of the solid waste processing capacity is utilized efficiently in the city. The current solid waste disposal system has caused an unmanaged generation of methane. The mixed solid waste disposed at open dumpsites accounts for 93 per cent of the total emissions, while 1 per cent can be attributed to the methane produced during composting. These numbers drive the city's vision of strengthening decentralized solid waste management.

Compared to solid waste, wastewater contributes to only 6 per cent of the emissions from the waste sector, since all the wastewater gets treated at aerobic technology based STPs that do not generate methane as a by-product.

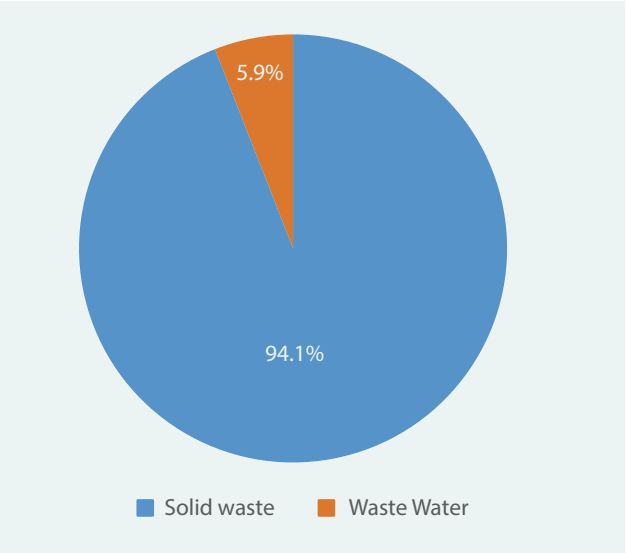


Figure 48: Emissions from Waste Sector

5.2 Chennai's Future GHG Emissions

Post the completion of current GHG inventory, the city's future GHG emissions were estimated based on a number of future emissions scenarios developed using the C40 Pathways Model and consultations with relevant stakeholders. The objective of the scenario development was to develop a robust evidence base, from which to derive ambitious city-wide emissions mitigation targets and strategic objectives that guide the development of actions (see chapter 6).

Informed by the scenarios developed, GCC is setting targets to reduce citywide GHG emissions by 1 per cent by 2030 compared to 2018-19 levels, 40 per cent by 2040, and net zero by 2050. These targets align with the C40 'Deadline 2020' definition of 1.5-aligned, demonstrating Chennai's vision to create a cleaner, greener and healthier city that aspires to meet the highest goals of the Paris Agreement.

The scenarios were developed through rigorous consultations with stakeholders directly involved with the sectors contributing to emissions in the city. The consultations were aimed at understanding each department's E&P Strategies, and iteratively discussing how these could be built upon to align with the highest ambitions of the Paris Agreement. The process adopted to build the future emission scenario is summarized in Figure 46.

These emission scenarios help project GHG emissions by Chennai over time, factoring in the increases in population and per capita incomes (leading to increased spending on vehicles and appliances), as well as several of the E&P policies and programmes by the national/state or local governments. This allows decision-makers to assess how their current package of programmes can impact the city's emissions by 2050 and identify the need for Ambitious actions to be taken. Four different scenarios have been developed using the Pathways Model.

a. Business-As-Usual Scenario

The BAU or Zero-Action Scenario makes projections about future emissions assuming no mitigation efforts are implemented, to serve as a reference point against which other scenarios can be measured.

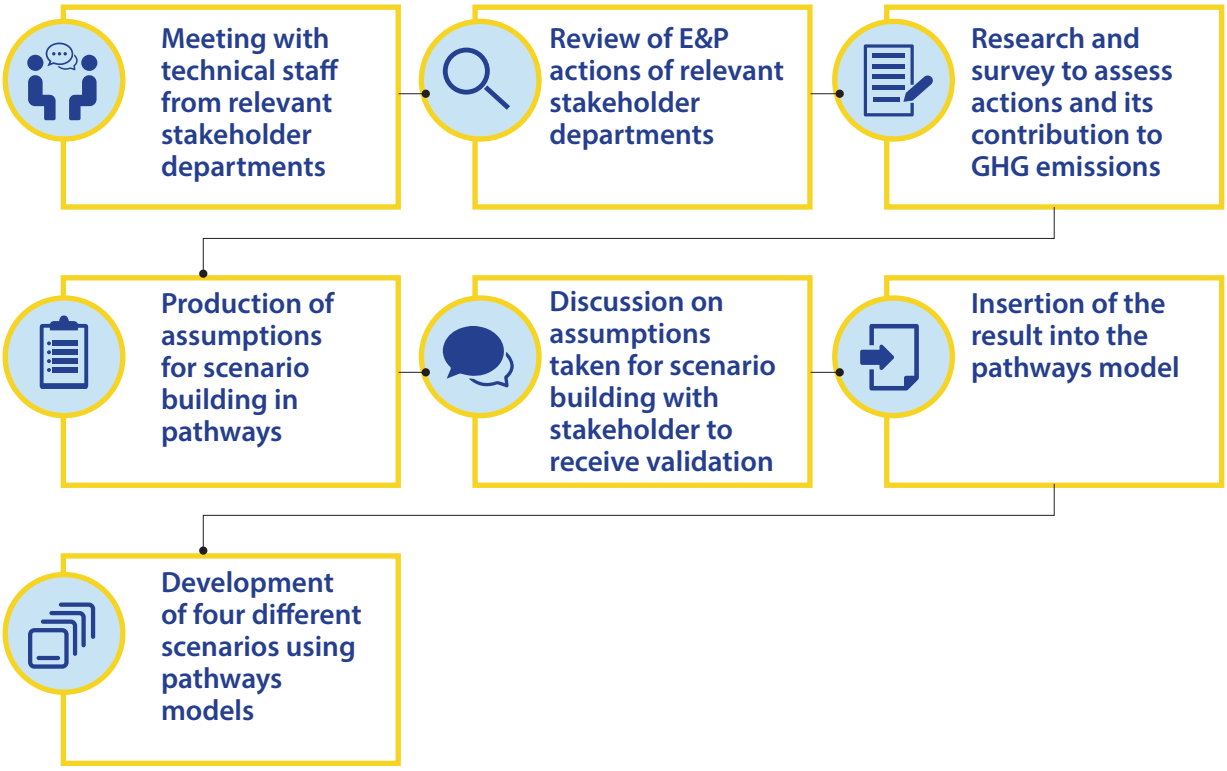


Figure 49: Development Process for Future GHG Emission Scenarios

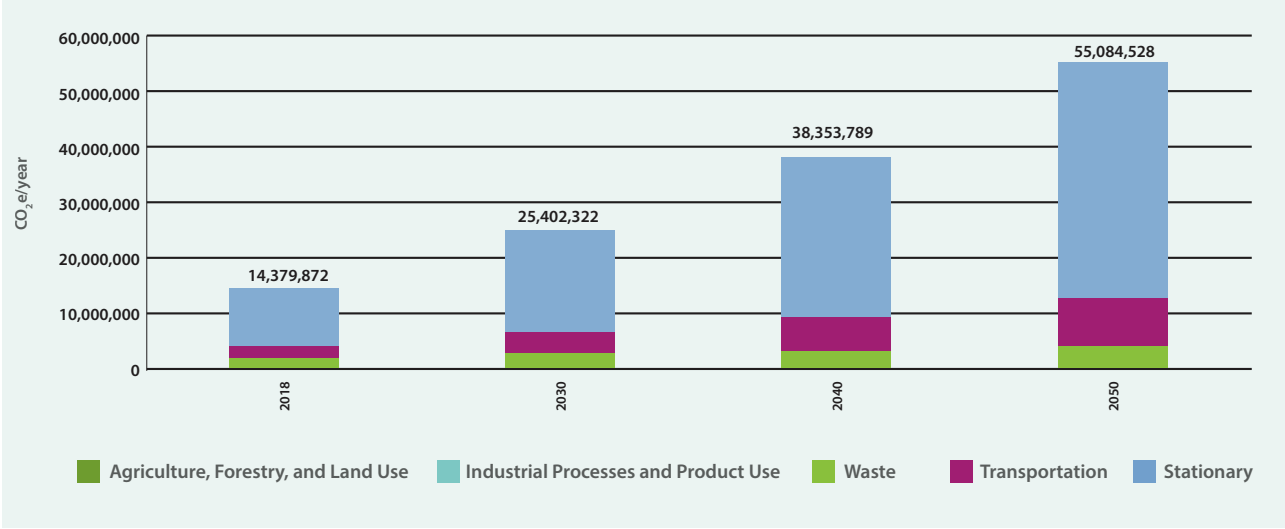


Figure 50: BAU Scenario

The BAU Scenario is projected using the city's base-year GHG inventory, considering the impact of the population and economic growth on each sub sector.[73] For each forecasting period, and sub-sector, weights are assigned to the population growth rate and the GDP growth rate. The weighted average of these growth rates are considered to compute the sectoral growth rate of emissions. The base growth rate for the population and GDP are given in Table 6.

Table 6 Key Assumptions for GHG Emission Forecast for BAU Scenario

	2018–30	2030–40	2040–50
Population Growth Rate	3.2%	2.6%	2%
GDP Growth Rate	7.1%	6.1%	5.5%

73 C40 Knowledge Hub. https://www.c40knowledgehub.org/s/guidenavigation?language=en_US&guideArticleRecordId=a3s1Q000001iaiGQAQ&guideRecordId=a3t1Q0000007IEWQAY.

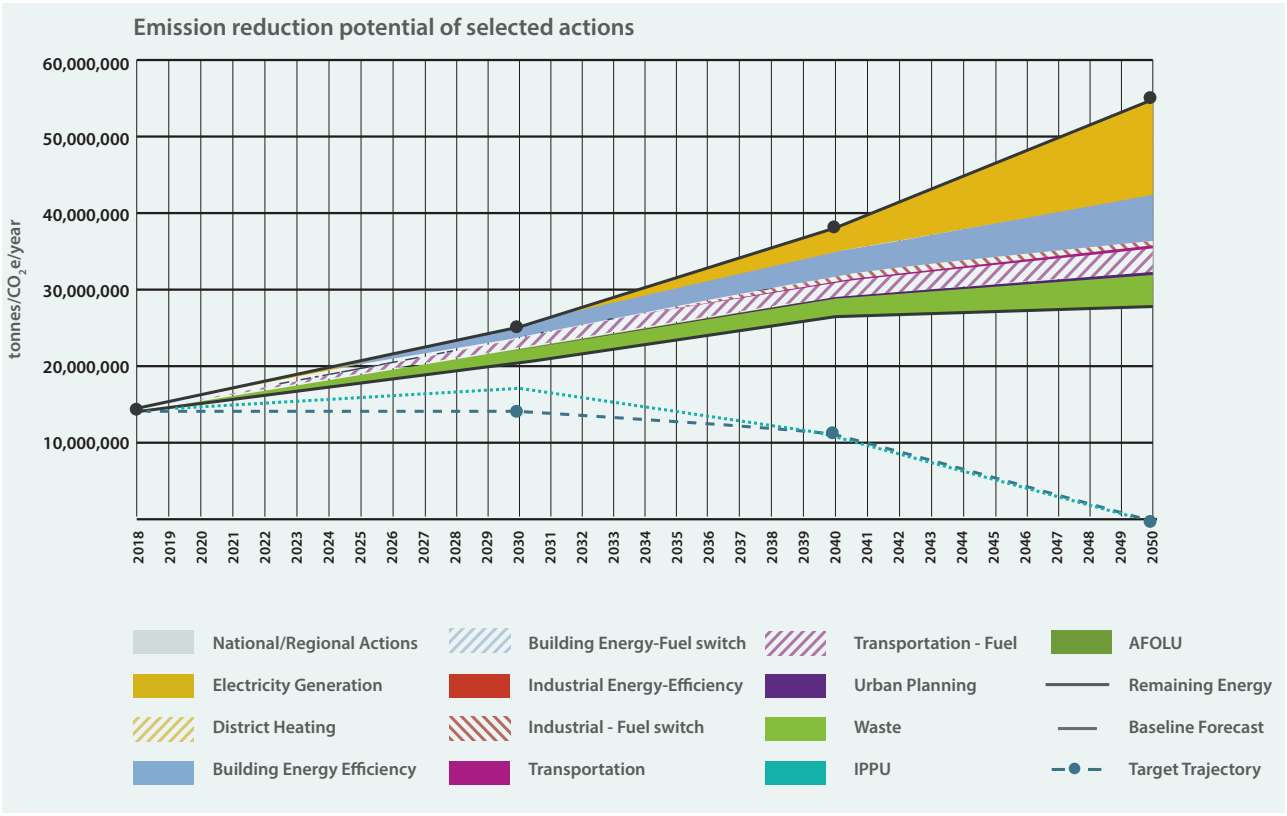


Figure 51: Pathways for Existing & Planned Scenario

As per the BAU scenario, annual emissions are expected to almost quadruple in comparison to the emissions in the base year of 2018 and are set to reach 55.08 million tons CO2e/year by 2050 due to high population and GDP growth forecasts.

8. Existing and Planned Scenario

The E&P Scenario helps determine anticipated emission reductions from the plans and policies already in place, enabling decision-makers to assess the gap between what they are expected to deliver and the ambition required in the city's existing targets. This is the starting point for identifying where further action is needed, which is then explored through additional scenarios.[74]

The E&P Scenario uses existing or planned city, regional and national actions, policies and programmes to demonstrate the emissions reductions trajectory for Chennai before the implementation of the climate action plan. The existing policies and commitments considered to build the E&P Scenario include:

- Nationally Determined Contributions (NDC), 2015

Table 7 Summary of Sector-wise Emission Reductions as per Ambitious Scenario

Sector	2030	2040	2050
Electricity Generation	22.0%	34.0%	40.7%
Building Energy	34.0%	35.1%	32.7%
Transport	9.7%	10.8%	11.7%
Waste	24.2%	14.4%	8.9%

74 C40 Knowledge Hub (https://www.c40knowledgehub.org/s/guidenavigation?language=en_US&guideArticleRecordId=a3s1Q000001iaiGQAQ&guideRecordId=a3t1Q0000007lEWQAY)

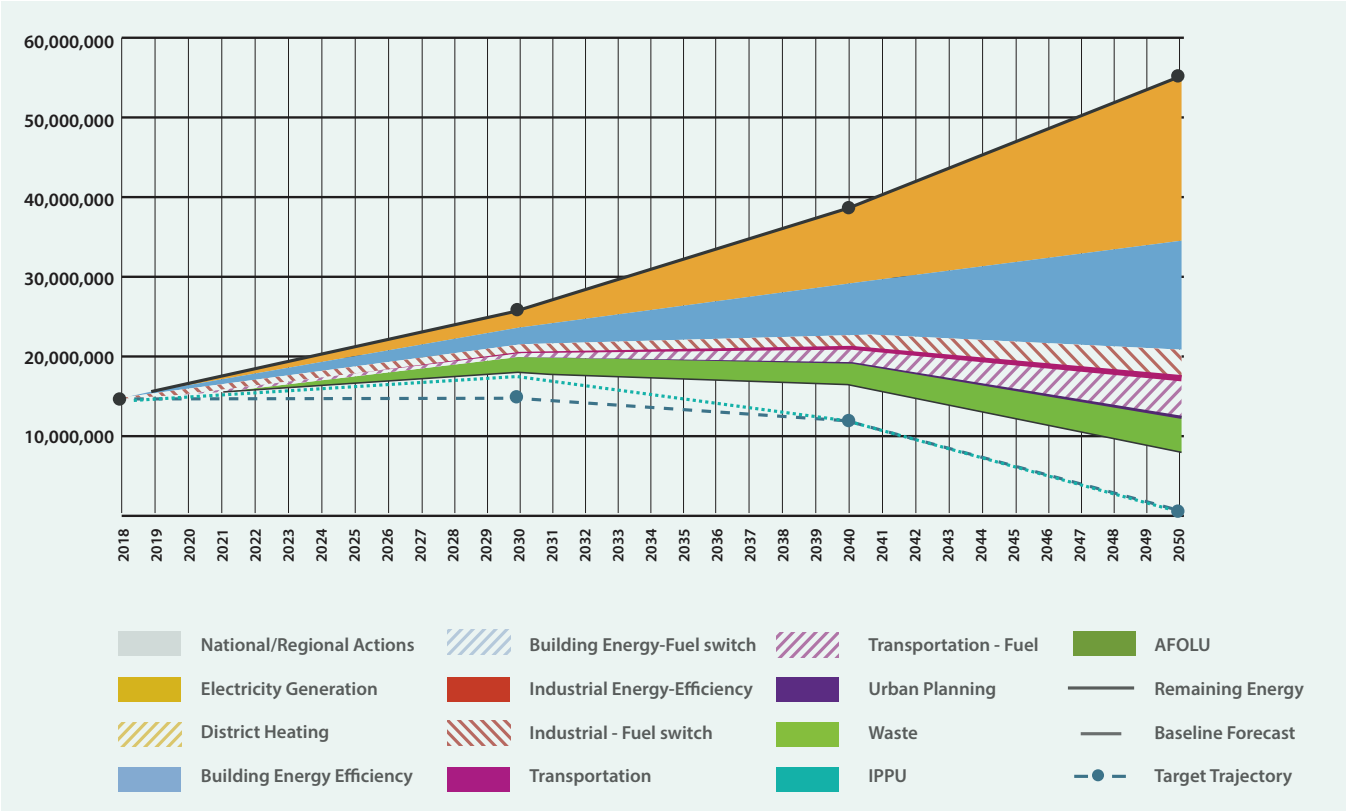


Figure 52: Pathways for Ambitious Scenario

- National Action Plan for Climate Change (NAPCC), 2008
- Tamil Nadu Action Plan for Climate Change (TNSAPCC), 2015
- Tamil Nadu Electricity Policy, 2019
- TANGEDCO's Net Metering Guidelines and tariff structures, 2021
- Energy Conservation Building Codes, 2007
- Chennai's Comprehensive Mobility Plan, 2019
- National Electric Vehicle Policy 2021,
- Waste or Wastewater Master plans at city level, 2016
- CMDA Master Plan, 2026

The projections for the E&P Scenario show that even with implementation of all existing plans and policies, emissions are still expected to increase by 44.8 per cent in 2030 and 86.4 per cent in 2040, compared to the base year 2018. By 2050, emissions will almost be double that of 2018. This means that more ambitious actions are required to meet the city's climate change commitments. As per the E&P Strategies, by 2050, Chennai can achieve a 64 per cent share of renewables in the electricity grid through solar photovoltaic (PV) initiatives by the Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO). The scenario tells us that due to the significantly increasing demand over time, it's necessary to achieve a more rapid shift away from coal and towards renewables.

Expanded network of metro rail and bus services, as planned under Chennai's Comprehensive Mobility Plan by 2050, is expected to reduce dependency on private vehicles from 50 per cent in 2018 to 38 per cent by 2050. Due to population and GDP growth, the E&P Policies leave a significant gap in meeting the 1.5°C Paris Agreement goals and the Deadline 2020 trajectory. Nevertheless, the scenario provided a basis that can be used to identify more ambitious strategies and policies in subsequent scenarios.

By 2050, emissions will have increased to 55.08 $mtCo_2e$, compared to 14.37 $mtCo_2e$ in 2018, indicating that more aggressive actions will be required for Chennai to deliver its fair share towards meeting the 1.5°C target.

c. Ambitious Scenario

An Ambitious Scenario incorporates strategies and actions that are defined as "ambitious yet achievable". It is the most important scenario used in developing this CAP, because it forms the basis of developing strategies and actions Chapter 6 onwards. To define what is "ambitious yet achievable", it has been critical to involve internal and external stakeholders to

determine realistic, credible strategies, and actions that align with city conditions and wider objectives.

This scenario for Chennai explores opportunities to enhance and scale-up existing national and state programmes and identifies additional actions to deliver higher emissions reductions to help Chennai move closer to meeting its targets. The scenario has been designed to consider new technologies, which will ensure economic growth, create new jobs, and reduce energy poverty and instability, by realising a vision for a city that is ahead of the curve in its transition towards a green economy. The Ambitious Scenario presents an ensemble of policy enablers, rigorous IEC and capacity-building efforts, and stringent implementation of regulatory and monitoring roles.

This scenario forms the basis of city-wide GHG targets and mitigation actions within the CCAP. The strategic level targets used, based on the Ambitious Scenario, are showcased in Chapter 6 in this document.

The Ambitious Scenario forecasts that by 2030, GHG emissions will peak, with an increase of 24.8 per cent over the base year, 2018-19. By 2040, the emissions will show a gradual reduction, but still be 13.2 per cent higher than the base year levels. This is due to the ongoing and upcoming projects identified by the Department of Energy for increasing the capacity of thermal power generation. This shows the importance of facilitating a greater switch from coal to renewables, along with working towards other grid reforms, as electricity demand increases over time with increased electrification in buildings and transportation.

By 2050, as the Percentage share of renewable energy increases, GHG emissions will be 44 per cent lower compared to the base year. Moreover, 100 per cent of the bus fleet in the city will be electric, as per the state's EV policy targets, which will, in turn, contribute to a decrease in on-road transportation emissions of 80 per cent compared to BAU in 2050. Similarly, the strategies for source segregation and decentralized waste processing will contribute to a decrease of 90 per cent, compared to BAU in 2050. Additionally, 100 per cent of buildings will be energy efficient, with increased adoption of energy-efficient appliances, which is forecasted to lower emissions from the sector by 70 per cent, compared to the BAU scenario.

These projections have helped in identifying the priority sectors and key strategic areas where climate actions are most required. The actions identified for each sector are detailed out in chapter 6 and form the basis of the actions proposed in the CCAP. Implementing them will result in significant reduction in the city's emissions and help in achieving its climate goals.

d. Extended Scenario

Implementation of all strategies under the Ambitious Scenario have the potential to deliver significant emission reductions, but these strategies together do not help achieve the Paris-aligned emissions trajectory, and hence there is a need for short term actions by 2030 and 2040. In 2050, the total emissions are still projected at around 12.5 MT CO_2e in the ambitious scenario. Chennai will need to identify additional strategies to reduce the remaining emissions. This "Extended Scenario" includes strategies that are necessary, but are currently unfeasible due to major political, institutional, technological, or financial barriers.[75]

To develop the Extended Scenario, a set of assumptions and conditions that allow for greater reduction in emissions (compared to the Ambitious Scenario) have been considered. The strategies have the potential to help Chennai increase its emissions by 2 per cent in 2030 and reduce its emissions by 36 per cent by 2040 and 87 per cent by 2050, compared to the base year of 2018. The major strategies identified are:

1. Achieving 100 per cent decarbonization of the electric grid by 2050, with significant reduction of coal in the energy mix by 2040;
2. Increasing the share of solar rooftops and other distributed renewable power in city's energy consumption;
3. Ensuring accelerated fuel shift to increase EV adoption to 100 per cent by 2050;
4. Shifting Chennai's waste management strategy from the current waste-to-energy model towards recycling; and
5. Supporting households and businesses in transitioning to electricity as a cooking fuel.

Table 8 lists the types of barriers that can potentially affect the strategy implementation and provides details for each type.

75 C40 Knowledge Hub. https://www.c40knowledgehub.org/s/guidenavigation?language=en_US&guideArticleRecordId=a3s1Q000001iaiGQAQ&guideRecordId=a3t1Q0000007lEWQAY.

Under the Extended Scenario, the residual emissions that Chennai will require to eliminate, in order to become carbon neutral by 2050, are projected to be 10.1 per cent of the 2018 baseline. The remaining emissions are required to be reported and monitored closely during action implementation. This should be incorporated in every revision of the plan. Further, the city must integrate any newly available technologies and solutions and update its projection of residual emissions.

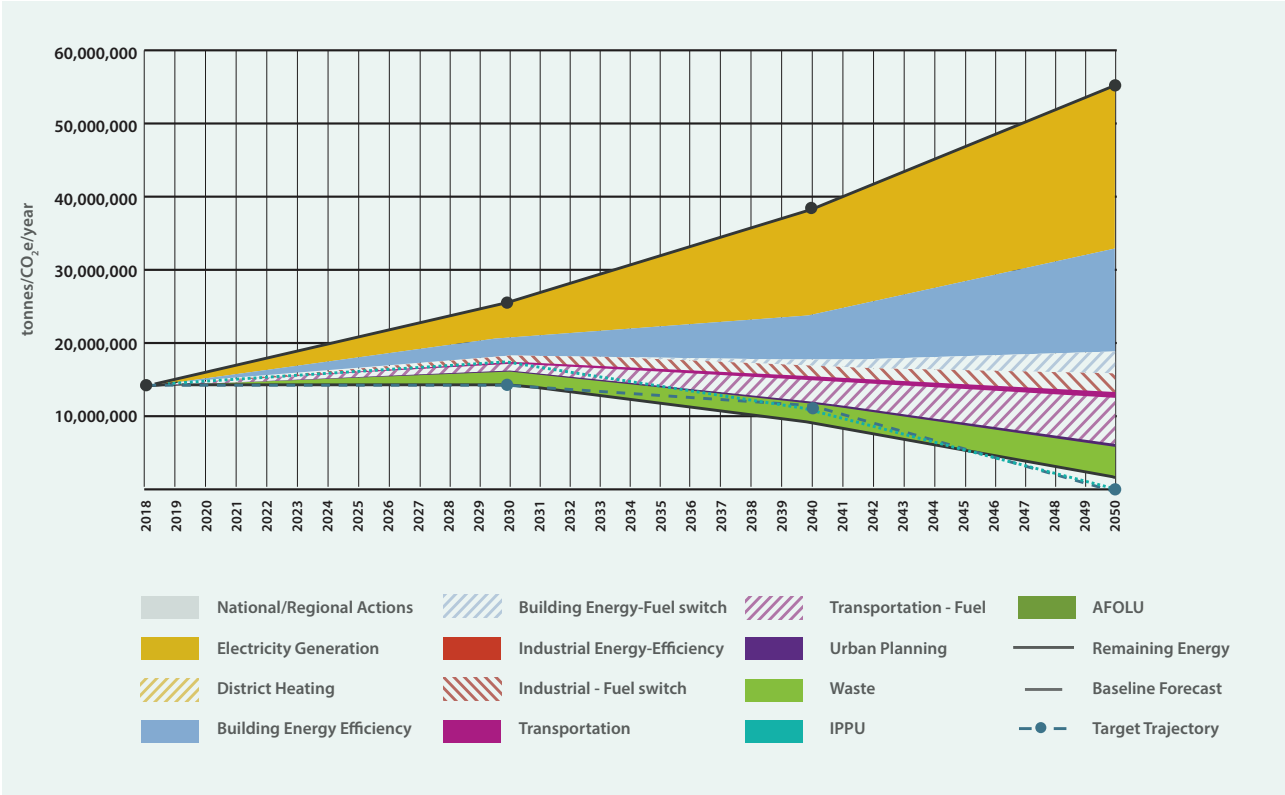


Figure 53: Pathways for Extended Scenario

Table 8 Barriers for Extended Scenario

Strategy #1	Achieve 100 per cent Decarbonization of Electric Grid by 2050
Status Under Ambitious Scenario	The proportion of city energy being derived from renewables is as follows: By 2030: 39 per cent By 2040: 67 per cent By 2050: 93 per cent
Strategy Description/ Assumptions	To accelerate the generation of renewable energy in the electric grid in 10 years, increasing the share of renewable power is essential. New targets for generation from renewable sources under extended scenario are: By 2030: 50 per cent By 2040: 84 per cent By 2050: 100 per cent

Strategy #1 *contd.*

BARRIERS

Practical and Technological

Insufficient Energy Storage Capacity

- The biggest barrier to the adoption of renewable power as the majority power source is the challenge of maintaining sufficient storage to address daily variation in solar and wind power. The Duck-Curve (as it is commonly known) refers to the phenomenon of inherent mismatch between solar energy production and power demand. Demand is typically lowest during midday, when production is highest; it peaks at night, when production is near zero. This daily cycle of surplus and deficit needs to be addressed through high capacity and output power storage systems.
- To transition to 100 per cent renewable power generation, at current demand levels, Tamil Nadu will require an electricity storage system with a peak output of 17,000 MW.* Currently, the pumped energy storage capacity is 400 MW. The daily energy storage required would be around 136 GWh. **
- An ADB assessment in 2020 established that the Tamil Nadu grid already faces risks due to instability induced by the intermittent generation of solar and wind power. Exceeding the current capacity is difficult without first building more storage systems.
- By 2030, utility scale energy storage equivalent to 30 GWh will be needed† for daily energy demand cycles.

* Data shared by TANGEDCO during one-to-one stakeholder consultation on 9 June 2022.

** Policy Note 2021-2022, Energy Department, Government of Tamil Nadu, 2021, http://cms.tn.gov.in/sites/default/files/documents/energy_e_pn_2021_22.pdf

† Based on the projected total electricity demand in 2030

Negative Co-Impacts of Hydroelectric Generation and Storage Systems

- Hydroelectric power generation and pumped water storage are high capacity and high stability. However, the construction of dams and reservoirs to leverage their resources directly contributes to negative ecological and social impacts on upstream communities and ecosystems, bottlenecking the development of this capacity.

Ageing Thermal Power-Generation Infrastructure

- Currently, around 70 per cent of electricity produced in Tamil Nadu is thermal powered.* Of the current installed capacity, almost 50 per cent has reached end of life. There is an immediate and pressing need to replace these plants. In the short term, it is unlikely that sufficient storage capacity will be developed to meet this demand through solar and wind power.
- The current proposed plan by the state is to replace and augment these power plants with additional coal and gas-powered thermal power plants. This is in pursuit of a policy of energy self-reliance and security. However, since these plants will have long service periods, they are unlikely to be phased out before 2050 – impacting the sectoral emissions by that year.
- The state must add total solar and wind of 5 GW and 3 GW, respectively, by 2030 to achieve the targets of 100 per cent decarbonization of the electric grid by 2050.

* Data shared by TANGEDCO during one-to-one stakeholder consultation on 9 June 2022.

Strategy #1 *contd.*

Political & Social

- A 400 MW pumped-water energy storage system was proposed by the state in 2007. Despite not involving any expansion of the elevated or lower reservoirs, the project is yet to receive environmental clearance (at the time of preparation of this CAP). Similar political and administrative friction is likely to emerge in the rolling out of infrastructure projects that are subject to scrutiny from the national government.
- Adoption of renewables in the grid cannot be accelerated unilaterally by the city. At the same time, the state does not plan on full decarbonization of the grid before 2070 and is instead focused on energy security and eliminating import of power from the central grid.

Legal & Institutional

- The state electricity rules only allow for a single, state-owned distribution company to operate the grid. This DISCOM, TANGEDCO, is widely known and acknowledged even by the state government as being inefficient, resulting in losses of several crore rupees each year.
- Widespread reform is not supported politically, as it is assumed that this would come with a rise in the cost of electricity.
- Without reform at the state level, Chennai remains dependent on the DISCOM and its energy mix.

Financial & Economic

- The city cannot invest directly in energy production or provide incentives – whether monetary, policy, or land-use – to attract private-sector investment in energy production, without support from programmes launched by State Energy Department or the Metropolitan Development Authority.
- Local governments can streamline permits and provide technical assistance only for distribution infrastructure.

Actions Proposed in CAP to Mitigate Barriers

Expand Utility Scale Energy Storage Systems for the Grid *(Refer Chapter 6.2.1)*

Actions to be led by state-level agencies, encouraged by the city:

- Developing state-wide energy storage plans, with projections of storage requirements to achieve 100 per cent renewable power use by 2050.
- Establishing a dedicated review board for storage projects, to fast-track environmental clearance and ensure high-quality technical inputs on environmental and social management plans for projects.
- Developing and passing enabling legislation and regulation for private-sector investments / privately developed energy storage systems.

Led by city with state-level support:

- Establishing an incubation centre for private- and public-sector research into alternative utility scale energy storage systems.

Targets:

- Commercial solar plants of 5 GW by 2030, and over 19 GW by 2050
- Storage capacity of 30 GWh for daily storage of power by 2030

Strategy #2

Increase Share of Solar Rooftops and Other Distributed Renewable Power in City's Energy Consumption

Status Under Ambitious Scenario

The proportion of city energy being derived from renewables is as follows:

10 per cent of the city's units to have rooftop solar installations by 2050

Contributes to an emission saving of about **1.1 million tons**

Strategy Description/ Assumptions

To accelerate building energy improvements in 10 years, increasing the share of decentralized renewable power is essential. New targets under extended scenario are:

	By 2030	By 2040	By 2050
Residential buildings	10 per cent	20 per cent	50 per cent
Commercial buildings	5 per cent	15 per cent	30 per cent

Strategy #2

Increase Share of Solar Rooftops and Other Distributed Renewable Power in City's Energy Consumption

BARRIERS

Financial & Economic

Rooftop Solar Power Feed in Tariff

- Tamil Nadu's solar energy policy 2019 had stated a target of achieving 3,600 MW of solar energy in the consumer category by 2023, but only about 325 MW or 9.03 per cent has been achieved by 2022. This differential can largely be attributed to the poor feed-in tariff for net-billed and gross-metres consumer solar connections. It is intrinsically linked to the technical and commercial losses in grid operation, and supports the need for comprehensive grid reform.
- The current feed-in tariff for solar rooftops is between Rs 3.6 and 3.1 per unit, while the domestic and commercial power tariff is around Rs 6.6 per unit (as of June 2022).
- Since bidirectional net-metering is not available to most consumers with solar installations, the IRR of solar rooftop projects is extremely low. Many public and private organisations, including IOCL and GCC, have flagged this as a major barrier to the development of solar rooftop power.

Strategy #2 *contd.*

Practical & Technological

- An ADB assessment in 2020 established that the Tamil Nadu Grid already faces risks due to instability induced by the intermittent generation of solar and wind power. Exceeding the current capacity is difficult without first building more storage systems.
- TEDA officials reiterated the importance of grid-level storage for stabilising the grid and suggested that revising the gross metring tariff can exacerbate the instability caused by intermittent availability of solar power.

High Cost of Decentralized Energy Storage Capacity

- In the absence of a viable net-metring policy, the technical alternative is for each unit to rely on battery storage for rooftop power. However, the capital cost of these systems is prohibitive. Widespread use of energy storage systems also has negative co-impacts and raises issues of battery life cycles and disposal.

Political & Social

- The cost of electricity in Tamil Nadu is subsidized to most households, decreasing the incentive at the individual consumer level to invest in solar PV systems. The state sees providing low-cost power in both the short and long term as key to its mandate. Hence, while there is willingness in the long term for utility scale systems, it is unlikely that decentralized systems will be a priority for subsidies or investments.

Legal & Institutional

- The city is unable to directly subsidize energy production through cash incentives, provide changes or compensation in land use, or create/enforce energy production mandates under building by-laws without the support of programmes by the State Energy Department or the Metropolitan Development Authority.

Actions Proposed in CAP to Mitigate Barriers

Revise Net-Metering/Gross Metering Policy for Grid Connected Solar PV Systems *(Refer Chapter 6.2.1)*

Actions to be led by state-level agencies, encouraged by the city:

- Revise solar rooftop policy to extend net-metering to all consumer installations with generation capacity under 15KW.

Metropolitan Development Authority, with city implementation support:

- Amend development control regulations to require installation of solar rooftop installations on all newly constructed buildings.

Strategy #2 *contd.*

Actions Proposed in CAP to Mitigate Barriers *(continued)*

Enabling Regulation for Investment and Financing in Solar Rooftop Systems

TEDA, with city partnership:

- Publishing legislation and guidelines to develop solar installation in shared buildings and enable leasing of rooftops for power generation.
- Creating regulatory framework and model contract to protect the interests of investors and building owners/occupiers.

Enabling Research and Investment into Alternative Power Generation and Storage Systems

City, with support from the state government:

- Establishing an incubation centre in collaboration with national and international research universities.
- Direct investment in startups and projects through technical support, equity, and land for pilot/demonstration projects.

Strategy #3 — Accelerate Fuel Shift to Increase EV Adoption to 100 per cent by 2050

Status Under Ambitious Scenario

By 2050, 60 per cent of 2W and 20 per cent of 4W are projected to shift to EVs.

Two wheeler	Four wheeler
60 per cent	20 per cent

Strategy Description/ Assumptions

To accelerate building energy improvements in 10 years, increasing the share of decentralized renewable power is essential. New targets under extended scenario are:

	By 2030	By 2040	By 2050
Two wheeler	10 per cent	45 per cent	100 per cent
Four wheeler	13 per cent	45 per cent	100 per cent

Strategy #3

Accelerate Fuel Shift to Increase EV Adoption to 100 per cent by 2050

Existing Policy at State Level

Demand Side Incentives under State Policy

For Electric Two-Wheelers

- 100 per cent road tax exemption until end of 2022.
- Waiver on registration charges/fees, as per Government of India's notification.

For Electric Four-Wheelers

- Road tax exemption increased from 50 per cent to 100 per cent until end of 2022.

Supply Side Incentives under Station Policy

- Reimbursement of SGST: 100 per cent of the SGST paid on the sale of EVs manufactured, sold, and registered for use in the state will be reimbursed to the manufacturing companies. The reimbursement will be given for sales by manufacturers effective until 31 December 2030.
- Capital Subsidy: In the case of intermediate products used in the manufacture of EV and charging infrastructure, where SGST reimbursement is not applicable, a capital subsidy of 15 per cent will be given on eligible investments over 10 years.

Strategy #3

Accelerate Fuel Shift to Increase EV Adoption to 100 per cent by 2050

BARRIERS

Legal & Institutional

- Domestic production of Li-Ion batteries for EVs is heavily constrained. Despite production incentives in place, in the short term, it is unlikely that this capacity will be built rapidly.
- There are cesses in place to disincentivize the import of batteries and other parts from international manufacturers, further restricting the growth of EVs.
- Rules for vehicle manufacture and purchase are made at the state level (Department of Transport).
- The city has a supporting role in raising funding for charging infrastructure. Its EV charging infrastructure will require either a) direct grants from the state government, or b) changes to the building regulations to allow the city to allocate land towards charging stations.
- The city cannot support the implementation of charging infrastructure at the building level until building regulations are amended.

Strategy #3 *contd.*

Financial & Economic

- The city is not able to directly invest in EV charging infrastructure.
- The city needs enabling legislation at the state level for it to solicit and support private-sector investments into charging infrastructure.
- Local governments can streamline permits and provide technical assistance to make it easier for entities to adopt EVs and increase charging, but are lacking funding sources.

Political & Social

- Regarding transportation electrification, there is a persistent myth that EVs are for the wealthy.
- The majority of car and 2W purchasers in the next 10–20 years will be purchasing the first private vehicle in their household. The perception of EVs as unreliable and difficult to charge is likely to discourage adoption. Households at middle-income level or below also do not have formal and reliable parking spaces.

Practical & Technological

- Required number of vehicles might not be available by 2030. The national government is pursuing a policy of incentivizing research and development towards hydrogen fuel cell EVs, with the aim of eliminating barriers to charging and fuelling. However, the engineering challenges must be solved to ensure a massive increase in HEVs, and supporting infrastructure must built rapidly to decarbonize.

Actions Proposed in CAP to Mitigate Barriers

Prepare a state/city EV roadmap to analyse strategies and the city's available actions to support the transition. This EV roadmap will require inputs on the manufacturing of vehicles, demand-side incentives for households and businesses purchasing EVs, and input from planning regulations – such as under the Comprehensive Mobility Plan – to incentivize EVs through parking regulation and enabling infrastructure. *(Refer Chapter 6.2.3)*

Strategy #4 — Change City Strategy Away from Waste-to-Energy and towards Recycling

Status Under Ambitious Scenario

The incineration/waste-to-energy facilities under the feasibility stage have been considered. The city has plan to increase its waste-to-energy capacity up to 1,200 TPD.

Strategy Description/ Assumptions

To accelerate building energy improvements in 10 years, increasing the share of decentralized renewable power is essential. New targets under extended scenario are:

	By 2030	By 2040	By 2050
Increase in recycling capacity	20 per cent	60 per cent	100 per cent
Reduction in waste-to-energy capacity	80 per cent	40 per cent	0 per cent

Strategy #4

Change City Strategy Away from Waste-to-Energy and towards Recycling

BARRIERS

Legal & Institutional

On-site Waste Processing by Bulk Waste Generators (BWGs):

- As per the SWM by-laws, BWGs are responsible for on-site waste processing. Most BWGs do not practice on-site processing due to poor enforcement of rules. The city government provides facilities to 11 zones out of 15, which are contractually bound to collect bulk waste from the BWGs. This collected waste is then given to either private waste processors, deposited at decentralized waste-processing units, or disposed of at dumping sites.

Practical & Technological

Inadequate Processing Capacity & Low Utilization Capacity

- Only 20 per cent of the city's waste is processed/recycled; the remaining 80 per cent goes to dumpsites. Chennai has a current total processing capacity of 2,460 TPD, out of which 1,422 TPD is for wet waste and 1,038 for dry waste. However, only about 26 per cent of this capacity is being fully utilized. The reasons are gap in segregation, inefficiency of collection, etc.
- Chennai needs to augment its current capacity, as well as ensure that the existing capacity is fully utilized.

Management of Legacy Waste

- The city has two active dumpsites: Perungudi and Kodungaiyur. Due to the lack of processing capacities, about 80 per cent of all waste generated gets dumped at the dumpsites.
- The dumpsites have a legacy waste of almost 94 cu.mt. (64 lakh cu. mt. in Kodungaiyur, and 30 lakh cu.mt in Perungudi). This is one of the major contributors to GHG emissions.
- Although bioremediation of dumpsites has been proposed in the SWM action plan, their effective remediation is yet to be initiated, as these dumpsites are still functional and continue to receive daily waste. Until a sanitary landfill is built for the city, the dumpsites will remain active. Currently, no dedicated landfill sites have been identified as per the master plans by the CMDA.

Financial & Economic

- The GCC has the financial capacity to increase recycling by developing material recovery facilities under SBM and state budget allocations. With the support of current finances, technical capacity can also be built to adopt new strategies of recycling, to move away from the waste-to-energy. However, there is a lack of leadership and willingness of local authorities.

Political & Social

Source Segregation of Compostable and Recyclables:

- As per the SWM by-laws of the GCC and the SWM Rules, source segregation is mandatory. However, only 41 per cent of waste segregation is done in Chennai as per City Action Plan, 2021.
- Residents and businesses must comply with mandatory source segregation through the three-bin system (blue = recyclables, green = organics and black = domestic hazardous), as per the SWM Rules, 2019. The Government of India, under SBM-U, continues to support cities to improve segregation through awareness generation. There are financial provisions for the under SBM for behaviour change communication, to spread awareness about source segregation.

Lack of Citizen Engagement

- Efficient solid waste management requires a high Percentage of segregation at source as well as decentralizing processing at household, and sub-ward levels. This ensures reduced transportation of waste to centralized processing facilities and, thus, reduced GHG emissions. All of these require a high degree of engagement from citizens. Currently, IEC for promoting source segregation, encouraging home composting, and advocating clean and healthy sanitation practices among the citizens are being carried out. However, a gap remains between the current citizen engagement and what is required.

Actions Proposed in CAP to Mitigate Barriers

100 per cent Segregation of Waste at Source and 100 per cent Collection Coverage by 2030 *(Refer Chapter 6.2.4)*

- Identifying gaps in door-to-door collection.
- Changing user behaviour and supporting home composting by incentivizing waste reduction and source segregation at home.
- Establishing demonstration wards to promote the implementation of garbage-free, plastic-free habitats.
- Monitoring for implementation of SWM by-laws.

100 per cent Decentralized Waste Processing *(Refer Chapter 6.2.4)*

- Conducting assessment studies to identify the challenge in utilizing existing processing capacity.
- Ensuring processing units are not in flood risk zones.
- Augmenting processing capacity to meet 100 per cent capacity of waste processing, by setting up various waste processing units (decentralized).
- Building a system to monitor the collection of segregated waste from BWGs. Encouraging all BWGs to set up on-site waste processing units.
- Encouraging community-level engagement programmes.
- Dedicating spaces for secondary storage of solid waste generated in buildings, through GDCR.
- Monitoring the remediation of legacy waste and setting up scientific landfill for inert waste.

Strategy #5

Support Households and Businesses in Transitioning to Electricity as a Cooking Fuel

Status Under Ambitious Scenario

Considers only a negligible transition away from LPG as the primary fuel for cooking.

Strategy Description/ Assumptions

Introduce measures to support the transition away from cooking with LPG and towards electricity as the primary cooking fuel.

	By 2030	By 2040	By 2050
Households cooking with electricity	10 per cent	30 per cent	100 per cent
Businesses cooking with electricity	5 per cent	30 per cent	80 per cent

Political & Social

Cultural Resistance to Induction Cooking

- There is a widespread belief that induction cooktops cannot achieve the kind of charring and heating required for many traditional dishes from the region.
- There is also a widespread image of LPG or PNG as the aspiration fuel, while induction cooktops are associated with makeshift cooking arrangements.

Lack of Citizen Engagement

- The saturation of clean fuels has not yet been achieved in many states. While 100 per cent of households have access to LPG for cooking, it has only been achieved recently. Hence, no targeted citizen engagement has happened on this issue.

Actions Proposed in CAP to Mitigate Barriers

- Chennai is yet to invest in pumped natural gas infrastructure for most of the city, making it easier to initiate the transition now.
- Strategic citizen's engagement, as with the other building energy priorities, is the key to ensuring that this transition takes place.

Remaining Emissions Analysis

Under the Extended Scenario, the residual emissions in 2050 are projected to be 8.1 per cent of the 2018 baseline.

The major factors responsible for the remaining emissions are: a) the incineration of waste for generating energy; b) continued use of fossil fuels by a third of all private vehicles and c) a lack of biogas capture systems at the wastewater treatment.

The remaining emissions will be reported on and monitored closely during action implementation. Assessment of residual emissions will be incorporated in future revisions of the plan, and further research may be required to gauge the reduction of all long-term residual emissions. Meanwhile, the GCC is committed to undertaking mitigation efforts before exploring other options, to offset any eventual residual emissions. The Monitoring Plan, as proposed in this CCAP, with bi-annual GHG inventories will also help in monitoring the sectoral GHG emissions reductions.

Source: Chennai Smart Cities Limited

CHAPTER 6

Chennai's Climate Action Plan

6.1 Sectoral Targets

The strategies in the Ambitious Scenario have been used from sector-wise targets and actions for the Energy & Buildings, Transport, and Waste sectors. Similarly, the risk identified through the Climate Change and Risk Assessment (CCRA) for Chennai has helped identify targets for adapting to climate risks for the urban flooding and water scarcity management, with a focus on vulnerable populations and the health sector. Table 9 lists these strategies with the sectoral goals and the objectives identified along with their projected targets, which have been developed in consensus with stakeholders.

Table 9 Abstract of Climate Mitigation & Adaptation Sectoral Visions, Objectives and Targets

Mitigation								
Goals	Sectors	Sectoral Vision	Objectives	Target Parameters	Targets			Estimated Percentage Reduction in Carbon Emissions
					2030	2040	2050	
Carbon Neutrality by 2050	Electrical Grid and Renewable Energy	All residents have access to reliable, affordable, and zero-emission energy	100 per cent Renewable Power for Grid	Percentage share of total grid electricity from coal	33%	25%	0%	38%
				Percentage share of total grid electricity from renewables	39%	67%	93%	4.6%
			Decentralized energy storage and generation	Percentage of total residential & commercial buildings with solar PV installed	2%	5%	10%	2.7%

Source: iStock Photo

Mitigation								
Goals	Sectors	Sectoral Vision	Objectives	Target Parameters	Targets			Estimated Percentage Reduction in Carbon Emissions
					2030	2040	2050	
	Building Energy	Making all buildings energy efficient	Energy-efficient appliances and equipment	Percentage of high-efficiency appliances in existing and new commercial buildings	40%	60%	100%	<1%
				Percentage of energy-efficiency appliances in existing residential buildings	40% Mid range energy efficient& 5% High range energy efficient	60% Mid range energy efficient & 10% High range energy efficient	80% Mid range energy efficient & 20% High range energy efficient	
				Percentage of energy-efficiency appliances in new residential buildings	20% Mid range energy efficient & 20% High range energy efficient	30% Mid range energy efficient & 40% High range energy efficient	40% Mid range energy efficient & 60% High range energy efficient	
				Percentage share of Commercial cooling system technology (% of high-efficiency chillers)	40%	80%	80%	3.3%
				Residential cooling system technology (% of high-efficiency chillers)	40%	60%	85%	
				Percentage share of LED lighting in commercial and residential buildings	10%	50%	80%	<1%
			Energy-efficient building design	Percentage of existing building stock envelopes are retrofitted through new construction efficiency	40%	60%	100%	28.3%

Mitigation								
Goals	Sectors	Sectoral Vision	Objectives	Target Parameters	Targets			Estimated Percentage Reduction in Carbon Emissions
					2030	2040	2050	
Carbon Neutrality by 2050	Transportation	Moving toward sustainable mobility	Fuel shift to less polluting energy sources	Percentage electrification of passenger automobiles	3%	10%	20%	1.6%
				Percentage electrification of MTC bus fleet	15%	50%	100%	7.5%
			80 per cent of all trips by walking, cycling, or public transit	Percentage mode share for public transport and NMT	61%	71%	80%	2.6%
	Waste Management	Efficient, effective, and resilient waste management system	100 per cent segregation of waste at source and 100 per cent collection coverage	Percentage of segregated waste collected at source	80%	80%	100%	7%
				Percentage of waste collected and transported for processing	80%	80%	100%	7%
			100 per cent decentralized waste processing	Percentage of paper recycled	80%	80%	100%	2.5%
				Percentage of plastic recycled	20%	60%	100%	
				Percentage of organic waste composted	60%	67%	70%	6.4%

Adaptation							
Goals	Sectors	Sectoral Vision	Objectives	Target Parameters	Targets		
					2030	2040	2050
Water Balance by 2050	Urban Flooding and Water Scarcity	From a water-reactive to a water-proactive Chennai	Efficient stormwater management system to prevent pluvial flooding	Percentage of arterial and sub-arterial roads covered with stormwater drainage network as feasible	50%	70%	100%
				Percentage of properties with rainwater harvesting systems as feasible	100%	100%	100%
				Percentage of households with access to reliable water supply	95%	100%	100%
			Conservation of natural water ecosystem and water resource management	Percentage of green cover in the city	25%	33%	35%
			Disaster risk reduction	Percentage of the population with access to information on disaster risk reduction measures	100%	100%	100%

Adaptation							
Goals	Sectors	Sectoral Vision	Objectives	Target Parameters	Targets		
					2030	2040	2050
Water Balance by 2050	Vulnerable Population and Health	Climate Proofing for All	Provision of climate-proof housing for vulnerable population	Number of slums located in high-flood risk areas	150	100	0
				Percentage of slum households having access to safe, resilient, and affordable basic services	50%	80%	100%
			Building climate-resilient health systems for all	Percentage of the population with access to health infrastructure (Basti Clinic)	60%	80%	100%
				Percentage of the population with access to information on the impact of climate change on human health	100%	100%	100%

Source: Urban Management Centre


Source: iStock Photo

6.2 Sectoral Goals

Each goal is further broken down into a set of priority sectors, with specific targets. Each priority sector, in turn, contains several action areas with corresponding actions and sub-actions. The goals, sectors, and targets for the CCAP are presented in the following tables in this section.

Each sector has been elaborated on as follows:

Figure 54: Chapter Flow

The following information is presented for each action:

- The lead and supporting stakeholders.
- The timeframe: short (by 2030), medium (by 2040), and long-term (by 2050). The timelines are based on the opportunity for accelerated GHG emissions reduction and are in alignment with the timelines of national, state, and city programs and plans.
- Monitoring indicators.
- Alignment with various state/national policies and international goals.
- The possible funding sources, through alignment and convergence with existing national/state opportunities.
- The wider benefits have been identified for each of the short-, medium- and long-term actions. These will positively impact the citizens of Chennai through livelihood creation opportunities, improved health, environment, service delivery, inclusivity, and partnerships.

6.2.1 Electrical Grid and Renewable Energy

Chennai, like most Indian cities, receives most of its energy from electricity generated by coal. In 2018–19, the city consumed almost 13,000 GWh of electricity, i.e., 14 per cent of the total power generated and purchased by TANGEDCO (the state government-run power distribution company). This consumption directly contributes to 61 per cent of the emissions of the city and is likely to increase as conventional vehicles are replaced by EVs and per-capita power demands grow with increased economic activity and incomes. This is critical since the IEA Report[76] found coal to be the single-largest source of global temperature increase. The report highlights that CO_2 emitted from coal combustion was responsible for over 0.3°C of the 1°C increase in global average annual surface temperatures above pre-industrial levels. The supply of electricity to Chennai thus represents an opportunity to significantly reduce the overall GHG emissions of the city. However, opportunities to increase the proportion of renewable power being sent to the grid are constrained technically and administratively, due to the status of the Tamil Nadu Electrical Grid.

Affordable and Clean Electricity in Chennai: Current Status

Tamil Nadu has been a forerunner in RE production. The state leads the nation in installed wind power capacity. There is also an acknowledgment of the strategic importance of green and renewable power technologies. Between 2015 and 2021, the Tamil Nadu Electrical Grid's RE production increased from about 20 per cent to over 32 per cent of the total power produced.[77] However, at this rate of increase, the state will only

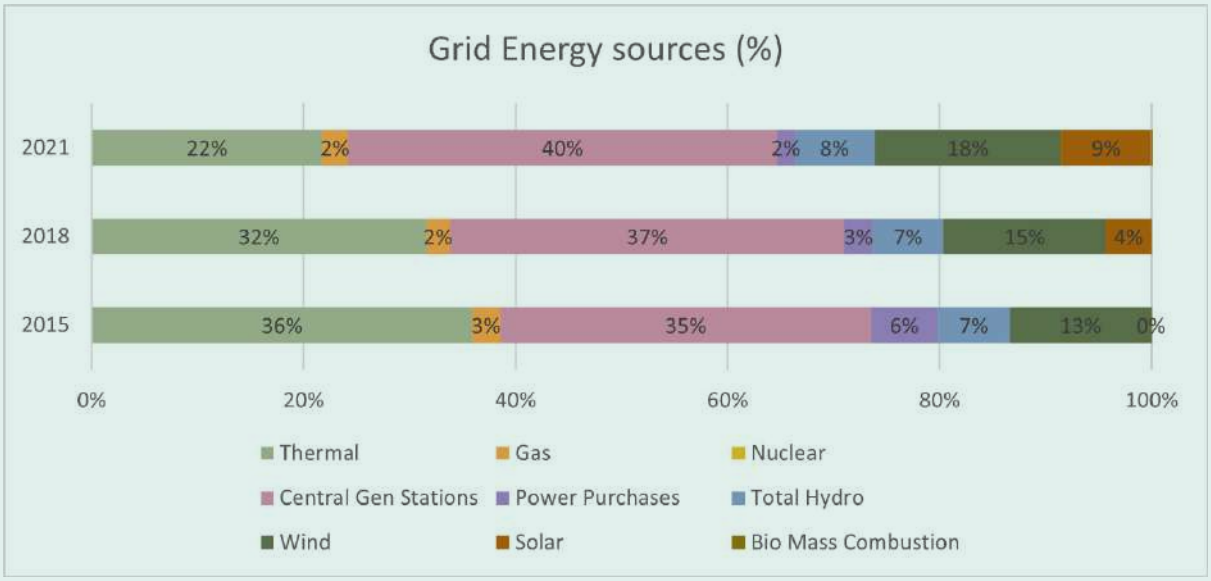


Figure 55: Comparison of Energy Produced (Absolute in MW) by Different Sources in Tamil Nadu

76 Impact of fossil fuel use on global temperature increases, IEA report, 2022

77 Data shared by TANGEDCO during one-to-one stakeholder consultation on 9 June 2022.

manage to convert about 70 per cent of its total power supply to renewable sources by 2050.[78] For 2018, the effective emission factor[79] of electricity consumed in Tamil Nadu was 0.67 ton/MWh.

In 2021, the Energy Department published a policy note recognizing the opportunity for transformative action in the power situation for the state. About 50 per cent of the thermal power capacity is over 25 years old and due for replacement.[80] The state is also investing significantly into renewable power capacity, with a target to install 20,000 MW additional renewable capacity by 2030. The projects that will contribute to the increased share of renewable energy generation in the GRID[81] are:

What is an Emission Factor?

An emission factor is a coefficient that allows for the conversion of activity data into GHG emissions. It is the average emission rate of a given source, relative to units of activity or process/processes.

1. Tamil Nadu Renewable Energy Park (TREP) – Development of a 20 MW wind-solar hybrid plant with battery energy storage system.

2. Solar Rooftop Programme for Domestic Consumers (GCRTS Phase-2) – Implementation of grid-connected solar rooftop program of MNRE by TEDA domestic consumers would be able to install grid connected solar photovoltaic system up to the capacity of their connected load.

3. Promotion of Energy Efficiency and Renewable Systems for Micro, Small, and Medium Enterprises (MSME) – Implementation of a sustainable energy-focused integrated scheme for the MSME sector to reduce their dependence on fossil fuel.

Key Gaps & Challenges

The growth of renewable power in Tamil Nadu is primarily constrained by six interrelated factors.

- **Increased grid instability due to proportion of intermittent renewables:** The biggest barrier to the adoption of renewable power as a major power source is the challenge of maintaining sufficient storage to address daily variations in solar and wind power. The demand for electricity is typically lowest at midday, when solar electricity production is highest. Conversely, while the electricity demand peaks at night, the solar energy production is near zero. Mismatches of demand and supply create grid instability, which can lead to load shedding or even complete blackouts. For Tami Nadu, this means a significant need for long-duration energy-storage systems.

- **Costs and fines associated with grid energy imports**: Currently, the gap between demand and supply in the state is made up through power purchases from the national grid operators. However, due to the high proportion of renewables and operational challenges faced by TANGEDCO, heavy spot rates have been imposed to discourage fluctuations in demand. This contributes to the debt burden of the utility company.

- **Lack of energy storage capacity**: For transition to 100 per cent renewable power generation, at current demand levels, Tamil Nadu would require an electricity storage system, with a peak output of 17,000 MW.[82] Currently, the pumped energy storage capacity at the state level is only 400 MW. The daily energy storage required for a 100 per cent transition to solar would be around 136,000 MW.[83] An ADB assessment in 2020[84] established that exceeding the current

78 Based on the analysis done by UMC on data shared by TANGEDCO during one-to-one stakeholder consultation on 9 June 2022.

79 https://climfoot-project.eu/en/what-emission-factor

80 Policy Note 2021-2022. Energy Department, Government of Tamil Nadu. 2021. http://cms.tn.gov.in/sites/default/files/documents/energy_e_pn_2021_22.pdf

81 Ibid.

82 Data shared by TANGEDCO during one-to-one stakeholder consultation. 9 June 2022.

83 Policy Note 2021-2022. Energy Department, Government of Tamil Nadu. 2021. http://cms.tn.gov.in/sites/default/files/documents/energy_e_pn_2021_22.pdf

84 https://www.adb.org/sites/default/files/linked-documents/51308-001-ra.pdf

capacity is difficult without first building more storage systems. However, such pumped water storage will require the construction of dams and reservoirs, which contributes negatively to the environment and has a huge impact on people.

- **Old thermal power generation infrastructure**: Currently, around 70 per cent of electricity produced in Tamil Nadu is thermal power[85]. Of the installed capacity, almost 50 per cent has reached the end of life. In the short term, it is unlikely that this demand is met through solar and wind power. The current plan, as proposed by the GoTN, is to replace and augment these power plants with additional coal and gas-powered thermal power plants[86]. Since these plants will have long service periods, they are unlikely to be phased out before 2050 – impacting the sectoral emissions by that year. Thus, there is an urgent need for the state to augment investments in RE, with energy-efficient systems and built environment and for Chennai to strongly advocate for increases in renewable energy and energy efficient buildings. In a recent announcement by the state government under the Tamil Nadu Climate Change Mission, the state has committed that no new coal power plants will be commissioned barring the once that are already been commissioned[87]. This will help in considerably reducing the emissions from the Energy Sector.

- **Tariff for rooftop solar power**: Tamil Nadu's Solar Energy Policy 2019 had declared a target of achieving 3,600 MW of solar energy in the consumer category by 2023, but only about 325 MW or 9.03 per cent of the target has been achieved as of 2022[88]. This differential can largely be attributed to the poor feed-in tariff for net-billed and gross-metered consumer solar connections. The current feed-in tariff for solar rooftops is between Rs 3.6 and 3.1/unit, while the domestic and commercial power tariff is around Rs 6.6/unit (as of June 2022). Since bi-directional net-metering is not available for most consumers with solar installations, the IRR of solar rooftop projects is extremely low; thus, citizens do not view this as a very advantageous initiative. Many public and private organizations, including the IOCL and the GCC, have flagged this as a major barrier to the development of solar rooftop power. There is a need for the state to revise the net-metering policy and offer attractive rates for more citizens to invest in rooftop solar power.

- **Policy governance of electricity grid in Chennai**: TANGEDCO is the only power distribution company operational in Chennai. As a state-run utility, the GCC has little influence over the operations of the utility within its jurisdiction. However, the overall monitoring and decision-making at TANGEDCO is linked with the Tamil Nadu Energy Board, and the Department of Energy (GoTN). An anchor organization, Tamil Nadu Energy Development Agency is responsible for promoting the development of renewable power resources in the state. The GCC's role in strengthening these institutions primarily centres on advocacy and technology incubation to support the existing strategies at the state level. The GCC can play a secondary role in advocating for or piloting reform. This must then be supported through enabling legislation at the state level, allowing the GCC to make direct investments or policies related to the generation or supply of electrical power.

Current Strategies

The GoTN is committed to mitigating climate change impact by bringing out policies conducive to RE generation. The TEDA is the dedicated agency for promoting energy conservation activities in the

85 Data shared by TANGEDCO during one-to-one stakeholder consultation on June 2022.

86 Policy Note 2021-2022. Energy Department, Government of Tamil Nadu. 2021. http://cms.tn.gov.in/sites/default/files/documents/energy_e_pn_2021_22.pdf

87 Climate change. No new coal-based power plants in the State, says Tamil Nadu government, The Hindu, 11th December 2022

88 TNERC's tariff for rooftop solar systems evokes mixed response. The Hindu. 26 October 202. https://www.thehindu.com/news/national/tamil-nadu/tnercs-tariff-for-rooftop-solar-systems-evokes-mixed-response/article37169841.ece/amp/

state, and it also has the responsibility of creating awareness about the potential and prospects of renewable energy besides enhancing renewable energy contribution in the overall energy mix in the state grid. Further, the TEDA acts as a bridge between small RE consumers and RE integrators. Currently, Tamil Nadu is pursuing two state-wide broad strategies towards green energy production.

1. Utility-scale RE: Utility-scale energy storage systems, with an individual capacity of 10 MW or greater, are essential for the adoption of RE as a part of the state grid. The State Energy Development Agency and TANGEDCO have taken concerted actions towards developing these utility scale RE storage systems.

2. Grid-connected rooftop solar energy: As the state nodal agency for the execution of RE projects and for coordination with the Ministry of New and Renewable Energy (MNRE), the TEDA has directly facilitated implementation of RE projects with a cumulative capacity of 63 MW of medium and small level projects – including 29 MW in domestic rooftop solar PV system and 17 MW of demonstration wind projects.[89] The GCC has already installed rooftop solar projects across 662 of its own buildings out of a total 2,000 buildings.

Accelerating this transition is the essential goal that will drive the transition to net-zero emissions in the sector.

Sectoral Vision for Electric Grid and Renewable Energy

Based on the understanding developed from the gap analysis and mapping of the initiatives taken by the state government and the GCC through strategic appraisals, the challenges and requirements for electric grid and RE were identified. The consultations with government and institutional stakeholders helped in identifying and prioritising actions and in framing the sectoral vision – "Access to Reliable, Affordable, and Zero-Emission Energy for All". In order to realize the sectoral vision – by reducing emissions from electric grid sector and enhancing RE – the following objectives and the key actions are given in the Table 10 along with the timeline, responsible stakeholders, monitoring indicators, alignment with plans, wider benefits, possible funding source and targets as follows:

Objective 1: 100 per cent Renewable Power for Grid

- Replace coal-fired plants with more biomass/ renewable power capacity.
- Expand utility-scale energy storage systems for the grid.
- Revise tariffs for consumer solar net-metering installations.

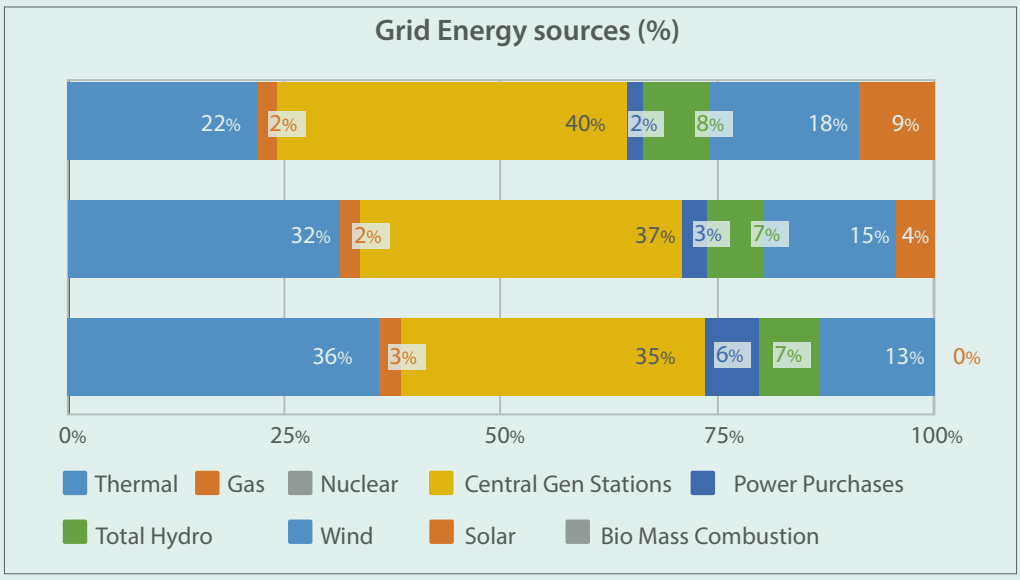


Figure 56: Comparison of Energy Produced (Percentage) by Different Sources in Tamil Nadu

89 Policy Note 2021-2022. Energy Department, Government of Tamil Nadu. 2022. http://cms.tn.gov.in/sites/default/files/documents/energy_e_pn_2021_22.pdf

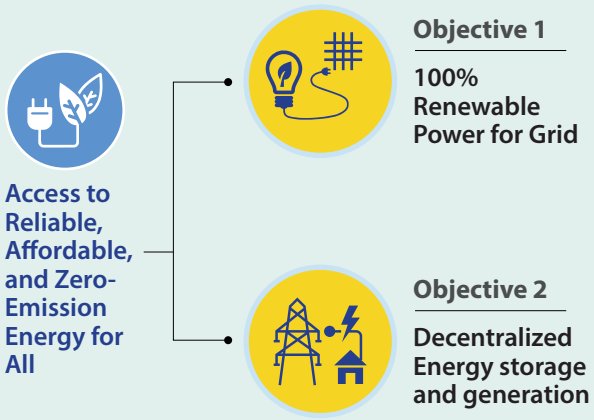


Figure 57: Sectoral vison for Electric Grid and Renewable Energy

Objective 2: Decentralised Energy storage and generation

- Pilot city-level energy storage systems.
- Integrate energy storage systems and urban energy generation into land-use planning.
- Enable regulation for investment and financing in solar rooftop systems.
- Expand DCR provisions to require solar in all new multi-family projects and all commercial buildings.
- Enable research and investment into alternative power generation and storage systems.

Proposed Actions Identified for Electrical Grid and Renewable Energy

Table 10 Actions Identified for Electrical Grid and Renewable Energy

Objective #1

100 per cent Renewable Power for Grid

Targets	2030	2040	2050
	33% of total grid electricity from coal	25% of total grid electricity from coal	0% of total grid electricity from coal
	39% of total grid electricity from renewables	67% of total grid electricity from renewables	93% of total grid electricity from renewables

The following action areas have been identified to deliver the City's targets:

1. Revise tariffs for consumer solar net metering installations.
2. Expand utility scale energy storage systems for the grid.
3. Replace coal fired plants with more biomass/ renewable power capacity.

Action 1

Revise tariffs for consumer solar net-metering installations.

Time Frame: Short Term (2025–30)

Sub Actions:

- Revise solar rooftop policy to extend net-metering to all consumer installations with generation capacity under 15KW.
- Amend development control regulations to require

Stakeholders

Lead Role:
- TANGEDCO

Supporting Role:
- TEDA
- Department of Energy, GoTN

Monitoring Indicator

- Percentage of total residential & commercial buildings with solar PV installed

Objective #1

100 per cent Renewable Power for Grid

Action 1 *contd* | Revise tariffs for consumer solar net-metering installations.

installation of solar rooftop installations on all newly constructed buildings

- Increase the feed-in tariff for the consumers.
- Producers of power can decrease the payback period of roof top solar systems to make them more lucrative.

- Ratio of Feed-in-Tariff to unit cost of residential power
- No. of applications for setting solar roof systems developed
- Revision in the net-tariff policy

Alignment with SDGs/ Plans

- State Energy Policy, 2019
- SDG 7: Affordable and Clean Energy

Wider Benefits

- Stabilisation of electricity pricing
- Reduction in dependence on energy imports from national grid
- Creation of livelihood opportunities in the sector
- Reduced financial burden on households

Possible Funding/ Financing Source

- Funding from TANGEDCO (since it would benefit from reductions in electricity demand)

Action 2 | Expand utility scale energy storage systems for the grid.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Develop a state-wide energy storage plan, with projections of storage requirements to achieve 100 per cent renewable power use by 2050.
- Conduct identification and feasibility analysis of developing pumped storage systems at existing reservoirs across the state.
- Establish a dedicated review board for storage projects to fast-track environmental clearance and to ensure high quality technical inputs on environmental and social management plans for projects.

Stakeholders

Lead Role:
- TANGEDCO

Supporting Role:
- TEDA
- Department of Electricity
- GCC
- WRD

Monitoring Indicator

- Increase in total Energy Storage capacity in KWh
- Ratio of Total Power output of storage systems and peak power demand (KW/ KW)

Alignment with SDGs/ Plans

- State Energy Policy, 2019
- SDG 7: Affordable and Clean Energy

Objective #1

100 per cent Renewable Power for Grid

Action 2 *contd* | Expand utility scale energy storage systems for the grid.

- Establish an incubation centre for private and public sector research into alternative utility scale energy storage systems
- Conduct competition for pilot-scale "alternative" energy storage systems, i.e., utility-scale storage with technology other than pumped storage and battery storage.
- Develop and pass enabling legislation and regulation for private sector investment/ privately developed energy storage systems.
- Develop a plan for financing and enabling direct private investment in energy storage systems.

Wider Benefits

- Increase in share of renewable power supplied to grid
- Electricity pricing is stabilized.
- Reduction in dependence on energy imports from the national grid
- Reduction in financial burden on TANGEDCO

Possible Funding/ Financing Source

- Private sector participation in energy storage to be increased

Action 3 | Replace coal fired plants with more biomass/renewable power capacity.

Time Frame: Long Term (2040–50)

Sub Actions:

- Develop a state-wide energy storage plan, with projections of storage requirements to achieve 100 per cent renewable power use by 2050.
- Conduct identification and feasibility analysis of developing pumped storage systems at existing reservoirs across the state.
- Establish a dedicated review board for storage projects to fast-track environmental clearance and to ensure high quality technical inputs on environmental and social management plans for projects.

Stakeholders

Lead Role:
- TANGEDCO

Supporting Role:
- TEDA
- Department of Electricity

Monitoring Indicator

- Percentage of RE in the grid mix

Alignment with SDGs/ Plans

- State Climate Action Plan
- State Energy Plan
- SDG 7: Affordable and Clean Energy
- SDG 3: Good Health & Well-being

Objective #1

100 per cent Renewable Power for Grid

Action 3 *contd* | **Replace coal fired plants with more biomass/renewable power capacity.**

Wider Benefits

- Reduction in cost of electricity for consumers
- Reduction in financial burden on TANGEDCO
- Improvement in air quality around decommissioned conventional power plants
- Creation of employment opportunities*

* *IASS, TERI, CEEW, and SCGJ. 2019. Future Skills and Job Creation with Renewable Energy in India. Assessing the Co-benefits of Decarbonising the Power Sector. Potsdam: IASS, New Delhi: TERI.*

Possible Funding/ Financing Source

- Existing budget allocations for power utility projects
- Through private sector participation

Objective #2

Decentralized Energy Storage and Generation

Targets

2030	2040	2050
2% of total residential & commercial buildings with solar PV installed	5% of total residential & commercial buildings with solar PV installed	10% of total residential & commercial buildings with solar PV installed

The following action areas have been identified to deliver the City's targets:

1. Pilot city-level energy storage systems.
2. Enabling regulation for investment and financing in solar rooftop systems
3. Enabling research and investment into alternative power generation and storage systems.
4. Integrate energy storage systems and urban energy generation into land use planning.
5. Expand DCR provisions to require solar in all new multi-family projects and all commercial buildings.

Objective #2

Decentralized Energy Storage and Generation

Action 1 | Pilot city-level energy storage systems.

Time Frame: Short Term (2022–25)

Sub Actions:

- Conduct more research into decentralized energy storage systems.
- The GCC can work with stakeholders to enable pilot projects that explore the feasibility of storing energy within the city.
- Inform wider R&D projects in the state/ nation through the pilot projects

Stakeholders

Lead Role:
- TANGEDCO

Supporting Role:
- TEDA
- Department of Electricity
- GCC

Monitoring Indicator

- Pilot recommendations developed to assess applicability of storage systems and next steps identified.

Alignment with SDGs/ Plans

- State Energy Policy, 2019
- SDG 7: Affordable and Clean Energy

Wider Benefits

- Creation of economic activity
- Increasing energy security within the city
- Emergence of the GCC as one of the first cities in India to dedicate resource to such research-sharing with other ULBs

Possible Funding/ Financing Source

- Equity investments from the city and state governments through land, preference in contracts, and technical support
- Other funding raised by the private sector

Action 2 | Enabling regulation for investment and financing in solar rooftop systems

Time Frame: Short Term (2022–30)

Sub Actions:

- Consult with industry leaders and stakeholders regarding the barriers to rooftop leases and utilization of shared rooftops for power generation.

Stakeholders

Lead Role:
- TANGEDCO

Supporting Role:
- TEDA
- Department of Electricity
- GCC
- CMDA

Objective #2

Decentralized Energy Storage and Generation

Action 2 *contd* | Enabling regulation for investment and financing in solar rooftop systems

- Set up pilot project in public buildings to explore lease and co-generation models for shared rooftops.
- Publish legislation and guidelines to develop solar installation in shared buildings. Regulatory framework and model contract to protect the interests of investors and building owners/occupiers.
- Integrate requirements into building by-laws and make them eligible to satisfy planning regulation requirements.
- Provide access to affordable credit in buildings with shared rooftop ownership or in LIG/EWS housing.
- Establish a simplified mechanism for investors to obtain permissions, documentation, and authorization to develop shared rooftop solar power systems.
- Empanel service providers for installation of rooftops.

Monitoring Indicator

- Percentage of total residential & commercial buildings with solar PV installed
- Percentage of solar potential leveraged

Alignment with SDGs/ Plans

- State Energy Policy, 2019
- SDG 7 – Affordable and Clean Energy

Wider Benefits

- Increase in equity by enabling lower income residents to benefit from decreases in electricity pricing
- Creation of livelihood opportunities

Possible Funding/ Financing Source

- Solar PV application programme – Phase 3, MNRE
- Technical support financed through partnerships with vendors and manufacturers
- Empanelment costs can raise revenue through fees

Action 3 | Enabling research and investment into alternative power generation and storage systems.

Time Frame

Short Term (2022–30)

Sub Actions:

- Consult with industry leaders and stakeholders to establish a "incubation centre" for energy systems.

Stakeholders

Lead role:
- TEDA
- Department of Energy

Supportive role:
- TNGCC
- CMDA
- GCC

Objective #2

Decentralized Energy Storage and Generation

Action 3 *contd* | Enabling research and investment into alternative power generation and storage systems.

- Make direct investment in start-ups and projects through technical support, equity, and land for pilot/demonstration projects.
- Launch projects and provide continued legislative support toward developing systems.

Monitoring Indicator
- New technologies identified for alternative power generation and storage systems
- Investment done on the new identified technologies

Alignment with SDGs/ Plans
- SDG 7: Affordable and Clean Energy

Wider Benefits
- Enhanced spectrum of energy generation and storage options

Possible Funding/ Financing Source
- Funding received for R&D under DoE, GoTN

Action 4 | Integrate energy storage systems and urban energy generation into land use planning.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Land requirements for energy infrastructure are likely to change significantly as the grid becomes more dependent on renewables/ more complex.
- The new master plan and GDCR create opportunities to reserve land for renewable power generation storage and transmission.

Stakeholders

Lead Role:
- TANGEDCO

Supporting Role:
- TEDA
- Department of Electricity
- CMDA
- GCC

Monitoring Indicator
- Reserved land in master plan/ local area plans for energy storage

Alignment with SDGs/ Plans
- State Energy Plan
- SDG 7 – Affordable and Clean Energy

Objective #2

Decentralized Energy Storage and Generation

Action 4 *contd*

Integrate energy storage systems and urban energy generation into land use planning.

Wider Benefits
- Enabling action for decentralized power storage systems

Possible Funding/ Financing Source
- Land as an equity investment in city-level power storage systems

Action 5

Expand DCR provisions to require solar in all new multi-family projects and all commercial buildings.

Time Frame
Medium Term (2030–40)

Sub Actions:

- Currently, the GDCR only requires rooftop solar to be installed in buildings with more than 16 dwelling units and commercial buildings with more than 300 sqm of commercial space. This provision maybe expanded to cover all projects with more than 1 dwelling and all commercial projects.

Stakeholders

Lead Role:
- CMDA

Monitoring Indicator
- Percentage of total residential & commercial buildings with solar PV installed
- Percentage of solar potential leveraged

Alignment with SDGs/ Plans
- State Energy Policy, 2019
- SDG 7: Affordable and Clean Energy
- CMDA Master Plan 2026

Wider Benefits
- Decentralised RE generation
- Increase in equity by enabling lower income residents to benefit from decreases in electricity pricing
- Creation of livelihood opportunities

Possible Funding/ Financing Source
- Not required

Impact on GHG Emission by Energy Grid and RE Sector

The key priority identified for decarbonizing the Energy Grid and Renewable Energy Sector include shifting power generation from thermal to renewables. Figure 58 compares power generation capacity between the BAU Scenario and the Ambitious Scenario, and shows the evolution of power generation by type and associated emissions factors for 2030, 2040, and 2050. This highlights impact of ambitious actions on GHG contribution from the sector.

The increase in the capacity of RE shows evident decrease in the emissions from the sector. The shift from thermal energy to RE in power generation will require incorporating 93 per cent renewables in Chennai's electricity generation mix by 2050, which currently stands at 26.5 per cent, as per the baseline contributing to GHG emissions. The shift to RE not only reduces GHG emissions, but also eliminates the emissions factor (from 0.68 to 0) by 2050. These Ambitious Actions identified for the Electric Grid and RE Sector contribute to a reduction of 44 per cent in Chennai's total GHG emissions.

6.2.2 Building Energy

The dominant source of emissions from buildings in Chennai comes from electricity consumption and LPG usage in the residential, commercial, institutional, and manufacturing facilities. As discussed earlier, "stationary energy use" leads to 70 per cent of all GHG emissions in Chennai.

Of this, electricity consumption in buildings contributes to 89 per cent of the emissions, while

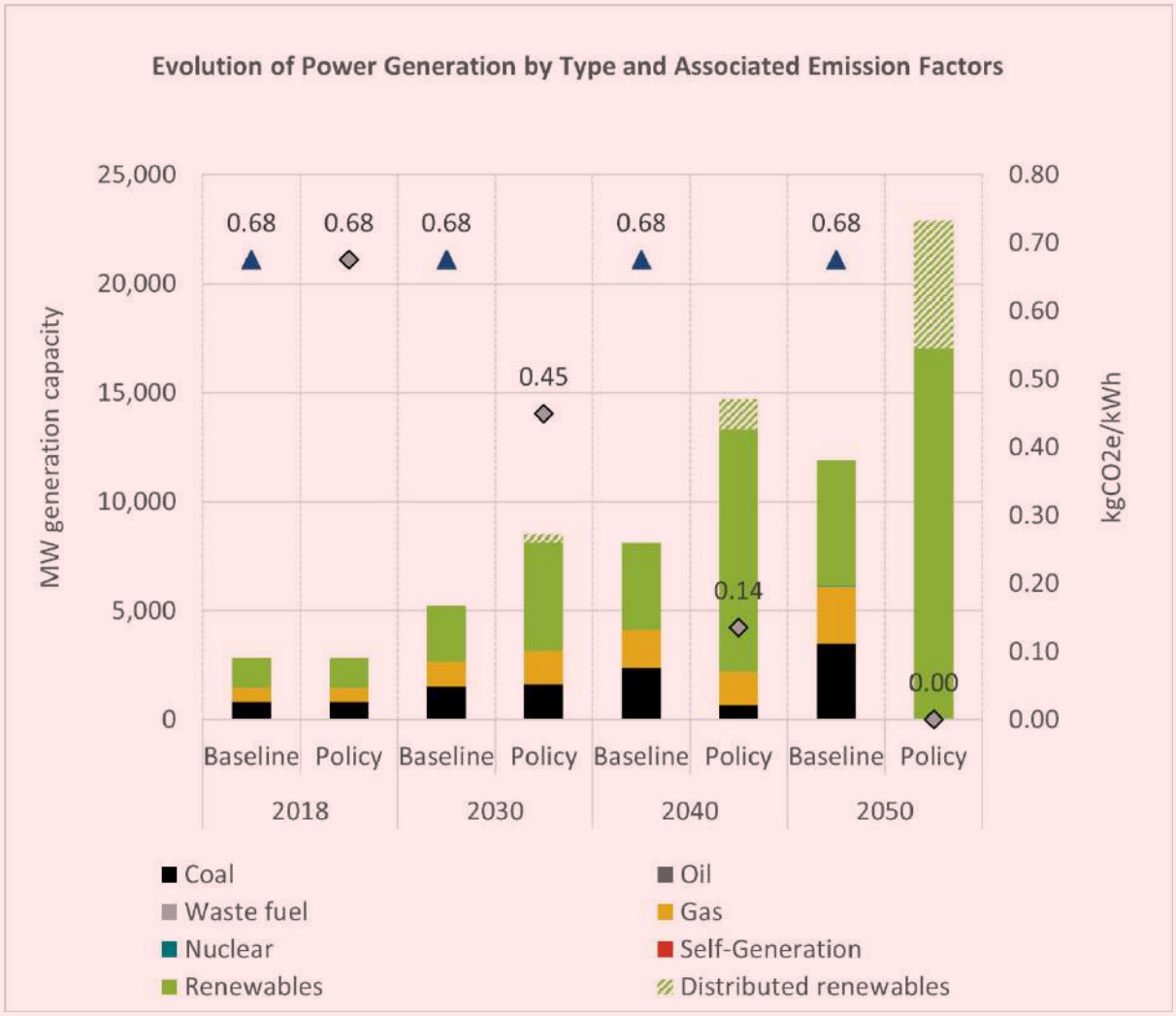


Figure 58: Reduction in Emissions Overtime Based on the Ambitious Scenario

LPG contributes to 11 per cent of emissions. Cooking, cooling, and heating water are the key activities in the buildings sector that consume the most amount of energy, leaving a large footprint. Based on the future scenario pathways analysis, factoring in increasing population and incomes the emissions from residential, commercial, institutional, and manufacturing facilities are estimated to increase by up to four times by 2050. Thus, having energy-efficient buildings is critical to reducing GHG emissions and supporting city-level mitigation strategies.

Tamil Nadu has taken extensive steps towards energy efficiency and energy saving for the industrial sector, by strengthening their institutional capacities through policies and regulations.[90] The GoTN has also historically been a pioneer, by drafting one of the country's first Energy Conservation Building Codes (ECBC) in 2008, before national codes were proposed. However, due to challenges and fragmentation in the implementation of policy and regulations, energy conservation in specific changes in the residential and commercial buildings of Chennai has been slow.

Existing Policy

The GCC has taken extensive steps towards ensuring that its buildings are as efficient as possible. There is a general order in place to only purchase appliances with an efficiency rating of 5 stars or higher. A detailed feasibility analysis has been conducted of every building owned by the GCC, and solar rooftops have been installed on all buildings that have been found feasible.

Overall, 662 out of the 2,000 buildings owned by the GCC have been installed with solar panels. All buildings have also been fitted with energy-efficient LED lighting, and the GCC's design and procurement standards now mandate the purchase of 5-star efficiency rated appliances.

In April 2022, the GoTN issued an order to the Tamil Nadu Housing Development Board (TNHDB), the Public Works Department (PWD), and the GCC, among others, to ensure that all buildings – especially schools and affordable housing – comply with the ECBC code 2017 or the Eco Niwas Samhita guidelines. It has also been proposed that these requirements be incorporated into the building by-laws through the upcoming Master Plan for the Chennai Metropolitan Region being prepared by the CMDA. Currently, the planning permission process for buildings also requires input-oriented energy efficiency measures. The installation of solar water heating is required on all buildings. The installation of solar panels is required in all buildings where it is feasible to install them. Rainwater harvesting systems, too, are mandatory for all buildings.

Key Gaps and Challenges

The GoTN and the GCC have taken steps to manage their own energy requirements in their buildings. However, being a historic city, Chennai has a large stock of existing buildings, and no roadmap has yet been developed to retrofit such buildings and infrastructure. Moreover, no mandate or mechanism has been in place for regular energy audits. Thus, a key challenge is to ensure energy efficiency in the buildings constructed by the private sector. Creating a strong supporting ecosystem will help increase the rate of adoption of energy-efficient design – in buildings constructed by both the government and the private sector.

Technical Barriers

- Availability of high-efficiency air-conditioning and heat pumps
- Skilled workers for retrofitting existing masonry and concrete buildings
- Architects and engineers to be aware of building energy analysis
- Awareness of energy efficiency in buildings.

The India Residential Energy Survey (IRES) estimates that only about 26 per cent of urban households in Tamil Nadu have knowledge of star ratings for appliances.[91] In particular, star-rated fans were the least common, preference for high-efficiency ratings was more common for larger appliances such as refrigerators. Households cited cost as one of the major drivers of not buying star rated appliances. In the absence of ECBC mandates and/or communication campaigns, this is unlikely to change. However, well-planned interventions can be effective and have substantial impact, as discussed in the Ambitious Scenario.

Economic Barriers

- Capital cost of energy efficient appliances, and insulation

90 State Energy Efficiency Index 2020, Ministry of Power & BEE

91 Awareness and adoption of energy efficiency in Indian homes, Insights from IRES (2020). CEEW. October 2020, https://www.ceew.in/sites/default/files/CEEW-Awareness-and-adoption-of-EE-in-Indian-homes-ES.pdf

- Impact of building design on available floor area and Floor Space Index (FSI) consumption

The Indian appliance market is extremely price sensitive, with the market share of 3-star efficiency AC units increasing due to the perceived balance in capital cost and value.[92] This also contributes to longer-than-recommended operational life for most devices and a high likelihood of such devices being bought by low-middle class economy households.

Administrative Barriers

- Lack of trained assessors for enforcement of ECBC codes
- Delays and gaps in building planning and building use permission process
- Fragmentation of implementation powers between the CMDA and GCC

Sectoral Vision for Building Energy Efficiency in Chennai

The gap analysis and mapping of the initiatives taken by the GoTN and the GCC through strategic appraisals has helped identify the challenges to improving the energy-efficiency of buildings. Further, actions have been delineated and prioritized based on consultations with government and institutional stakeholders. The sectoral vision that emerges is — **"Achieving Energy Efficiency in All Buildings".**

In order to realise the sectoral vision and reduce emissions from built habitat sector, the following objectives and the key actions are given in the Table 11 along with the timeline, responsible stakeholders, monitoring indicators, alignment with plans, wider benefits, possible funding source and targets as follows:

Objective 1: 100 per cent use of energy efficient appliances

- Conduct IEC programme on building and appliance energy efficiency.
- Introduce credit programmes for upgrading electric appliances and cooling solutions in EWS housing.
- Emphasis on property value-based energy conservation requirements.

Objective 2: Energy-efficient building design

- Mandate ECBC compliance and establish ECBC/green building cell for monitoring all the new buildings approvals.
- Provide technical support for Energy Efficiency Building Design – through certification and guidebooks.
- Empanel cadre of service providers for construction and retrofitting buildings to be ECBC compliant.
- Provide FSI compensation for buildings with energy efficient building envelope.
- Introduce economic incentives to enforce ECBC compliance.
- Create a public database of "certified" energy usage for renters and buyers.

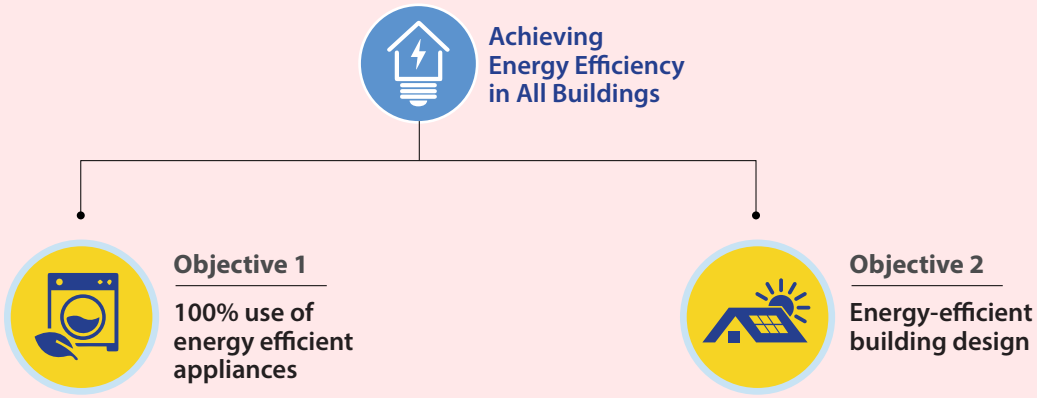


Figure 59: Sectoral Vision for Building Energy Efficiency

92 https://www.teriin.org/sites/default/files/2020-01/modified-accelerating-the-uptake.pdf

Proposed Actions Identified for Energy-Efficient Buildings

Table 11 Proposed Actions Identified for Energy-Efficient Buildings

Objective #1

100 per cent Use of Energy Efficient Appliances and equipment

Targets						
2030	40% high-efficiency appliances in existing and new commercial buildings	40% mid-range energy efficient appliances and 5% high range energy efficient appliances in existing residential buildings	20% mid-range energy efficient appliances and 20% high range energy efficient appliances in new residential buildings	40% high-efficiency chillers in Commercial cooling system technology	40% high-efficiency chillers in Residential cooling system technology	10% LED lighting in commercial and residential buildings
2040	60% high-efficiency appliances in existing and new commercial buildings	60% mid-range energy efficient appliances and 10% high range energy efficient appliances in existing residential buildings	30% mid-range energy efficient appliances and 40% high range energy efficient appliances in new residential buildings	80% high-efficiency chillers in Commercial cooling system technology	60% high-efficiency chillers in Residential cooling system technology	50% LED lighting in commercial and residential buildings
2050	100% high-efficiency appliances in existing and new commercial buildings	80% mid-range energy efficient appliances and 10% high range energy efficient appliances in existing residential buildings	40% mid-range energy efficient appliances and 40% high range energy efficient appliances in new residential buildings	80% high-efficiency chillers in Commercial cooling system technology	85% high-efficiency chillers in Residential cooling system technology	80% LED lighting in commercial and residential buildings

The following action areas have been identified to deliver the City's targets:

1. Conduct IEC programme on building and appliance energy efficiency.
2. Introduce credit programmes for upgrading electric appliances and cooling solutions in EWS housing.
3. Emphasise property value-based energy conservation requirements.

Action 1

Conduct IEC programme on building and appliance energy efficiency.

Time Frame: Short Term (2022–30)

Sub Actions:

- Set up a "Building experience centre" where information about energy efficient appliances (such as LED lighting

Stakeholders

Lead Role:
- GCC

Supporting Role:
- CMDA
- Real-estate Developers
- Built environment professionals
- Appliance manufacturers and retailers

Objective #1

100 per cent Use of Energy Efficient Appliances and equipment

Action 1 *contd* | Conduct IEC programme on building and appliance energy efficiency.

and cooling), building materials, finishes, details and designs are displayed to generate awareness among residential and commercial building clients.

- Conduct door-to-door IEC among vulnerable communities and in newly developing areas to promote energy efficiency in building design and electric appliances.

Monitoring Indicator

- Percentage of high efficiency appliances in existing and new commercial & residential buildings
- Percentage LED lighting in commercial and residential buildings

Alignment with SDGs/ Plans

- State Energy Conservation and Building Code
- BEE guidelines
- SDG 10: Reduced Inequalities
- SDG 11: Sustainable Cities and Communities

Wider Benefits

- Increased household resilience to heatwaves and enhancing their quality of life
- Lower operating costs households especially for low-income groups
- Increased livelihood opportunities

Possible Funding/ Financing Source

- CSR funding from appliance manufacturers and vendors
- Funding from BEE/ MNRE

Action 2 | Introduce credit programmes for upgrading electric appliances and cooling solutions in EWS housing.

Time Frame

Medium Term (2030–40)

Sub Actions:

- Create programmes for providing access to affordable credit/ loan for purchasing high efficiency electric appliances to lower income households through collaborations between banks and the GCC/ TNUHDB.

Stakeholders

Lead Role:

- GCC

Supporting Role:

- TNHDB
- Financial institutions i.e., banks, cooperative societies

Monitoring Indicator

- Percentage of high efficiency appliances in existing and new commercial & residential buildings

Objective #1

100 per cent Use of Energy Efficient Appliances and equipment

Action 2 *contd*

Introduce credit programmes for upgrading electric appliances and cooling solutions in EWS housing.

Alignment with SDGs/ Plans

- ECBC
- BEE guidelines
- SDG 10: Reduced Inequalities
- SDG 11: Sustainable Cities and Communities

Wider Benefits

- Increased household resilience to heatwaves and enhancing their quality of life
- Lower operating costs for the households, especially for low-income groups

Possible Funding/ Financing Source

- CSR funding from appliance manufacturers and vendors
- Loan instrument funding under lending for SHGs and priority sector lending

Action 3

Emphasise property value-based energy conservation requirements.

Time Frame

Long Term (2040–50)

Sub Actions:

- Introduce more stringent ECBC requirements for properties with higher assessed value.

Stakeholders

Lead Role:
- GCC

Supporting Role:
- CMDA

Monitoring Indicator

- Percentage of buildings in compliance with ECBC standards
- Percentage reduction in per-capita energy demand of the city

Alignment with SDGs/ Plans

- ECBC
- BEE guidelines
- SDG 10: Reduced Inequalities
- SDG 11: Sustainable Cities and Communities
- SDG 12: Responsible Consumption and Production

Objective #1

100 per cent Use of Energy Efficient Appliances and equipment

Action 3 *contd* | **Emphasise property value-based energy conservation requirements.**

Wider Benefits
- Economic benefit through energy saving
- Enhanced resilience to heat

Possible Funding/ Financing Source
- Funding from BEE/ MNRE
- GCC fundings

Objective #2

Energy efficient building design

Targets	2030	2040	2050
	40% of new construction efficiency through retrofitting building envelopes	60% of new construction efficiency through retrofitting building envelopes	100% of new construction efficiency through retrofitting building envelopes

The following action areas have been identified to deliver the City's targets:

1. Mandate ECBC compliance and establish ECBC/ green building cell for monitoring all the new buildings approvals.
2. Provide technical support for Energy Efficiency Building Design – through certification and guidebooks.
3. Empanel a cadre of service providers for the construction and retrofitting of buildings to make them ECBC compliant.
4. Provide FSI compensation for buildings with an energy efficient building envelope.
5. Create a public database of certified energy usage for renters and buyers
6. Introduce economic incentives to enforce ECBC compliance.

Objective #2

Energy efficient building design

Action 1 | Mandate ECBC compliance and establish ECBC/ green building cell for monitoring all the new buildings approvals.

Time Frame: Short Term (2025–30)

Sub Actions:

- Notify the ECBC codes at the state level.
- Integrate ECBC codes in the TNCDBR, 2019.

Stakeholders	**Lead Role:** • Energy Department, GoTN **Supportive Role:** • CMDA
Monitoring Indicator	• Notified ECBC
Alignment with SDGs/ Plans	• ECBC • BEE
Wider Benefits	• Increased stock of green and energy efficient buildings • Thermally comfortable buildings that save up on energy cost and improve work/ living environment, improves health of residents
Possible Funding/ Financing Source	• Funding from BEE/ MNRE

Action 2 | Provide technical support for Energy Efficiency Building Design – through certification and guidebooks.

Time Frame: Short Term (2025–30)

Sub Actions:

- Develop guidelines or ready reckoners for designers, clients, and consultants to train professional for implementation of ECBC codes.

Stakeholders	**Lead Role:** • GCC **Supporting Role:** • CMDA • Urban Development Department

Objective #2

Energy efficient building design

Action 2 *contd*

Provide technical support for Energy Efficiency Building Design – through certification and guidebooks.

- Introduce a certification programme for chartered building surveyors, to produce building assessment reports for energy efficiency.

Monitoring Indicator

- Percentage of existing and new buildings in compliance with ECBC standards
- Percentage reduction in per-capita energy demand of the city

Alignment with SDGs/ Plans

- State Energy Conservation and Building Code
- BEE guidelines
- SDG 11: Sustainable Cities and Communities
- SDG 17: Partnership for the goals

Wider Benefits

- More sensitive and appropriate building design, construction and maintenance
- Enhanced livelihood opportunities

Possible Funding/ Financing Source

- BEE
- Co-funding from building industry and developers
- Skill development programmes under the National Skill Development Corporation

Action 3

Empanel a cadre of service providers for the construction and retrofitting of buildings to make them ECBC compliant.

Time Frame

Short Term (2022–30)

Sub Actions:

- Empanel service providers for individual homes/small business owners to comply with ECBC requirements in their new/redeveloped buildings.

Stakeholders

Lead Role:
- GCC

Supporting Roles:
- CMDA
- Vendors and service providers

Monitoring Indicator

- Percentage of existing and new buildings in compliance with ECBC standards
- Percentage reduction in per-capita energy demand of the city

Objective #2

Energy efficient building design

Action 3 *contd*

Empanel a cadre of service providers for the construction and retrofitting of buildings to make them ECBC compliant.

Alignment with SDGs/ Plans	• ECBC codes • SDG 11: Sustainable Cities and Communities • SDG 17: Partnership for the Goals
Wider Benefits	• Large chunk of existing building stock aligns with energy efficient guidelines • Enhanced livelihood opportunities
Possible Funding/ Financing Source	• Empanelment fees as service providers

Action 4

Provide FSI compensation for buildings with an energy efficient building envelope.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Conduct a pilot study to assess cost impact of compliance with ECBC for model buildings of several types.
- Modify the General Building Regulations to add allowable deductions in FSI calculations against area lost to energy-efficiency improvements.

Stakeholders	**Lead Role:** • GCC **Supporting Roles:** • CMDA
Monitoring Indicator	• Percentage of existing and new buildings in compliance with ECBC standards • Percentage reduction in per-capita energy demand of the city
Alignment with SDGs/ Plans	• SDG 11: Sustainable Cities and Communities

Objective #2

Energy efficient building design

Action 4 *contd*

Provide FSI compensation for buildings with an energy efficient building envelope.

Wider Benefits	• Energy savings and reduced emissions
Possible Funding/ Financing Source	• This is a financing mechanism.

Action 5

Create a public database of certified energy usage for renters and buyers

Time Frame

Medium Term (2030–40)

Sub Actions:

- Maintain a registry of buildings in the city along with their ECBC ratings.
- Make it mandatory for property owners to share their energy-use certificate with prospective tenants, to support them in making informed decision as building energy use is a significant factor in their decision for both commercial and residential tenants.

Stakeholders	**Lead Role:** • GCC **Supporting Roles:** • CMDA • Developers/ property owners
Monitoring Indicator	• Percentage of existing and new buildings in compliance with ECBC standards • Percentage reduction in per-capita energy demand of the city
Alignment with SDGs/ Plans	• State Energy Conservation and Building Code • BEE guidelines • SDG 11: Sustainable Cities and Communities • SDG 17: Partnership for the goals
Wider Benefits	• Smoother implementation and monitoring of ECBC compliance • More sensitive and appropriate building design, construction and maintenance
Possible Funding/ Financing Source	• Funded through empanelment fees of authorized surveyors

Objective #2

Energy efficient building design

Action 6 | Introduce economic incentives to enforce ECBC compliance.

Time Frame: Long Term (2040–50)

Sub Actions:

- Introduce a multiplier on property tax rates, based on energy/water consumption.
- Confer bi-annual awards for most sustainable properties, and for sustainable practices in building construction and design.

Stakeholders

Lead Role:
- GCC

Supporting Roles:
- CMDA
- Developers/ property owners

Monitoring Indicator

- Percentage of existing and new buildings in compliance with ECBC standards
- Percentage reduction in per-capita energy demand of the city

Alignment with SDGs/ Plans

- State Energy Conservation and Building Code
- BEE guidelines
- SDG 10: Reduced Inequalities
- SDG 11: Sustainable Cities and Communities
- SDG 12: Responsible Consumption and Production

Wider Benefits

- Increased revenues of GCC

Possible Funding/ Financing Source

- This is a financing mechanism

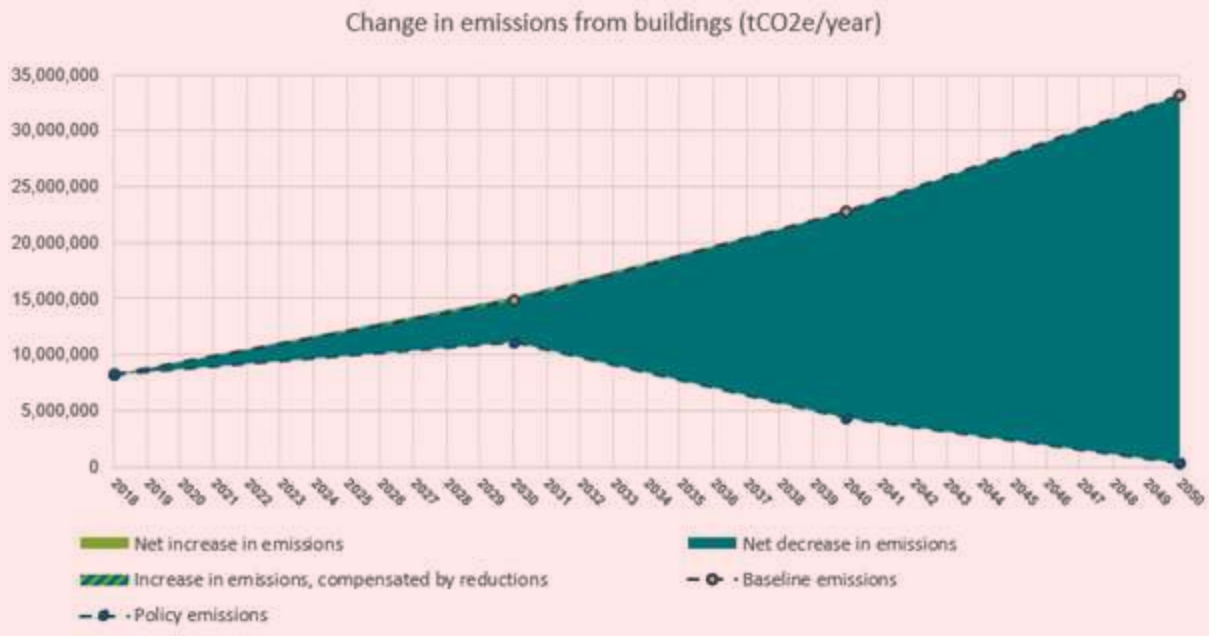


Figure 60: Change in Emissions from Building Energy Sector Based on Ambitious Scenario

Impact on GHG Emission by Building Energy Sector

Figure 60 shows the key priorities identified for the electricity GRID and building energy scale-up to ensure a net decrease in emissions from buildings.

Facilitating the adoption of energy-efficient appliances by offering affordable credit finance, IEC, and capacity building for the use of energy-efficient products and construction of energy-efficient buildings can reduce the emissions from the sector significantly – from 33.16-million-ton CO_2e/ year to 0.29-million-ton CO_2e/ year. The Ambitious Actions identified for building energy efficiency contributes to 37.3 per cent of total reductions in the city's total GHG emission reduction by 2050.

6.2.3 Transport

Four of every 10 citizens in Chennai use private vehicles fuelled by fossil fuels, i.e., petrol and diesel. Like in most Indian cities, in Chennai, the dependency on buses, suburban rail, metro, and non-motorized transport is low. Due to an almost 10 per cent increase in household income in the 2008–18, there has been a major shift towards households buying two-wheelers and four-wheelers. Thus, the trips made by these vehicles has increased, while there has been a sizeable reduction in Percentage share of trips by public transport. Trips by non-motorized transport (cycling and walking) have also decreased by 6 per cent in the same timeframe. Only about 28.2 per cent of Chennai's population is now dependent on public transport. In 2019, the modal split was as follows:

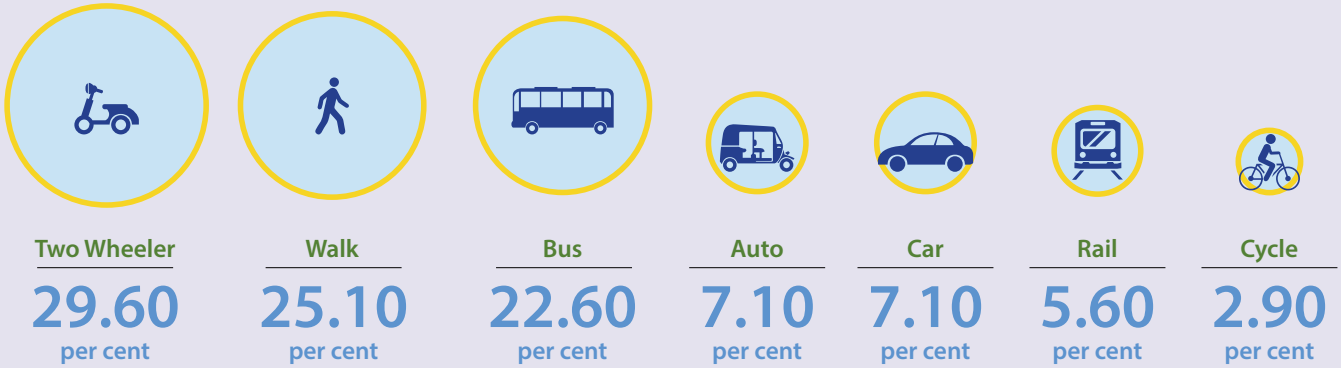


Figure 61: Vehicular Mode Share in Chennai

The increased dependency on private vehicles has contributed to urban problems such as traffic congestion, increased travel time, and air quality deterioration.

Chennai is a part of a large metropolitan region, which contributes to significant travel distances and long commutes among the residents and employees. The three primary providers of public transit in Chennai are the Metropolitan Transport Corporation (bus service), the Chennai Metro Rail Corporation Limited (metro-rail), and the MRTC (suburban rail service). These three together provide access to around 36.4 per cent of the city's area through public transport.

The State Transport Authority (Chennai region) is responsible for the regulation and policymaking for transport in Chennai. The long-term solution for the city will be to focus on the adoption of public transportation and moving as many commuters as possible to public transit. A key component along with enhancing public transport infrastructure is in enhancing access through improving last-mile connectivity for public transit services, strengthening intermodal transfers, improving pedestrian access, and enhancing parking fees as a mechanism to promote public transport.

The CMDA is responsible for transport and mobility planning for both the GCC, as well as for the larger metropolitan region, and has prepared this plan in collaboration with CMRL.

Currently, Chennai has around 37 public charging infrastructure at selected metro stations for electric vehicle charging, provided at a nominal service fee – set up and maintained by the CMRL using their own funds and service fee money .

The state has offered a road tax waiver on the purchase of electric vehicles. There is still a lot more than could be done to incentivize the transition away from fossil fuels and toward electric vehicles.

Key Gaps and Challenges

Of the total emissions from transport, 84 per cent are contributed by private transport modes, which are largely fossil fuel-based vehicles. The projections carried out in the Ambitious Scenario specifies that the strategies towards fuel shift and modal shift on NMT and public transportation will contribute to 12 per cent reduction in the year 2050. It shows that there is an urgent need to shift towards cleaner fuels and modal shift from private transport to public transportation. The major challenges identified for fuel shift and mode shift are as follows:

- **Upfront cost of electric vehicles:** Currently, 7 per cent of travel demand is met through four-wheeler vehicles, and about 25 per cent through two-wheeler vehicles. This number is projected to grow rapidly with the increase in household incomes and longer commute distances. Thus, more households are likely to be purchasing their first motor-vehicles in the coming years. Since EVs are several times more expensive than the entry-level combustion engine alternatives, adoption of electric mobility in private transport remains a challenge.
- **Last-mile connectivity of transport services:** Only about 25 per cent of the city has access to public transport within 400 m, and less than 5 per cent within 100 m. This, combined with the near-to-zero cost of parking for both two- and four-wheeler vehicles, renders public transport an inconvenient option for mobility for an average commuter. To address this, the network and level-of-service on bus routes must be increased considerably, to ensure that 100 per cent of the city area is accessible through public transit. Further, the level of service also needs to be expanded, to ensure that each public transport station has four to ten departures per hour. Routes need to be rationalised, so that 90 per cent of trips are possible within 45 minutes or with one mode/route change.
- **Access to footpaths and cycle tracks:** Currently, Chennai has limited dedicated cycling infrastructure, and does not maintain records or metrics of coverage of footpaths. This is reflected by the fact that only 3 per cent of the mobility demand in the city is met by cycles. While the Comprehensive Mobility Plan acknowledges the importance of cycling to sustainable mobility for the city, more radical proposals are needed to make cycling a safe and efficient choice for the majority of road users.
- **Cost of metro travel and subsidies to bus service:** The two primary public services for intra-city travel are the bus service and the metro rail. The bus service is heavily subsidized for all travellers, and completely free for many groups including women and students. The average round trip cost of the bus service is Rs 10-20, while the average round trip cost of metro travel is more than Rs 70. The metro is also not perceived as an end-to-end solution; anecdotal reports

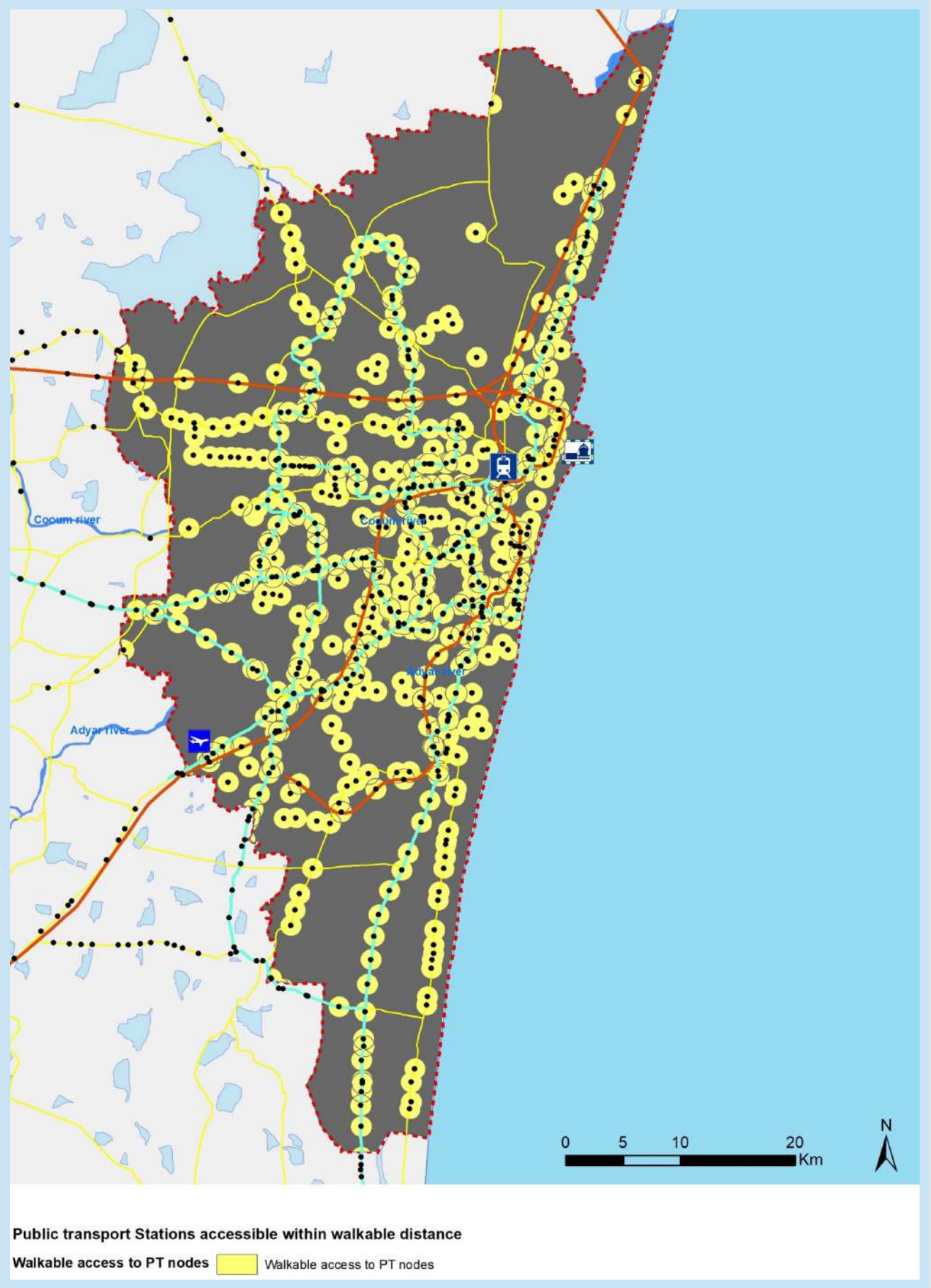


Figure 62: Public transport stations accessible within walkable distance of 400 metres

suggest that users have to take a different mode at the last mile for most trips. More mechanisms are needed to effectively target these subsidies and to ensure that the projected mode shift martializes.

- **Lack of integrated payment modes and way-finding tools**: The public transit services of the city lack an integrated and connected universal mode of payment. While it is possible to buy e-tickets through an app for the metro service, the same is not available for the bus service. There is also no app or unified route map that can navigate across transit modes or provide real-time information on bus and metro timings. Making these tools available is essential for improving the experience of public transit users, which, in turn, will drive adoption.
- **Institutional fragmentation in the transportation sector**: The various public transit services in the city of Chennai are fragmented across different levels of governance. None of the three primary services reports to the city government. Even at the state level, while the metro rail reports to the Urban Development Department, the bus service is managed by the Transport Department. There is also fragmentation between service operations and the required planning and management of urban spaces for supporting these operations. The division of powers between the Chennai Metropolitan Development Authority (CMDA) and the GCC adds to this already complex institutional dynamic.

Ongoing Initiatives

The effort of decarbonizing and making transit more sustainable is supported by actions at the national and state levels. One of the biggest opportunities identified by the national government is the blending of biofuels (ethanol) into petrol and diesel. Blending mandates in India has increased the demand of ethanol as a fuel in the last decade.[93] All fuel providers have achieved 10 per cent blending of ethanol in petrol ahead of schedule. The demand projection of fuel ethanol shows that the requirement of ethanol for blending will rise to double than the existing capacity.[94] This blending directly reduces emissions by 50 per cent for two-wheeler vehicles (2W) and 30 per cent for four-wheeler vehicles (4W).[95]

The state government has an ambitious plan in place to further expand public transport services and enable multi-modal connectivity for citizens. At the state level, the GoTN has also offered a road tax waiver on the purchase of electric vehicles (EVs). Going forward, more people will need to choose public transportation, cycling, or walking in future, to reduce the reliance on private 2W and 4W. To this end, the Chennai Mobility Plan and the State Transportation Policy lay out several infrastructure projects aimed at increasing the coverage and quality of mass transit services throughout the city.

The city has also implemented several street improvements projects with pedestrian and cycling friendly features across the city in close collaboration with international and local NGOs. The city's comprehensive mobility plan addresses these barriers through a mix of initiatives:

1. Holistic planning of road networks for the metropolitan region to create additional connections and relieve traffic
2. Developing cycling and pedestrian friendly streets on selected roads
3. Development of off-street parking facilities
4. Development of additional metro rail lines to increase coverage of transit services.

The CMDA is responsible for long-term strategies and planning of transportation in Chennai, which includes planning for transportation network, major public transport corridors.

Furthermore, with an intention to bring together all the agencies working in the transport sector together in Chennai, Chennai Unified Metropolitan Transport Authority (CUMTA) has been formed as the nodal department under the chairmanship of the Hon' CM of Tamil Nadu. CUMTA was set up with the vision to ensure every citizen of Chennai has the right to the city by providing a seamless and sustainable urban mobility framework and services across bus, metro, rail, walking and cycling. CUMTA

93 Roadmap for Ethanol Blending in India 2020-25, Report of the Expert Committee, NITI Aayog, Ministry of Petroleum and Natural Gas, June 2021

94 As per Roadmap for Ethanol Blending in India 2020-25, current (year 2021-22) ethanol demand is 437 crore litres and projection for year 2025-26 is 1016 crore litres, which is subject to penetration of EVs and penetration of E100 two wheelers.

95 As per impact assessment of usage of E20 fuels compared to neat gasoline as mentioned in Roadmap for Ethanol Blending in India 2020-25, Report of the Expert Committee, NITI Aayog, Ministry of Petroleum and Natural Gas, June 2021

will play a strategic role in promoting, overseeing, coordinating and monitoring the implementation of the actions identified under the Transport sector of the CCAP.

Sectoral vision for Transport in Chennai

Based on the findings from the gap analysis and mapping of the initiatives taken by the state government and the GCC through strategic appraisals, the challenges and requirements for the transport sector were identified. The projections of GHG emissions for the Ambitious Scenario, and the consultations with government and institutional stakeholders, helped to identify and prioritize actions and frame the sectoral vision – **"Moving towards Sustainable Mobility"**.

In order to realize the sectoral vision and reduce emissions from transportation sector, the following objectives and the key actions are given in the Table 12 along with the timeline, responsible stakeholders, monitoring indicators, alignment with plans, wider benefits, possible funding source and targets as follows:

Objective 1: Fuel shift to less polluting energy sources through shifting vehicles away from fossil fuels to renewable sources

- Incentivize electrification of private vehicles (with special focus on 2 wheelers and 3 wheelers) to achieve 100 per cent electrification by 2050.
- Support the electrification of MTC Bus Service to reach 100 per cent Electrification of city bus routes by 2040.
- Develop a Level-3 Electric charging stations for every 50 parking units within GCC.
- Enable intermediate charging points for electric bus.
- Increase ethanol blending in petrol and diesel to 30 per cent and 20 per cent, respectively.

Objective 2: 80 per cent of all trips by walking, cycling, or public transit through mode shift towards more efficient modes

- Decrease urban block size to increase walkability.
- Improve pedestrian access and road design around bus stops.
- Increase intermodal connectivity, coverage, and frequency of public transportation services.
- Identify and develop Bicycle Highways, exclusive to NMT users.

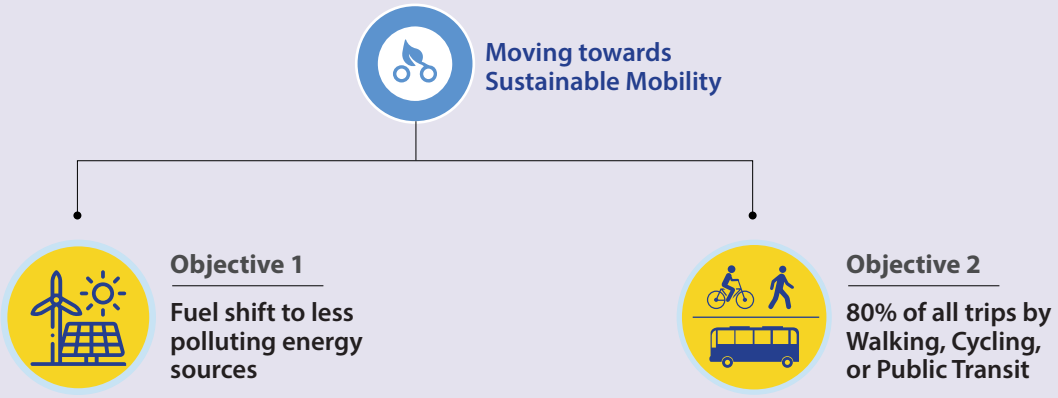


Figure 63: Sectoral vision for Transport

Proposed Actions Identified for Transport

Table 12 Proposed Actions Identified for Transport

Objective # 1

Fuel Shift to Less Polluting Energy Sources

Targets	2030	2040	2050
	3% Electrification of passenger automobiles	10% Electrification of passenger automobiles	20% Electrification of passenger automobiles
	15% Electrification of MTC bus fleet	50% Electrification of MTC bus fleet	100% Electrification of MTC bus fleet

The following action areas have been identified to deliver the City's targets:

1. Enable intermediate charging points for electric buses.
2. Incentivize electrification of private vehicles to achieve 100 per cent electrification by 2050.
3. Support the electrification of MTC bus service to reach 100 per cent electrification of city bus routes by 2040.
4. Develop a Level-3 electric charging stations for every 50 parking units within GCC.
5. Increase ethanol blending in petrol and diesel to 30 per cent and 20 per cent, respectively.

Action 1 — Enable intermediate charging points for electric buses.

Time Frame: Short Term (2022–30)

Sub Actions:

- Identify nodes to set-up the intermediate charging stations for the bus fleet by considering the bus routes.

Stakeholders

Lead Role:
- MTC

Supporting Role:
- CMDA
- GCC

Monitoring Indicator

- Number of MTC routes with at-least 1 L2 or better charging/fast charging station suitable for public buses within 500m of the route.

Objective # 1

Fuel Shift to Less Polluting Energy Sources

Action 1 *contd* | **Enable intermediate charging points for electric buses.**

Alignment with SDGs/ Plans	• State Energy Plan • Chennai Comprehensive Mobility Plan • SDG 7 – Affordable and Clean Energy
Wider Benefits	• Increased hours of service for bus routes • Revenue by allowing car charging during off peak times
Possible Funding/ Financing Source	• National programmes i.e., FAME • Existing infrastructure funding for bus electrification • Advertisement rights-based revenue generation

Action 2 | Incentivize electrification of private vehicles to achieve 100 per cent electrification by 2050.

Time Frame: Long Term (2040–50)

Sub Actions:

- **State level action:** Introduce tax incentives on the purchase of EVs (with special focus on 2-wheelers and 3-wheelers) in the short term to make them attractive as a choice for a household's first vehicle purchase.
- **Local level action:** Provide dedicated parking slots for electric vehicles in public places, as well as reduced parking charges.

Stakeholders	**Lead Role:** • Department of Transport **Supporting Role:** • CMDA • GCC
Monitoring Indicator	• Percentage of private vehicle sales that are Evs in each fiscal quarter
Alignment with SDGs/ Plans	• State Energy Plan • Chennai Comprehensive Mobility Plan • SDG 7: Affordable and Clean Energy • SDG 3: Good Health & Well-being
Wider Benefits	• Reduction in electric private vehicle costs of ownership – leading to more households purchasing their first vehicle. • Improved air quality
Possible Funding/ Financing Source	• Funding from Department of Transport

Objective #1

Fuel Shift to Less Polluting Energy Sources

Action 3: Support the electrification of MTC bus service to reach 100 per cent electrification of city bus routes by 2040.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Develop a comprehensive Bus Service Strategy for MTC services in Chennai, including a "electrification plan" for the services.
- Identify routes within the city where electrification of the route is viable under current circumstances.
- Identify potential sites for intermediate charging stations which can make additional routes viable for electric buses.
- Advocate for electrification of buses on routes near public buildings, gardens, and monuments, to improve street experience and overall public health.
- Target 15 per cent of all bus routes in GCC jurisdiction to be electrified.
- Develop a road condition index for prioritization of maintenance in GCC. GCC and MTC to agree on a road condition benchmark for major bus routes. GCC can leverage a share in advertising revenue from bus stops to fund maintenance on this route.

Stakeholders

Lead role:
- MTC

Supportive role:
- GCC

Monitoring Indicator

- Number of electric buses assigned by MTC on routes in Chennai
- Change in ridership on routes where electric buses are being used
- Change in air quality along bus routes

Alignment with SDGs/ Plans

- State Energy Plan
- Chennai Comprehensive Mobility Plan
- SDG 7: Affordable and Clean Energy
- SDG 3: Good Health & Well-being

Wider Benefits

- Reduction in operational costs of service, which also benefits citizens
- Decrease in emissions associated with transportation
- Reduction in noise pollution
- Improvement in air quality
- Improved public health
- Increased energy resilience
- Environmental benefit and health benefits due to improved air quality

Possible Funding/ Financing Source

- National programmes i.e., FAME
- MTC
- Department of Transport

Objective #1

Fuel Shift to Less Polluting Energy Sources

Action 4 | Develop a Level-3 electric charging stations for every 50 parking units within GCC.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Amend GDCR, to require project with more parking units to incorporate charging stations with L3 level services.
- Introduce norms for development of public EV charging station
- Prepare guidelines for electricity and parking charges, can be issued by GCC/CMDA
- Incorporate the requirements under the parking policy and as part of the BU permission process.

Stakeholders

Lead Role:
- CMDA

Supporting Role:
- GCC
- CUMTA

Monitoring Indicator

- Total Number of L3 chargers available in city.
- Area of the city within 500m of a public L3 charging point.

Alignment with SDGs/ Plans

- State Energy Plan
- Chennai Comprehensive Mobility Plan
- SDG 7: Affordable and Clean Energy
- SDG 3: Good Health & Well-being

Wider Benefits

- Environmental benefit and health benefits due to improved air quality

Possible Funding/ Financing Source

- National programmes i.e., FAME
- Land allocations as equity investments in charging stations,
- Private sector investments
- Advertisement rights-based revenue generation

Action 5 | Increase ethanol blending in petrol and diesel to 30 per cent and 20 per cent, respectively.

Time Frame: Medium Term (2030–40)

Stakeholders

Lead Role:
- Ministry of Petroleum and Natural Gas

Supporting Role:
- Oil and Gas companies (IOCL etc.)
- Ministry of Transport

Objective #1

Fuel Shift to Less Polluting Energy Sources

Action 5 *contd*

Increase ethanol blending in petrol and diesel to 30 per cent and 20 per cent, respectively.

Monitoring Indicator	• Percentage of fuel blending at source achieved by oil companies
Alignment with SDGs/ Plans	• State Energy Plan • Chennai Comprehensive Mobility Plan • SDG 7 – Affordable and Clean Energy • Ethanol Blending Programme (EBP), GoI
Wider Benefits	• Improved Air Quality • Boost to agricultural economy and farmer's income • Reduced dependency on crude oil imports
Possible Funding/ Financing Source	• National infrastructure funding

Objective #2

80 per cent of all trips by Walking, Cycling or Public Transit

Targets

2030	2040	2050
61% mode share for public transport and NMT	67% mode share for public transport and NMT	80% mode share for public transport and NMT

The following action areas have been identified to deliver the City's targets:

1. Decrease urban block size to increase walkability.
2. Improve pedestrian access and road design around bus stops.
3. Improve intermodal connectivity, coverage, and frequency of public transportation services.
4. Increase women ridership by providing women-only electric buses and subsidized tickets to women passengers.

   Increase differently abled ridership by providing differently abled-only electric buses and subsidized tickets to women passengers.
5. Identify and develop Bicycle Highways exclusive to NMT users.

Objective #2

80 per cent of all trips by Walking, Cycling or Public Transit

Action 1 — Decrease urban block size to increase walkability.

Time Frame: Short Term (2022–30)

Sub Actions:

- Implement TOZ policy through upcoming master plans of CMDA.
- Create pedestrian and cyclist access by creating public accesses and routes through large projects is important for pedestrian access.

Stakeholders

Lead Role:
- CMDA

Supporting Role:
- GCC

Monitoring Indicator

- Percentage of population within 400m walk of public transportation option (e.g., bus, metro, light rail)
- Average block area and perimeter based on pedestrian routes

Alignment with SDGs/ Plans

- Chennai Metropolitan Masterplan
- Chennai Comprehensive Mobility Plan
- SDG 7 – Affordable and Clean Energy
- SDG 10 — Reduced Inequalities

Wider Benefits

- Equitable, affordable, safe, and accessible mobility for all including women, children and elderly

Possible Funding/ Financing Source

- National programmes i.e., SMART, AMRUT
- Fundings from Finance Commission

Action 2 — Improve pedestrian access and road design around bus stops.

Time Frame: Short Term (2022–30)

Sub Actions:

- Develop and implement a Street Design Guidelines and Maintenance Standard for all urban roads

Stakeholders

Lead Role:
- CUMTA

Supporting Role:
- Town Planning Dept., GCC
- MTC
- CMDA

Objective #2

80 per cent of all trips by Walking, Cycling or Public Transit

Action 2 *contd* | Improve pedestrian access and road design around bus stops.

- Conduct capacity building programmes for ULB officials to orient them about street design guidelines and maintenance standards.
- Integrate road design standards to guide bus-stop placement, location relative to sidewalk, and access and street infrastructure around the stop.

Monitoring Indicator

- Percentage of total street length in city with walkable street design
- Percentage increase in trips by Walk and Bicycle

Alignment with SDGs/ Plans

- Chennai Metropolitan Masterplan
- Chennai Comprehensive Mobility Plan
- SDG 7 – Affordable and Clean Energy
- SDG 10 — Reduced Inequalities

Wider Benefits

- Increase in active mobility contribute to public health, improvement in air quality, decrease in mobility and economic activity

Possible Funding/ Financing Source

- State grants/ municipal bonds
- Development charges

Action 3 | Improve intermodal connectivity, coverage, and frequency of public transportation services.

Time Frame

Short Term (2022–30)

Sub Actions:

- Develop a detailed set of service level benchmarks for public transportation level of service in Chennai – revolving around accessibility, frequency, punctuality, and user experience.
- Identify routes where level of service is below benchmark levels and prioritization of service improvements in these areas.

Stakeholders

Lead Role:
- CSCL

Supporting Role:
- CMRL
- MTC
- MRTC
- CUMTA

Monitoring Indicator

- Number of public transit users in Chennai
- Average distance to nearest public transit stops from all points in the city

Objective #2

80 per cent of all trips by Walking, Cycling or Public Transit

Action 3 *contd*

Improve intermodal connectivity, coverage, and frequency of public transportation services.

- Create an open-access API to track and publish information on public transit services.
- Develop an integrated and connected universal mode of payment to access all modes of public transport, i.e., Oyster card on London, Octopus card in Hong Kong, OV-chipkaart in Amsterdam.

Alignment with SDGs/ Plans

- Chennai Comprehensive Mobility Plan
- SDG 7 – Affordable and Clean Energy

Wider Benefits

- Increase in productivity for passengers and services dependent on public transit
- Improved quality of service, improved ridership for public transportation services
- Increased opportunities for non-fare revenue development for bus service
- Increased access to affordable transport services for urban poor

Possible Funding/ Financing Source

- National fundings under Smart cities Mission
- Open public data paired with a paid API for businesses that gives access to more information

Action 4

Increase women ridership by providing women-only electric buses and subsidized tickets to women passengers.

Increase differently abled ridership by providing differently abled-only electric buses and subsidized tickets to women passengers.

Time Frame

Short Term (2022–30)

Stakeholders

Lead Role:
- MTC

Supporting Role:
- CSCL

Monitoring Indicator

- Increased share of women PT users

Objective #2

80 per cent of all trips by Walking, Cycling or Public Transit

Action 4 *contd*

Increase women ridership by providing women-only electric buses and subsidized tickets to women passengers.

Increase differently abled ridership by providing differently abled-only electric buses and subsidized tickets to women passengers.

Alignment with SDGs/ Plans	• SDG 7 – Affordable and Clean Energy • SDG 10: Reduced Inequalities
Wider Benefits	• Inclusivity and Equity in mobility • Improved air quality
Possible Funding/ Financing Source	• National fundings under Smart cities Mission

Action 5 | Identify and develop Bicycle Highways exclusive to NMT users.

Time Frame: Short Term (2022–30)

Sub Actions:

- Conduct a study for LUTP integration to prioritize areas where bicycle ridership can be increased.
- Empanel agencies to develop required infrastructure as per the street design guidelines.

Stakeholders	**Lead Role:** • CMDA **Supporting Role:** • GCC • CUMTA
Monitoring Indicator	• Total area of the city within 400m of a dedicated NMT route
Alignment with SDGs/ Plans	• Chennai Metropolitan Masterplan • Chennai Comprehensive Mobility Plan • SDG 7 – Affordable and Clean Energy • SDG 10 — Reduced Inequalities
Wider Benefits	• Increase in active mobility contribute to public health, decrease in mobility and economic activity • Improved air quality • Reduced noise pollution
Possible Funding/ Financing Source	• Infrastructure bonds

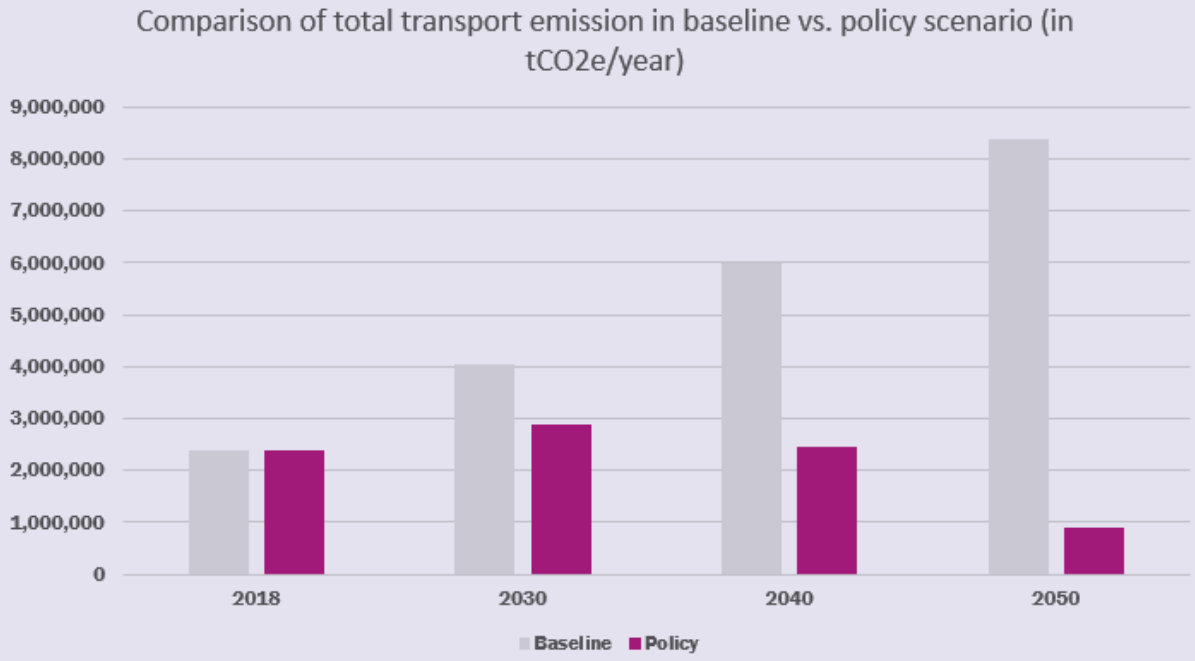


Figure 64: Change in Emissions from Transport Sector in the Ambitious Scenario

Impact on GHG Emission by Transport Sector

The Figure 64 shows the key priorities identified in the Transport Sector to scale up the net decrease in emissions.

Facilitating the adoption of EVs by transforming the entire bus fleet and private vehicles, and improving public transport and NMT infrastructure, can reduce the emissions from the sector significantly from 8-million-ton CO_2e/year to 0.9-million-ton CO_2e/year. The Ambitious Actions identified for the transport sector will contribute to 13.1 per cent of the city's total GHG emission reduction by 2050.

6.2.4 Waste Management

The Solid Waste Management (SWM) sector alone contributes to 13 per cent of Chennai's overall greenhouse gas emissions based on the GHG inventory of 2018–19.

SWM is monitored by the Deputy Commissioner (Health) and the GCC. As per the data provided by SWM Department (GCC), the city generates around 5,461 tons per day (per capita waste generation of 643 gm), whereas the waste collection is around 5,100 tons per day. Like most Indian cities, the Percentage of wet waste in the entire solid waste is high; 45 per cent of the domestic waste is biodegradable waste, while about 38 per cent is dry waste and 17 per cent is construction and demolition waste. Figure 65 shows the existing scenario across the solid waste value chain.

The GCC undertakes door-to-door waste collection in partnership with private agencies. It collects 100 per cent of the entire waste generated from all its 15 zones. However, segregation levels at the source are low. Only about 45 per cent of all waste generated is segregated at the household level. Around 93 per cent of the waste collected is

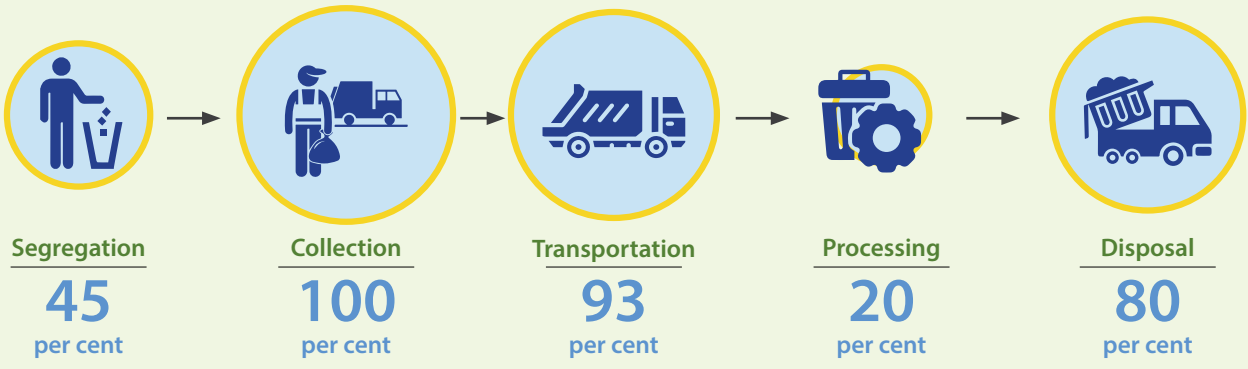


Figure 65: Insights from SWM Value Chain in Chennai

transported to processing units and to dumpsites, while the remaining is recycled through the informal network of waste recyclers.

Currently, the responsibility of collection and transportation is carried out by four concessionaires, in different zones as follows:

Only 20 per cent of all waste collected is processed at various processing facilities, while 80 per cent of unsegregated waste is directly dumped at the Kodungaiyur and Perungudi dumpsites.

The current wet waste processing facilities include micro-composting centres, vermi-composting, biogas, bio CNG plants, windrow compost, coconut, and garden waste processing plants. Together, they have a processing capacity of 1,422 TPD, out of which only 490 TPD gets utilised. The dry waste processing includes Material Recovery Facilities (MRF), Resource Recovery Centres (RRC), plastic bailing units, and incineration plants.[96] These, put together, have the capacity to process 1,038 TPD, but currently, only 147 tons of dry waste is being processed daily.

The Service Level Benchmarks (SLB) for the year 2020-21 also highlight the need to focus on source-level segregation and processing of waste.

Table 13 Details of Quantity of Waste Collection and Transportation in Chennai

Sr. No.	Zones	Quantity of Waste Collected	Quantity of Waste Transported to Processing Facility	Quantity of Waste Transported to Dumpsite
1.	Zone 1, 2, 3	2445 TPD	445 TPD	2000 TPD
2.	Zone 4, 5, 6, 7, 8	300 TPD	160 TPD	140 TPD
3.	Zone 9, 10, 13	1542 TPD	342 TPD	1200 TPD
4.	Zone 11, 12, 14, 15	923 TPD	95 TPD	828 TPD
	Total	5210 TPD	1042 TPD	4167 TPD

Figure 66: Service-Level Benchmark Performance of Solid Waste in Chennai, 2021

96 City Action Plan, SWM Department

The city does not levy a separate SWM user charge, and this is collected as part of the unified property tax bill. However, with plans of augmenting SWM services, the city needs to think of strategies towards meeting revenue expenditure of waste. Figure 66 shows the existing situation as of 2021 compared to the Service Level benchmarks.

Chennai ranked 43rd across the country in the annual Swachh Survekshan 2021. The city currently has not been able to achieve star rating under the Garbage Free Cities (GFC) protocol of the Ministry of Housing and Urban Affairs.

To ensure concerted actions towards improving waste management, Chennai has prepared a City Solid Waste Action Plan and City Sanitation Action Plan in 2021. The City Solid Waste Action Plan has proposed augmentation of waste processing capacity in the city and recommended various projects such as waste, energy, and bio mining.[97]

Figure 67 shows the planned methods for processing the total waste generated by the GCC. This includes plans for waste processing through material recovery, micro-composting, incineration, scientific landfill, etc.[98]

Carbon Emissions Contribution by Solid Waste

As compared to GHG inventory 2015-16, there is no change in the amount of emission by solid waste sector. Currently, SWM contributes to about 1.7 million tCO2e carbon emissions per year. The GHG emission calculations show that of this, 91 per cent is attributable to open dumping of waste.

Considering the population growth, if the current trends of waste collection, processing, and dumping continue in a BAU Scenario, the carbon emissions are likely to increase to 4,351,546 tCo2e/year by the year 2050. However, by making concerted actions in augmenting waste processing, which is also linked to an efficient source-segregation system, the overall carbon emission is projected to be reduced to 2,047,290 tCo2e/year till 2050.

The GCC aims to achieve "zero waste to dumpsite",[99] i.e., with bioremediation of the legacy waste and their closure, close to zero waste will be sent to dumpsites. This will ensure 100 per cent processing of waste generated, while promoting reuse, recycle, and reduction of the waste.

In order to achieve this vision, Chennai needs to establish systems for 100 per cent source segregation,

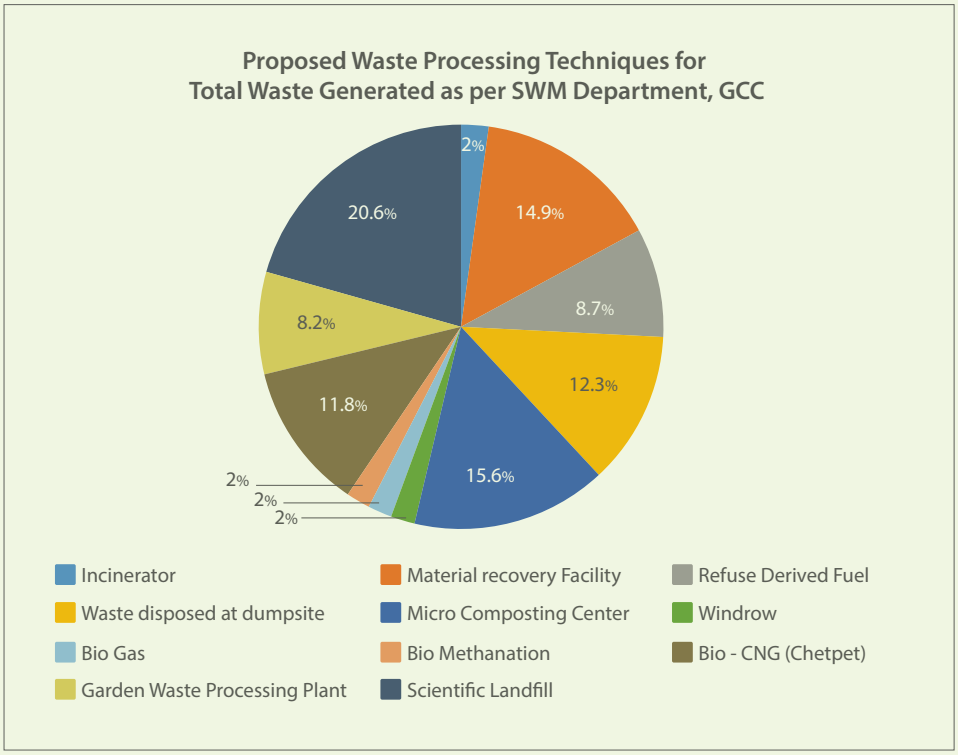


Figure 67: Proposed Waste Processing Techniques for Total Waste Generated as per SWM Department, GCC

97 City Action Plan. SWM Department. 2021.

98 SWM Department, GCC

99 Based on stakeholder consultation with SWM Dpt. GCC, 8th June,2022

have adequate processing capacities for different types of waste, and ensure the scientific closure of existing dumpsites Perungudi and Kodungaiyur.

Key Gaps & Challenges

- **Low rates of source segregation**: Only 45 per cent of waste segregation is done overall. Segregation at source, which is most critical to ensure efficient waste processing, stands at 41 per cent as per city action plan, 2021.
- **Defaults in transporting waste to processing facilities**: The GCC follows a performance-based model for SWM, where a concessionaire is supposed to provide entire collection, transportation, and cleanliness for the city, including priority services, special services, and citizen complaints. The payment will be linked to a set of key performance indicators set by the GCC. One of these KPIs include an indicator on the amount of waste transported to the designation location. However, it does not mention that the designated location must be a "waste processing facility". Consequently, out of 5,210 TPD of total waste collected, only 1,042 TPD gets transported to processing facilities. There is an urgent need to ensure collected waste is transferred to the processing facilities instead of dumpsites.
- **Inadequate processing capacity as well as low utilisation capacity:** Only 20 per cent of the city's waste is processed/recycled; the rest 80 per cent goes to dumpsites. Chennai has a current total processing capacity of 2,460 TPD, out of which 1,422 TPD is for wet waste and 1,038 is for dry waste. However, only about 26 per cent of this capacity is being fully utilised. The reasons for this are a gap in segregation, inefficiency of collection, etc. Chennai needs to not only augment its current capacity, but also ensure that the existing capacity is fully utilised.
- **Segregated bulk waste collection:** 11 zones out of 15 are contractually bound to collect bulk waste from the bulk waste generators,

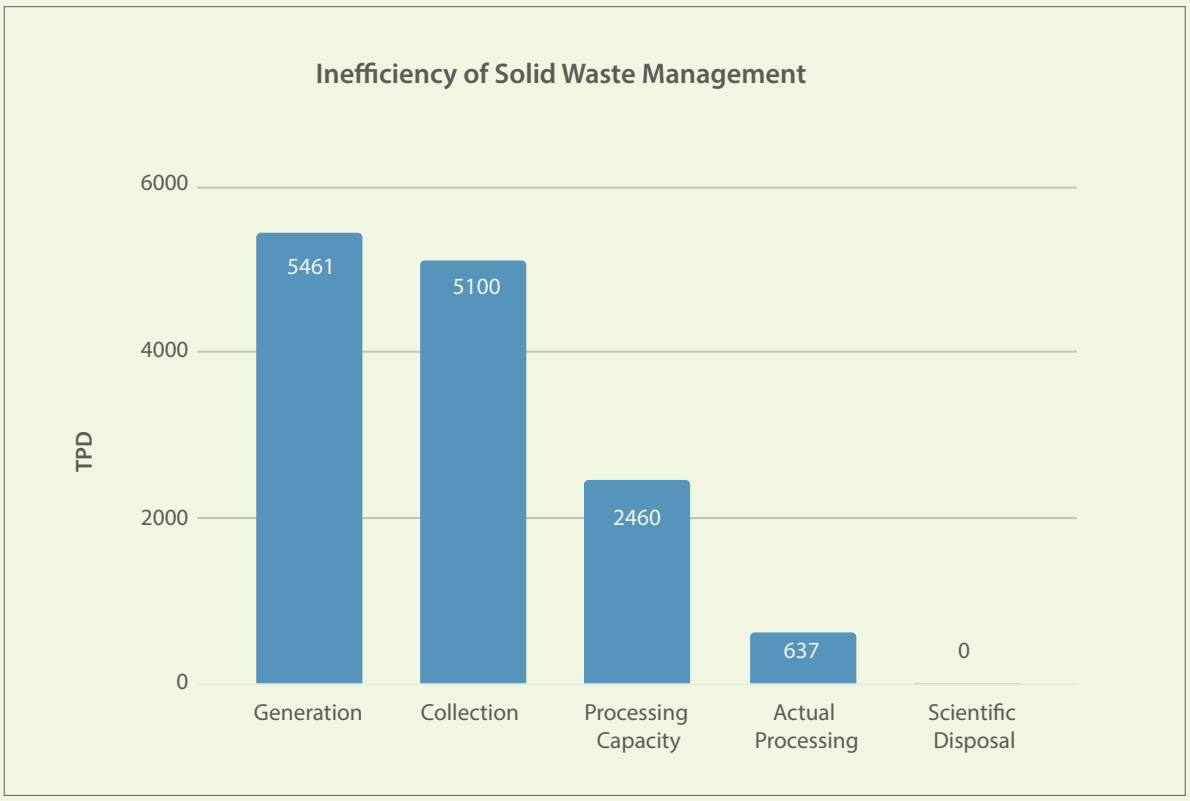


Figure 68: Inefficiency of Solid Waste Management in Chennai

and this collected waste is then given to either private waste processors, deposited at decentralised waste processing units, or disposed of at the dumping sites. The key challenge is to ensure the implementation of on-site waste processing as per SWM by-laws.

- **Management of legacy waste**: The city has two active dumpsites, Perungudi and Kodungaiyur. Due to the lack of processing capacities, about 80 per cent of all waste generated gets dumped at the dumpsites. These two dumpsites have a legacy waste of almost 94 Cu.mt (64 lakh cu.mt in Kodungaiyur and 30 lakh cu.mt in Perungudi), contributing heavily to GHG emissions. Due to the presence of the legacy waste, one of the major challenges faced is

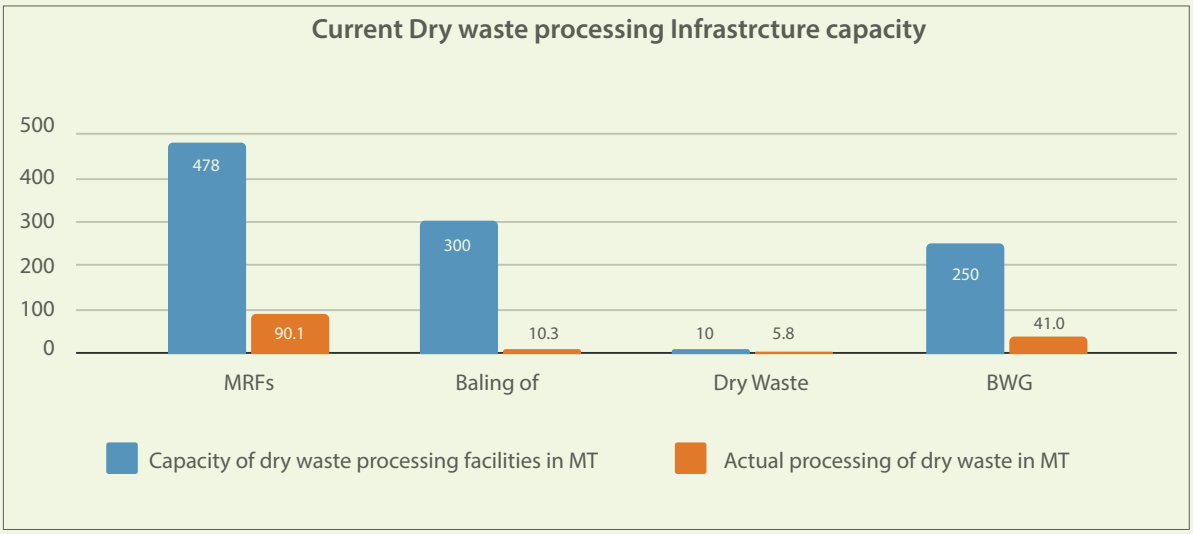


Figure 69: Current dry waste processing facilities v/s actual processing (2021)

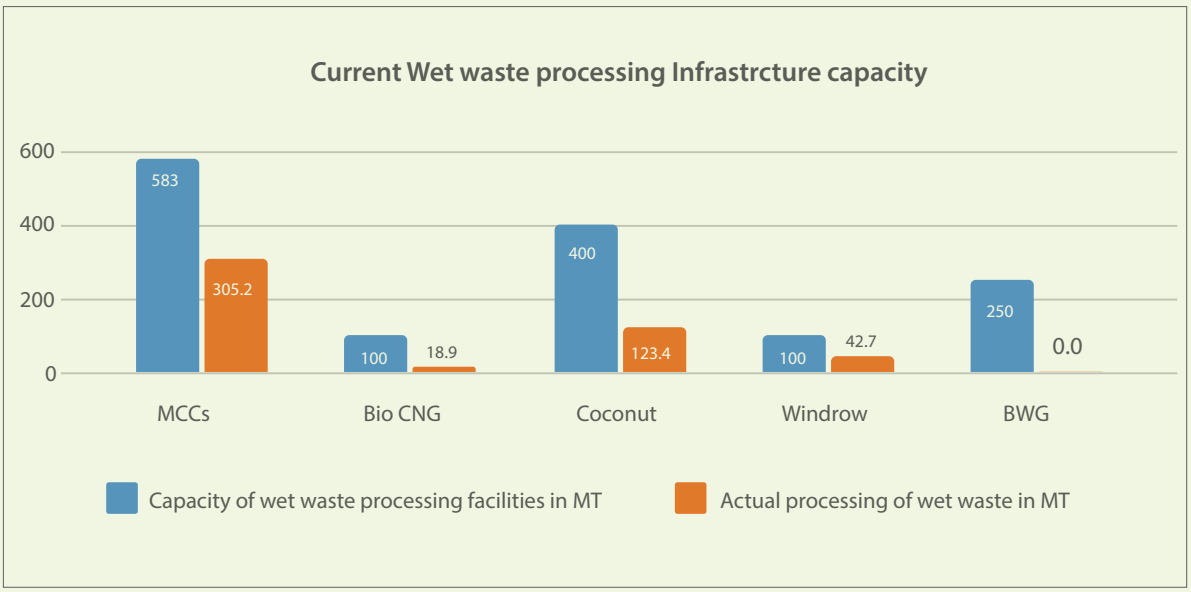


Figure 70: Current wet waste processing facilities v/s actual processing (2021)

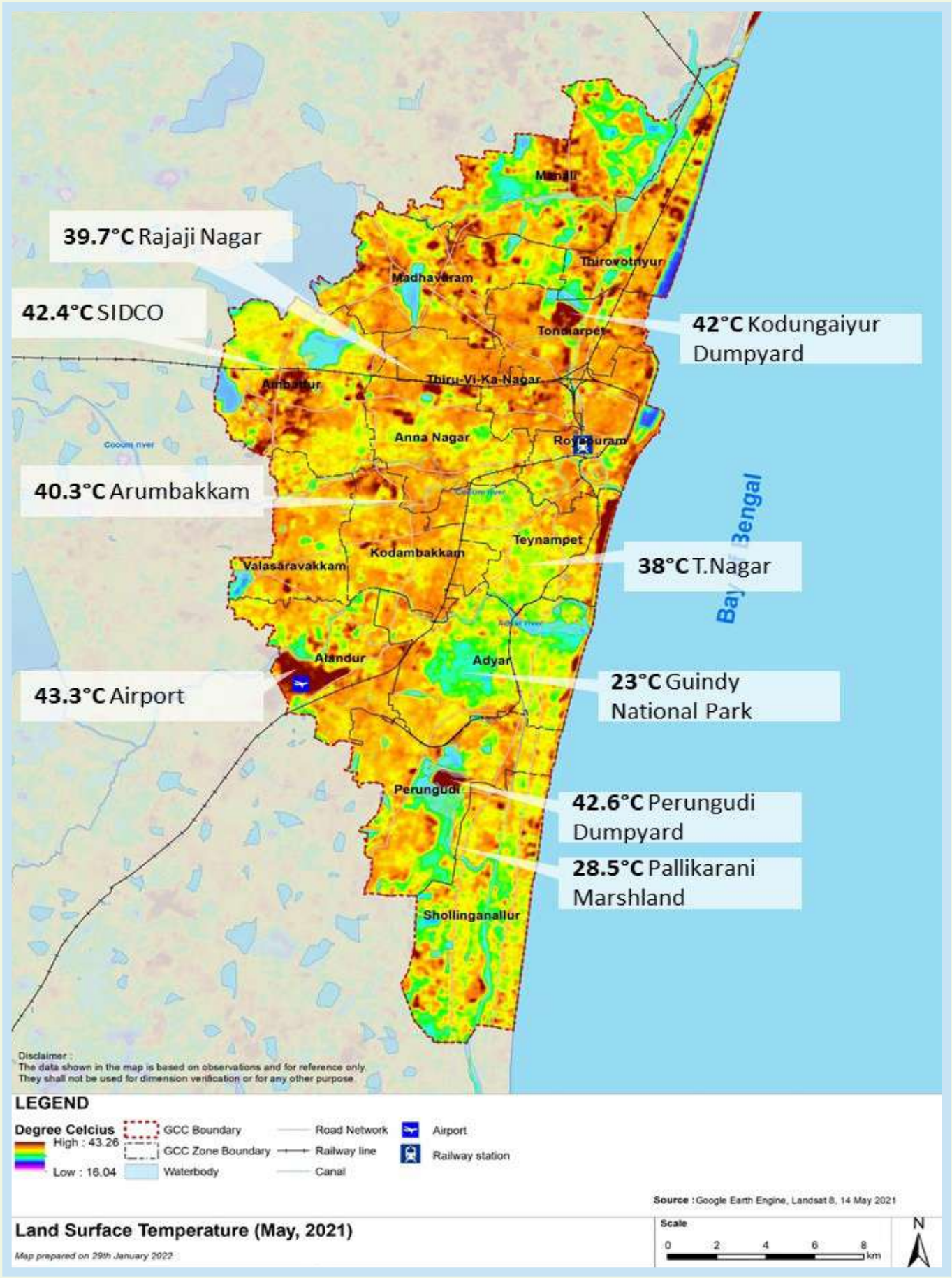


Figure 71: Land Surface Temperature Map Showing Comparatively Higher Temperatures around Dumping Sites

the localised rise in temperature. Figure 71 shows an increase in temperatures in the areas near the dumpsite. The city is yet to set up an operational scientific landfill site.

- **Lack of citizen engagement**: Efficient solid waste management requires a high Percentage of segregation at source as well as decentralising processing at household and sub-ward levels. This ensures reduced transportation of waste to centralised processing facilities, and hence, reduced GHG emissions. A high degree of engagement from citizens is essential to achieve this. Currently, IEC for promoting source segregation, encouraging home composting, and advocating clean and healthy sanitation practices among the citizens are being carried out.
- **Weak enforcement of efficient waste management across the value chain:** Chennai had developed solid waste management by-laws in 2016; however, the implementation of these by-laws must be monitored regularly, along with incentivizing the segregation at source through penalties, property tax, appreciation at community level, etc.

Ongoing Initiatives

There are various initiatives proposed by the GCC that present opportunities towards reducing carbon emissions and building a climate resilient system. Based on consultations with the SWM team of the GCC, and by aligning with the City Solid Waste Action Plan for 2021–26, these are some of the initiatives proposed by GCC:

- Setting up of six 100 MT/day Bio-CNG (compressed biogas) plants at various locations for wet waste processing
- Capacity addition for dry waste processing by establishing material recovery facility
- Co-processing by way of sending bulk dry waste to Dalmia Cement
- Processing of dry waste by establishing incinerators.
- 700 TPD of wet waste processing facility through windrow composting of 400 TPD from Kodungaiyur dumpsite and 300 TPD from Perungudi dumpsite
- Material Recovery Facility of 1000 TPD.
- Bio-mining of 64 lakh cu.mt from Kodungaiyur dumpsite

Sectoral Vision for Waste Management in Chennai

The GCC's vision in the SWM sector is to achieve zero waste to reach the dumpsite. The sectoral vision identified is –– **"Efficient, Effective, and Resilient Waste Management System".**

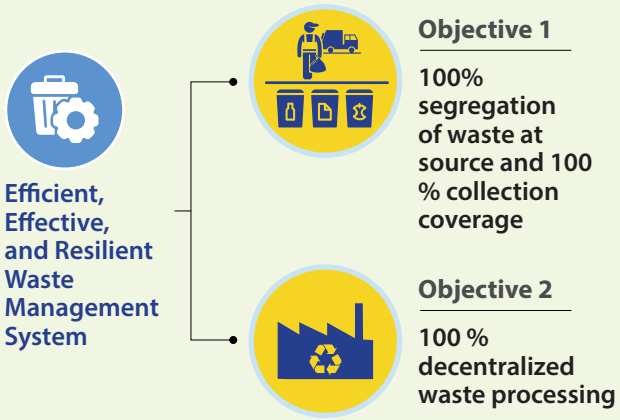


Figure 72: Sectoral Vision for Waste Management

In order to realize this vision and reduce emissions from waste sector, the following objectives and the key actions are given in the Table 14 along with the timeline, responsible stakeholders, monitoring indicators, alignment with plans, wider benefits, possible funding source and targets as follows:

Objective 1: 100 per cent segregation of waste at source and 100 per cent collection coverage:

- Identify gaps in door-to-door collection.
- Change user behaviour and support home composting by incentivizing waste reduction and source segregation at home.
- Establish demonstration wards to promote the implementation of garbage-free, plastic-free habitats.
- Monitor the implementation of SWM by-laws.

Objective 2: 100 per cent decentralised waste processing

- Conduct assessment to identify the challenge in utilising existing processing capacity.
- Ensure the processing units are not in flood risk zones.
- Augment processing capacity to meet 100 per cent capacity of waste processing, by setting up various waste processing units (decentralised).
- Build a system to monitor the collection

of segregated waste from bulk waste generators (BWGs). All BWGs should be encouraged to set up on-site waste processing units.
- Ensure dedicated space for secondary storage for solid waste generated in buildings, through GDCR.
- Monitor remediation of legacy waste and setting up of scientific landfill for inert waste.

Proposed Actions Identified for Waste

Table 14 Proposed Actions Identified for Waste

Objective #1

100% segregation of waste at source and 100 % collection coverage

Targets

2030	2040	2050
80% of segregated waste collected at source	80% of segregated waste collected at source	100% of segregated waste collected at source
80% of waste collected and transported for processing	80% of waste collected and transported for processing	100% of waste collected and transported for processing

The following action areas have been identified to deliver the City's targets:

1. Identify gaps in door-to-door collection.
2. Change user behaviour and support home composting by incentivizing waste reduction and source segregation at home.
3. Establish demonstration wards to promote the implementation of garbage-free, plastic-free habitats.
4. Monitor implementation of SWM by-laws.

Action 1 | **Identify gaps in door-to-door collection.**

Time Frame: Short Term (2022–25)

Sub Actions:

- Address the shortfall in the number of waste-collecting vehicles as per requirement by assessing the requirement and actual number.
- Ensure city-wide collection structure for different types

Stakeholders

Lead Role:
- SWM Department, GCC

Monitoring Indicator

- 100 per cent waste collection
- Route rationalisation of collection vehicles in place

Objective #1

100% segregation of waste at source and 100 % collection coverage

Action 1 *contd* | Identify gaps in door-to-door collection.

of waste, specific bins for segregated waste.

- Conduct route rationalization of the collection system to reduce fuel consumption of transportation and GPS enabled collection vehicle to enhance efficiency in collection.
- Provide revised contracts for collection of waste, with measurable performance parameters such as amount of waste to be collected per day.
- Ensure competition between agencies to maintain performance in door-to-door waste collection & segregation, through revising contracts.

Alignment with SDGs/ Plans
- SWM bye-laws, 2019
- City Action Plan
- SDG13: Climate Action

Wider Benefits
- Improved streets and neighbourhood, no dumpsites on roads
- Improved health
- Lower maintenance of storm water and sewer drainage systems
- Enhanced opportunities for livelihoods especially for waste pickers

Possible Funding/ Financing Source
- SBM –Urban
- GCC Budget-SWM dept.

Action 2 | Change user behaviour and support home composting by incentivizing waste reduction and source segregation at home.

Time Frame
Short Term (2022–25)

Sub Actions:

- Massive IEC campaigns on source segregation to be taken up for citizens to adopt this practice (such inter-personal outreach can be achieved by engaging SHG members)
- Establish regulatory framework for segregation along with conditions & mechanism to enforce implementation.

Stakeholders

Lead Role:
- SWM Dept. GCC

Supporting Role:
- NGOs
- NULM Cell

Monitoring Indicator
- Preparation of a Communication Strategy focusing on inter-personal messaging
- Amount of reduction in wet waste collected from households

Objective #1

100% segregation of waste at source and 100 % collection coverage

Action 2 *contd*

Change user behaviour and support home composting by incentivizing waste reduction and source segregation at home.

- Propose incentives for the households that are regularly segregating their waste and practicing home composting in property tax, or appreciation at community level segregation and composting. Rebates in municipal taxes/ user charges) or recognition (token of appreciation) of such practitioners at ward/city level.
- Encourage involvement of resident welfare association towards source segregation at community level, also the compost generated can be sold out.

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- SDG 3: Good Health and Well Being
- SDG 12: Responsible Consumption and Production
- SDG 14: Life below Water
- City Action Plan
- SWM Bye laws, 2019

Wider Benefits

- Enhanced livelihood opportunities in IEC and waste processing especially for SHGs
- Reduction in emissions for transportation of wet waste

Possible Funding/ Financing Source

- CSR
- ISR
- SBM-Urban

Action 3

Establish demonstration wards to promote the implementation of garbage-free, plastic-free habitats.

Time Frame

Short Term (2025–30)

Sub Actions:

- Set up one ward as a garbage-free and plastics-free ward in each zone.
- Enforce ban of single-use plastic.

Stakeholders

Lead Role:
- GCC

Supporting Role:
- Private Players
- NGOs

Monitoring Indicator

- Guidelines for establishing demonstration wards
- Amount of fines collected on defaulters of plastic waste ban

Objective #1

100% segregation of waste at source and 100 % collection coverage

Action 3 *contd*

Establish demonstration wards to promote the implementation of garbage-free, plastic-free habitats.

Alignment with SDGs/ Plans

- SDG 13:Climate Actions
- SDG 11:Sustainable Cities and Communities
- SDG 12:Responsible Consumption and Production
- SDG 15: Life on Land
- SDG 6: Clean water and Sanitation
- Swachh Survekshan indicator 1.4 (Plastic Ban)
- Plastic waste management rules, 2016

Wider Benefits

- Improved neighbourhoods and streets
- improved health
- Lower maintenance of storm water and sewer drainage systems

Possible Funding/ Financing Source

- GCC Budget- SWM Dept.

Action 4 — Monitor implementation of SWM by-laws.

Time Frame

Short Term (2025–30)

Sub Actions:

- The SWM by-laws of the GCC prepared in 2016 mandates levying of penalties for the generators who don't adhere to laws; BWGs; illegal dumping; waste burning; littering in canal banks and public places, etc. These must be monitored.

Stakeholders

Lead Role:

- GCC
- CDMA

Monitoring Indicator

- Reduction in household waste
- Percentage of manure produced at neighbourhood level.

Alignment with SDGs/ Plans

- SDG 11:Sustainable Cities and Communities
- City Action Plan
- Swachh Survekshan
- Master Plan,2026

Objective #1

100% segregation of waste at source and 100 % collection coverage

Action 4 *contd* | **Monitor implementation of SWM by-laws.**

Wider Benefits
- Improved air quality due to reduced garbage burning incidents

Possible Funding/ Financing Source
- SWM Department, GCC

Objective #2

100 per cent Decentralised Waste Processing

Targets	2030	2040	2050
	80% of paper recycled	80% of paper recycled	100% of paper recycled
	20% of plastic recycled	60% of plastic recycled	100% of plastic recycled
	60% of organic waste composted	67% of organic waste composted	70% of organic waste composted

The following action areas have been identified to deliver the City's targets:

1. Conduct assessment to identify challenges in utilising existing processing capacity.
2. Ensure the processing units are not located in flood risk zones.
3. Augment processing capacity to meet 100 per cent capacity of waste processing, by setting up various waste processing units (decentralised).
4. Encourage community-level engagement programmes.
5. Include provision in the GDCR for ensuring dedicated space for storage for solid waste generated in buildings.
6. Ensure remediation of legacy waste and setting up of scientific landfill for inert waste.

Objective #2

100 per cent Decentralised Waste Processing

7. Implement a monitoring system for collection of segregated waste from BWGs and installation of on-site waste processing units.

8. Install biogas capture systems at the wastewater treatment.

Action 1 | Conduct assessment to identify challenges in utilising existing processing capacity.

Time Frame: Short Term (2022–25)

Sub Action:

- Amend KPIs of concessionaires to include transportation of 100 per cent of waste collected to designated waste processing facilities.

Stakeholders	**Lead Role:** • SWM GCC **Supporting Role:** • Research institutions & technical agencies
Monitoring Indicator	• Percentage of utilisation of existing processing capacity • Percentage of waste reaching processing facility
Alignment with SDGs/ Plans	• SDG 11: Sustainable Cities and Communities • SDG 12: Responsible Consumption and Production
Wider Benefits	• Enhancing inclusivity by including research institutes, technical experts. (information access)
Possible Funding/ Financing Source	• GCC Budget- SWM Dept.

Objective #2

100 per cent Decentralised Waste Processing

Action 2: Ensure the processing units are not located in flood risk zones.

Time Frame: Short Term (2022–30)

Sub Actions:

- Undertake study to assess flood risk of existing facilities
- Ensure that waste processing is not affected during flood events. The proposed waste processing facilities should be sited in safe locations.

Stakeholders	**Lead Role:** • SWM Dept. GCC **Supporting Role:** • Disaster Management Cell, GCC
Monitoring Indicator	• No disruption in the processing of collected waste during flood events.
Alignment with SDGs/ Plans	• SDG 6:Clean water and Sanitation • SDG 13: Climate Actions
Wider Benefits	• Improving physical access to the city infrastructure, thus enhancing healthy environment
Possible Funding/ Financing Source	• SBM Fund • GCC Budget-SWM Dept

Action 3: Augment processing capacity to meet 100 per cent capacity of waste processing, by setting up various waste processing units (decentralised).

Time Frame: Short Term (2022–30)

Sub Actions:

- Study to assess gaps, identify locations at zonal/sub-zonal levels.

Stakeholders	**Lead Role:** • SWM Dept. GCC

Objective #2

100 per cent Decentralised Waste Processing

Action 3 *contd*

Augment processing capacity to meet 100 per cent capacity of waste processing, by setting up various waste processing units (decentralised).

- Ensure intensive IEC to promote composting at source (household), community (apartment/society/ neighbourhood/lane) level.
- Incentivize societies and households to set up composting units.

Monitoring Indicator
- Percentage of waste processed
- Percentage of societies / households composting at source

Alignment with SDGs/ Plans
- SDG 11: Sustainable Cities and Communities
- SDG 12: Responsible Consumption and Production
- Swachh Survekshan

Wider Benefits
- Reduced fuel consumption and improved air quality, noise pollution
- Enhanced livelihood opportunities in IEC and waste processing especially for SHGs and waste picker

Possible Funding/ Financing Source
- CSR
- Green Bonds
- SBM-Urban
- GCC Budget-SWM Dept.

Action 4 Encourage community-level engagement programmes.

Time Frame: Short Term (2025–30)

Sub Actions:

- Engage SHG members for creating awareness on waste segregation at source and adoption of composting technologies at society/ household level.

Stakeholders

Lead Role:
- GCC
- CDMA

Supporting Role:
- NGOs
- CSR

Monitoring Indicator
- No. of Self Help Groups engaged for IEC and composting adoption

Alignment with SDGs/ Plans
- SDG 12: Responsible Consumption and Production
- SDG 11: Sustainable Cities and Communities
- Swachh Survekshan

Objective #2

100 per cent Decentralised Waste Processing

Action 4 *contd* | **Encourage community-level engagement programmes.**

Wider Benefits	• Enhanced livelihood opportunities for SHGs of urban poor women and waste pickers in IEC and waste processing
Possible Funding/ Financing Source	• CSR • ISR • SBM fund

Action 5 | **Include provision in the GDCR for ensuring dedicated space for storage for solid waste generated in buildings.**

Time Frame Short Term (2025–30)

Stakeholders	**Lead Role:** • CMDA • SWM Dept.-GCC
Monitoring Indicator	• Inclusion of dedicated storage space for waste in building plan approval process.
Alignment with SDGs/ Plans	• SDG 6: Clean water and Sanitation
Wider Benefits	• Removal of encroachments from footpaths and streets, hence improved walkability
Possible Funding/ Financing Source	• Not required

Objective #2

100 per cent Decentralised Waste Processing

Action 6

Ensure remediation of legacy waste and setting up of scientific landfill for inert waste.

Time Frame: Short Term (2025–30)

Sub Actions:

- Converting the reclaimed land into a scientific disposal site if it aligns with SWM rules, partially it can be used to set up waste processing units.

Stakeholders

Lead Role:
- SWM Dept-GCC
- CPCB

Monitoring Indicator

- Percentage of area/waste reclaimed or remediated

Alignment with SDGs/ Plans

- SDG 13: Climate Actions
- SDG 3: Good Health and Well-being
- SDG 15: Life on Land
- Swachh Survekshan
- City Action Plan
- Master Plan, 2026
- C40's Urban Natural Declaration

Wider Benefits

- Air quality improvements, groundwater improvements
- Reduction of UHI effects
- Economic benefit through increased market value of properties in nearby areas

Possible Funding/ Financing Source

- SBM fund
- Green bond
- Municipal bond
- GCC Budget- SWM Dept.
- PPP, land reclamation—based financing model

Objective #2

100 per cent Decentralised Waste Processing

Action 7: Implement a monitoring system for collection of segregated waste from BWGs and installation of on-site waste processing units.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Implement segregated waste collection from BWGs in 4 zones.
- Create training workshops and market places for BWGs to understand and adopt appropriate technologies.
- Ensure stringent enforcement of by-laws for on-site waste processing.

Stakeholders

Lead Role:
- SWM Dept-GCC

Supporting Role:
- BWGs

Monitoring Indicator

- Percentage of BWGs with functional on-site waste processing units.

Alignment with SDGs/ Plans

- SDG 11: Sustainable Cities and Communities
- SDG 12: Responsible Consumption and Production
- SDG 13: Climate Action
- Swachh Survekshan (2.12)
- SWM by-laws, 2016

Wider Benefits

- Reduced transportation costs and emissions
- Enhanced opportunities for start-ups and technology innovators

Possible Funding/ Financing Source

- GCC Budget-SWM Dept
- SBM-Urban

Action 8: Install biogas capture systems at the wastewater treatment.

Time Frame: Short Term (2022–25)

Stakeholders

Lead Role:
- CMWSSB

Objective #2

100 per cent Decentralised Waste Processing

Action 8 *contd*

Install biogas capture systems at the wastewater treatment.

Monitoring Indicator	• Reduction in GHG emission from bio gas at STPs
Alignment with SDGs/ Plans	• SDG 11: Sustainable Cities and Communities • SDG 12: Responsible Consumption and Production • SDG 13: Climate Action
Wider Benefits	• Improved Air Quality
Possible Funding/ Financing Source	• Fundings from state govt. under finance commissions • AMRUT • SMART Cities

Source: Urban Management Centre

Impact on GHG Emission by Waste Sector

The key priorities identified for the Waste Sector is to collect, segregate, and process 100 per cent of the solid waste being generated in the city. To understand the impact of these actions on reduction in GHG emissions, remaining emissions for the BAU Scenario and Ambitious Scenario are compared as shown in the Figure 73.

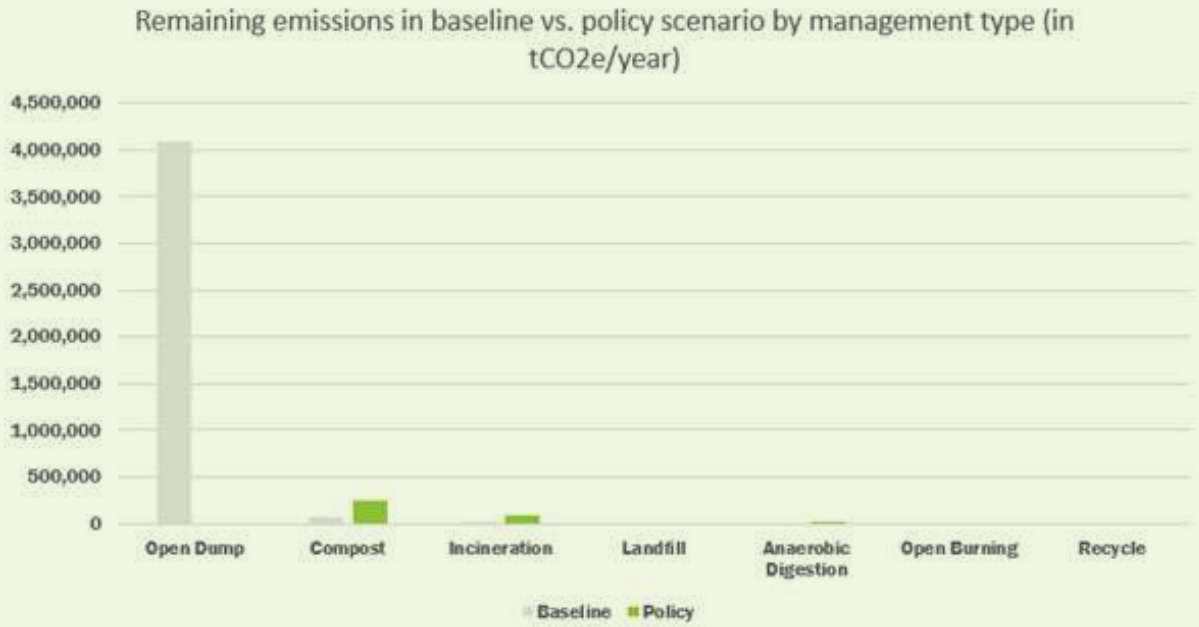


Figure 73: Remaining Emissions from Waste Sector for 2050 as per the Ambitious Scenario

As per baseline, 91 per cent emissions from waste sectors are contributed by open dumping of mixed waste, the key priorities identified for reducing emissions from the sector focuses on processing of 100 per cent municipal waste that is being generated. The implementation of ambitious actions will increase the recycling efficiency from 8 per cent currently to 50 per cent by the year 2050. The remaining 50 per cent of the dry waste is to be incinerated based on the current plans and projects of GCC. The increase in incineration capacity as per the current plans is the major reason behind the emissions, which remains even after the implementation of Ambitious Actions. Several of the current strategies and investments are aimed at increasing the incineration capacity through the 'Waste-to-Energy' plants. Out of total remaining emissions from Waste Sector, 27.8 per cent is contributed by incineration and 72.13 per cent by increase in composting efficiency. The Ambitious Actions identified for this sector contributes to 8.9 per cent of total reductions in the city's total GHG emission reduction in 2050.

6.2.5 Urban Floods and Water Scarcity Management

Chennai experienced catastrophic flooding in the years 1976, 1985, 1996, 1998, 2005, 2015, and 2021. The floods of 2015 were some of the most severe events, inflicting heavy damages to life,[100] property, and public infrastructure and they brought the city to a standstill for many days. The IPCC AR6 Report 2021 indicates that South Asia is expected to experience increasing bouts of extreme precipitation with increased rainfall intensity in shorter periods of time. Additionally, Chennai, being a coastal city, is also at risk from storm surges and sea-level rise (SLR). The projected SLR of 1 m is expected to inundate around 30 sq. km of low-lying areas in the GCC. About 16 per cent of GCC's population currently lives in low-lying areas and near the coastlines are most vulnerable to the compounded impacts of flooding and permanent inundation due to SLR.

100 The floods claimed 289 lives as per Government records, Flood Risk Reduction in Chennai Metro, Interim Report, December 2021

Along with facing challenges of frequent flooding, Chennai continues to face huge water scarcity issues. It has already experienced 'day-zero' in 2019, when all four water reservoirs on which the city is dependent ran dry and created a situation of water scarcity. Moreover, all climatic hazards ranging from flooding to SLR to increased heat to water scarcity disproportionately impact the urban poor.

Institutional Measures for Flood Mitigation in Chennai

To address the challenges and initiate measures for preventing inundation in Chennai, the GoTN constituted the "Advisory Committee on Mitigation and Management of Flood Risk in Chennai Metro" in 2021. The committee comprises sectoral experts, academic researchers, and senior government officials from departments that have a clear role in mitigating and managing any future flooding events.

The state government is focussed on the development of civic infrastructure in Chennai under Singara Chennai 2.0 and Chennai City Partnership Programme, which includes building storm water drains and public recreational spots. The CMDA has piloted the creation of a sponge park near the Kelambakkam Bus Terminus to augment percolation of storm water. The CMDA has further plans to increase permeable surface coverage and reduce the effects of UHI, by developing blue-green infrastructure and allocating land for it in its upcoming master plan.[101]

Current Strategies to Prevent Flooding and Disaster Management

According to the Guidelines on the Management of Urban Flooding issued by NDMA in 2010, water resource development and management shall consider hydrology of drainage basins and execute macro and micro drainage works. In the context of Chennai, it's the Water Resource Department (WRD) at the state level that is responsible for executing macro-drainage work, while the Storm Water Drainage (SWD) department of the GCC executes micro-drainage works. According to the maps provided by the SWD of GCC, only 28 per cent of the entire length of its 7303 km road network is currently equipped with storm water drainage.[102]

A 2018 CAG assessment highlighted several issues in the design of the SWD network in terms of missing links, gradient issues, reverse flows, inadequate drain size due to miscalculation of surface run-off resulting from lower rainfall intensity.[103] Following the NDMA guidelines (2010), the Disaster Management Plan prepared by the GCC in 2017 (and implemented in 2021), zonal offices were mandated to complete the desilting of drains as a pre-monsoon activity in order to allow the free flow of stormwater.

The encroachment on the river flood plains, waterbodies, natural drains (nullah) is a major reason behind the floods, as it obstructs the free flow of flood water and substantially reduces the percolation capacity of land. To protect these precious waterbodies from encroachment, the Tamil Nadu Protection of Tanks and Eviction of Encroachment Act (TNPTEEA), 2007 was enacted under the control of the WRD. Prior to this, the Tamil Nadu District Municipalities Building Rules, 1972 had envisaged a similar buffer zone of 15 m from the margin of the waterways. However, inadequate preparation and implementation of the statutory plans, combined with weak enforcement of the acts/ rules continued unchecked development in the protected lands.[104]

According to the climate vulnerability index, Chennai is also vulnerable to other potential threats and disasters such as cyclones, heatwaves, and drought. The Tamil Nadu State Disaster Management Authority (TNSDMA) has developed a State Disaster Management Plan (SDMP) 2018–30, in accordance with the Sendai Framework.[105] The SDMP specifies the roles and responsibilities of all stakeholders in different phases of disaster management and spells out the goals and strategies of the TNDMA, to address the risks faced by the state and to specify the measures for disaster risk reduction.

Key Gaps and Challenges

- **Need to strengthen planning mechanisms and policy implementation: There is a need for** holistic urban planning which takes

101 As mentioned by CMDA during Stakeholder Consultation meeting on 10th June 2022

102 Half of Chennai has no storm water drains, Komal Goutham, The Times of India, November 15, 2021

103 Dayanand Krishnan. (27 November 2021). All that's wrong with storm water drains in Chennai and how to fix them, Dayanand Krishnan, Citizen Matters.

104 Flood management and response in Chennai and its suburban areas, Report of CAG India, March 2016

105 Tamil Nadu State Disaster Management Plan, 2018-2030, TNSDMA

into consideration the geology and the hydrogeology of the area thereby reducing encroachment of natural drains and water bodies. Land-use and environmental policies require better implementation mechanisms, thereby reducing the impacts of flooding and, UHI, as well as damaged natural drains crucial for recharging surface water reservoirs through the catchment from their respective basins. For instance, the Pallikaranai marshland in Chennai, which was earlier spread over an area of 5,000 ha, only around 600 ha by 2006. Once a bird sanctuary, it has been encroached upon by several residential and commercial projects and is also being used as a local dumpsite. Thus, Chennai's natural water drainage system stands severely damaged, increasing the risk of both flooding and water scarcity.

- **Need to strengthen enforcement of existing regulations:** While several policies, guidelines and standards such as the TNPTEEA (2007) and the SWM by-laws (2019) have been drafted and implemented to prevent encroachment on waterbodies and the disposal of solid or liquid waste in the storm water drains and waterbodies, these provisions have not been adequately implemented, resulting in the clogging of SWDs. The Tamil Nadu Combined Development and Building Rules (TNCDBR), 2019 has a provision for water conservation through rainwater harvesting (RWH) in all building within CMA, to address the problems of water shortage as well as urban flooding. However, due to weak enforcement, few buildings have implemented it. Moreover, the WRD has failed to converge the efforts towards restore and augment capacities of tanks and reservoirs.[106]
- **Enhanced coordination across various departments:** Various government departments and agencies under the GoTN, such as the WRD, SWD Department of the GCC, and the IMD have failed to coordinate – leading to faulty planning of the SWD network. Moreover, the climate vulnerabilities caused by the increasing intensity of rainfall and projected risks of flooding and sea-level rise have not been considered in the planning of infrastructure and housing projects.
- **Need to strengthen infrastructure design, maintenance and service delivery:** Storm water drains need to be planned and designed as per projected rainfall intensity, coefficient of surface run-off and contour study . Chennai is currently in process of laying storm water drains with improved capacities. While the Disaster Management Plan of the GCC spells out that desilting of all drains should be done as a pre-monsoon activity, the CAG report's[107] assessment of SWD maintenance records, revealed that the lack of regular desilting has led to the clogging of drains, and resulted into water inundation in the nearby areas. Illegal discharging of black water into storm water drains also acts as a deterrent for regular cleaning of these drains.

Ongoing Initiatives

Chennai has undertaken a range of initiatives in response to climate change. Many initiatives towards augmentation of the existing physical infrastructure system are planned and underway, and various other measures to mitigate flood risks and disaster management by various departments in Chennai are also being implemented.

The initiatives are summarised here:[108]

Table 15 List of Ongoing Initiatives for Urban Flooding and Water Resource Management

	Major Focus Areas	Projects/Initiatives
1.	**Conservation of Natural water eco-system**	CMDA has planned to develop blue-green infrastructure to increase the surface permeability to prevent water stagnation during heavy rainfall and reduce impact on critical infrastructure

106 Tamil Nadu Budget 2022: Waterbodies remain neglected and unnoticed over last decade. (14th March, 2022). *The New Indian Express*

107 CAG India. (March 2016). Flood management and response in Chennai and its suburban areas

108

	Major Focus Areas	Projects/Initiatives
2.		An additional 57 water bodies in the city are set to be rejuvenated and beautified as part of the third phase of the Smart City Mission. The lakes will be desilted to a depth of 1-1.5m and beautified. The Tamil Nadu Water Investment Company Limited (TWIC) will be the agency responsible for preparing DPR and rejuvenating these lakes. The major funding for lake rejuvenation will come from the Smart Cities Mission.*
3.		The Town Planning Department, of the GCC has plans to increase permeable surface and reduce the effects of increasing heat by developing vegetation cover in the city through the "Miyawaki"' technique in 33 per cent of the land reserved for open spaces.
4.		The state WRD has proposed actions in catchment areas, and these can be used as an opportunity to align with the action of restoring water bodies.
5		Chennai, being a signatory to the C40's Urban Nature Declaration, has a vision of "Making our Cities Greener and More Resilient". As part of this commitment, Chennai has planned to increase green cover of the city by way of plantation on roadsides, OSR (Open Space Reservation) lands, canals, and lake sides. The State Water Resource Department has proposed actions in catchment areas; these could be used as opportunities to align with the action of restoring water bodies
6		The Department of Environment, Climate Change and Forest (GoTN) has rolled out an initiative under JICA-GoTN funded project to develop green riparian belt along the banks of Adyar and Cooum Rivers and Buckingham Canal by planting local species of vegetation at a cost of Rs 231 crore.
7		The Chennai Rivers Restoration Trust has initiated a wetland conservation programme to restore 358 acres of the Adyar Creek and Estuary. The trust is also undertaking the Integrated Cooum River Eco Restoration Project and the Adyar River Restoration Project
8		The CMWSSB has plans for the development and rehabilitation of the internal surface water sources (lakes). To experience the full benefit of surface runoff during precipitation, the areas in the catchment of these lakes have been restricted for development by the master plan. The CMWSSB master plan also suggests restoring the original catchment by removing encroachments, for all the water sources, in order to facilitate the intercepted inflows back into the lakes.
6.	**Stormwater management**	The Town Planning Department, GCC, has a mandatory condition that all multi-storied buildings must have a rainwater harvesting (RWH) system to get a "building use" permit.
		The GCC has proposed constructing the missing links or improving of defunct drains at 335 locations, under a project funded by Chennai Mega City Development Mission, 2018, at the cost of Rs 290 crores.
9	**Disaster risk reduction**	As per SDMP, the Flexi Fund component within Centrally Sponsored Schemes, can be used to undertake irrigation/ restoration activities for risk reduction. This must be in accordance with the guidelines framed by the GoI's Ministry of Finance
10.		As per the CMDA, disaster management teams at the ward/panchayat levels, comprising volunteers, may be created and trained in specific areas, e.g., early warning, immediate rescue, first-aid, food management, shelter management, water supply and sanitation, and damage assessment.

* 54 more waterbodies in city to get facelift.. (23 December 2018). The Times of India https://timesofindia.indiatimes.com/city/chennai/57-more-water-bodies-in-city-to-get-facelift/articleshow/67211810.cms 7 Chennai Smart City, Greater Chennai Corporation, https://cscl.co.in/node/146

	Major Focus Areas	Projects/Initiatives
11.	**Water source augmentation**	The CMWSSB Master Plan for water supply had envisaged 10 projects for source augmentation with a planned additional capacity of 1,980 MLD, over the current capacity of 1,642 MLD. For example, under the Telugu Ganga project, water from Kandaleru Reservoir in Andhra Pradesh is planned to be transported via canal to Poondi Reservoir to meet the increasing demand of water in Chennai. Similarly, Cauvery River water is also being transported through a pipeline to the Veeranam Lake, to fulfil the water demand of the city.
12.	**Sea-level rise**	The Housing and Urban Development Department has set up a Special Purpose Vehicle (SPV) to develop Chennai's coastline from Marina Beach to Kovalam covering 30 km at a cost of Rs 100 crores. The project aims to implement ecological activities such as preservation of flora and fauna, bio-fencing for SLR, and shoreline parks with salt-tolerant species.**

Sectoral Vision for Urban Flood Management in Chennai

Based on the gap analysis and mapping of the initiatives by the GCC and other important departments through strategic appraisals, the challenges, and requirements for adaptation towards flood resilience have been identified. Consultations with government and institutional stakeholders have helped identify and prioritise actions and frame the sectoral vision – "**From a Water-Reactive to a Water Proactive Chennai".**

To realise the sectoral vision and enable Chennai to transform from a water reactive to a water proactive city, the following objectives and actions have been identified:

Objective 1: Efficient Storm Water Management System to Prevent Pluvial Flooding

The actions identified under this objective aim to build flood-resilient systems and infrastructure to minimize the risk of flooding and its associated impacts. These actions along with sub-actions are

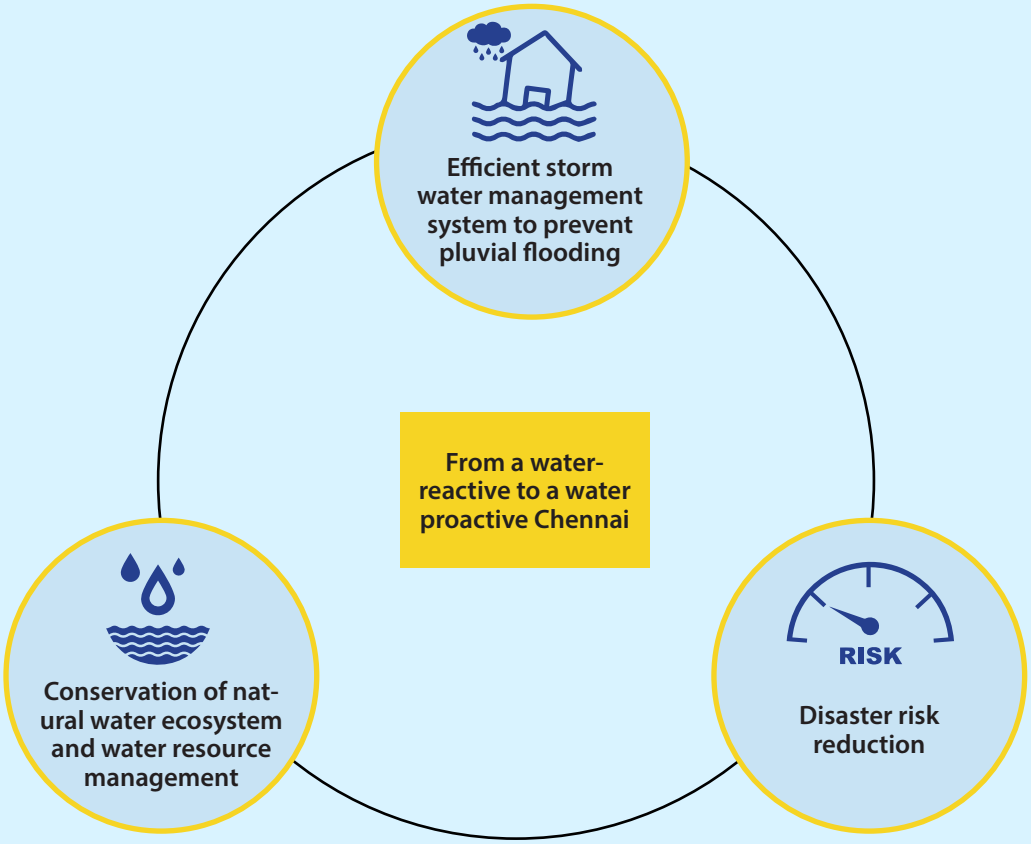


Figure 74: Sectoral Vision for Urban Floods and Water Scarcity Management Sector

** Special purpose vehicle set up to develop Chennai's coastline at Rs.100 crores. The Times of India. 27 July 2022, https://timesofindia.indiatimes.com/city/chennai/special-purpose-vehicle-set-up-to-develop-chennais-coastline-at-rs-100-crore/articleshow/93160520.cms

primarily twofold: first is to augment existing storm water drainage capacity and second is to augment ground water percolation through rain water harvesting and creation of blue-green infrastructure.

This also contributes to the target of augmenting green cover in the city. The key actions are given in the Table 16 along with the timeline, responsible stakeholders, monitoring indicators, alignment with plans, wider benefits, possible funding source and targets as follows:

- Improve the capacity of the storm water drainage network based on current and predicted future rainfall intensities and coefficient of surface run-off.
- Regularize the maintenance of Storm water drains to prevent waterlogging.
- Create a prioritized list of areas for construction of new storm water drains.
- Augment permeable surfaces in open spaces (at all levels -in buildings, societies, parks, OSRs, streets) to reduce run-off and enhance water recharge through introducing mandate in building by-laws.
- Strengthen implementation of by-laws for rainwater harvesting (RWH) in all new construction as per the rule 55 of Tamil Nadu Combined Development and Building Rules, 2019.
- Initiate IEC campaigns on constructing RWH systems.
- Develop sponge parks, rain gardens, bio-diversity parks, urban forests, and other blue green infrastructure to achieve the city's urban nature declaration targets. This action will contribute to increasing green-cover of the city and act as carbon-sink, resulting in reduction of GHG emissions. It will also impact positively on micro-climate of the nearby area and reduce effects of urban heat island.

Objective 2: Conservation of Natural Ecosystem and Water Resource Management

The actions identified here are to safeguard the city from floods and to manage existing water resources efficiently. These include engineering and planning solutions for restoration of natural drains and water bodies on one hand and on implementing strategies towards efficient water usage on the other. These actions and sub-actions are as follows:

- Ensure preservation of natural drain to maintain natural flow of water covering the entire catchment area.
- Demarcate boundaries and initiate actions for eviction and prevention of encroachment on waterbodies and wetlands under Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007. This will ensure restoration of water storage capacity of the waterbodies and decreased vulnerability of citizens living on the encroached lands.
- Reserve land for green belt development in 12-15 m buffer all along the Adyar and Cooum Rivers with strict enforcement of "No Development Zone" on both sides for native vegetation plantation. The implementation of this action will help in increasing green cover in 35 per cent of the GCC area.
- Formalise systems for groundwater connections for monitoring of groundwater withdrawal.
- Implement a city-level system for water metre and volumetric water charge through policy level interventions.

Objective 3: Improved Disaster Risk Reduction

The actions identified under this objective aim to reduce disaster risk and impacts by strengthening early warning and data monitoring systems and community engagement. These will help in achieving the target of 100 per cent population within GCC with access to information on disaster risk reduction measures, including slum dwellers, fisherfolk population, and other vulnerable communities. The actions and sub-actions are as follows:

- Strengthen data monitoring and ensure consistency to minimise the gaps in local weather forecasting model and tidal changes for sea-level rise, while collaborating with private and non-governmental organisations.
- Undertake periodical assessment on SLR, extent of areas eroded, saltwater intrusion, disturbance to the eco-diversity, etc.
- Generate awareness in communities about disaster preparedness and leveraging the support provided for disaster risk reduction.
- Ensure strict monitoring of all roads to be resurfaced to maintain contour levels of the roads as per the construction plans.
- Institutionalisation and capacity building of "first responders" for climate emergencies.
- Assess disaster response readiness of the disaster relief centres.
- Initiate studies on the emerging issues pertaining to SLR and its impacts.

Proposed Actions Identified for Urban Flooding and Water Scarcity

Table 16 Proposed Actions Identified for Urban Flooding and Water Scarcity

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Targets	2030	2040	2050
	50% of arterial and sub-arterial roads covered with stormwater drainage network as feasible	70% of arterial and sub-arterial roads covered with stormwater drainage network as feasible	100% of arterial and sub-arterial roads covered with stormwater drainage network as feasible
	100% of arterial and sub-arterial roads covered with stormwater drainage network as feasible	100% of arterial and sub-arterial roads covered with stormwater drainage network as feasible	100% of arterial and sub-arterial roads covered with stormwater drainage network as feasible
	95% of households with access to reliable water supply	100% of households with access to reliable water supply	100% of households with access to reliable water supply

The following action areas have been identified to deliver the City's targets:

1. Improve the capacity of storm water drainage network based on current and predicted future rainfall intensities and coefficient of surface run-off.
2. Regularize the maintenance of storm water drains to prevent waterlogging.
3. Create a prioritized list of areas for the construction of new storm water drains.
4. Augment permeable surfaces in open spaces (at all levels – in buildings, societies, parks, OSRs, streets) to reduce run-off and enhance water recharge through introducing mandate in building by-laws.
5. Strengthen the implementation of bylaws for rainwater harvesting (RWH) in all new construction as per the rule 55 of Tamil Nadu Combined Development and Building Rules, 2019.
6. Initiate IEC campaigns on constructing RWH systems.

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Action 1

Improve the capacity of storm water drainage network based on current and predicted future rainfall intensities and coefficient of surface run-off.

Time Frame

Short Term (2022–30)

Sub Actions:

- Upgrade the existing storm water drains based on the contour studies and detailed examination that factor in future rainfall intensity, level of inundation projected by flood warning system, and connections to the natural drains. Connect the storm water drains to natural drainage, through leveraging technical support for design from relevant technical support institutions.
- Delineate geographical regions for storm water management based on catchment and watershed assessment not based on administrative boundaries.
- Commission studies to prepare micro-catchment drainage maps of Chennai.

Stakeholders

Lead Role:
- Storm Water Drainage Department, GCC

Supporting Role:
- IMD
- Anna University/ IIT-M

Monitoring Indicator

- Micro-catchment drainage maps of Chennai prepared and available across departments for use
- Missing links constructed
- No. of water stagnation locations

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- SDG 15- Life on Land
- SDG 6: Clean Water & Sanitation
- SDMP 2018-30
- Advisory Committee for Flood risk reduction & mitigation in Chennai

Wider Benefits

- Reduced period of flooding, leading to lesser livelihood loss,
- Improved health, reduced incidences of vector borne diseases (malaria, dengue etc.)
- Reduced costs of roads maintenance

Possible Funding/ Financing Source

- Funds from Govt. of India under missions i.e., Smart Cities Mission
- Funding under foreign aid and development assistance

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Action 2

Regularize the maintenance of storm water drains to prevent waterlogging.

Time Frame: Short Term (2022–30)

Sub Actions:

- Enforce SWM by-laws, 2019 by penalizing garbage dumping in public areas to prevent solid waste in storm water drains.
- Ensure strict monitoring of drain cleaning by reviewing the frequency of cleaning and desilting of storm water drains by SWD Department, GCC.
- Disconnect all illegal sewage discharges into storm water drains by residential and commercial establishments. Penalise defaulters under the Water (Prevention and Control of Pollution) Act, 1974, GoTN.
- The GCC could introduce a scheme to provide legal sewer connections
- Engage with licensed plumbers to help identify remaining illegal connections

Stakeholders

Lead Role:
- Storm Water Drainage department, GCC

Supporting Role:
- IMD
- Plumber's association

Monitoring Indicator

- No. of work orders issued for desilting of the drains every 6 months
- No. of defaulters penalized for throwing garbage in public areas
- Amount of penalties received from the penalising under SWM bye laws and Water Act
- No. of properties connected to sewer lines

Alignment with SDGs/ Plans

- GCC Disaster Management Plan, 2021
- SDG 13: Climate Action
- SDG 15: Life on Land
- SDG 6: Clean Water & Sanitation

Wider Benefits

- No black water into waterbodies leading to cleaner, healthier waterbodies
- Enhanced livelihoods and skilling opportunities

Possible Funding/ Financing Source

- SWD dept., GCC - Budget

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Action 3 — Create a prioritized list of areas for the construction of new storm water drains.

Time Frame: Short Term (2022–25)

Sub Actions:

- Identify water stagnation areas and areas with missing links and prepare a list of relevant areas.

Stakeholders

Lead Role:
- Storm Water Drainage department, GCC

Supporting Role:
- Town Planning Department, GCC

Monitoring Indicator
- No. of new areas identified for SWDs
- List of new areas identified for SWDs

Alignment with SDGs/ Plans
- GCC Disaster Management Plan, 2021

Wider Benefits
- Improving access to information for better decision making by the authority

Possible Funding/ Financing Source
- SWD dept., GCC - Budget

Action 4 — Augment permeable surfaces in open spaces (at all levels – in buildings, societies, parks, OSRs, streets) to reduce run-off and enhance water recharge through introducing mandate in building by-laws.

Time Frame: Short Term (2022–30)

Sub Actions:

- Introduce provisions in building bylaws that mandate permeable spaces.

Stakeholders

Lead Role:
- Town Planning Department, GCC

Supporting Role:
- Parks & Gardens Department, GCC
- CMDA
- Local associations of engineers/architects

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Action 4 *contd*

Augment permeable surfaces in open spaces (at all levels – in buildings, societies, parks, OSRs, streets) to reduce run-off and enhance water recharge through introducing mandate in building by-laws.

- Establish a system for educational sessions for licensed architects and engineers on importance of permeability through greening and other nature-based solutions.

Monitoring Indicator
- Percentage of permeable surface increased in city
- No. of new open/ green space developed

Alignment with SDGs/ Plans
- SDG 13: Climate Action
- SDG 15: Life on Land

Wider Benefits
- Improved accessibility
- Environmental benefit through water recharge
- Reduced risks of diseases due to water stagnations

Possible Funding/ Financing Source
- SWD dept., GCC - Budget

5 Strengthen the implementation of bylaws for rainwater harvesting (RWH) in all new construction as per the rule 55 of Tamil Nadu Combined Development and Building Rules, 2019.

Time Frame

Short Term (2022–26)

Sub Actions:

- Ensure no new building without a RWH system get building use permission.
- Organize large-scale implementation of RWH systems for all typologies of buildings by conducting awareness programmes at the community level and enforcing bylaws for RWH.

Stakeholders

Lead Role:
- Town planning department, GCC

Supporting Role:
- Storm water management department, GCC
- CMWSSB

Monitoring Indicator
- Percentage of buildings with BU permission having RWH system installed
- No. of ward-wise service providers/ design consultant empanelled

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Action 5 *contd*

Strengthen the implementation of bylaws for rainwater harvesting (RWH) in all new construction as per the rule 55 of Tamil Nadu Combined Development and Building Rules, 2019.

- Empanel zone-wise service providers/ design consultants for building developers to provide technical support for installing and maintaining RWH systems in their buildings, to harvest all the storm water within site based on the Rainwater Harvesting and Conservation manual of CPHEEO.

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- SDG 15: Life on Land
- SDG 6: Clean Water & Sanitation
- Advisory committee for Flood risk reduction & mitigation in Chennai
- Tamil Nadu Combined Development and Building Rules, 2019

Wider Benefits

- Environmental benefit through groundwater aquifer recharge
- Reduced pumping costs for ground water
- Enhanced opportunity for livelihood for RWH workers

Possible Funding/ Financing Source

- CSR support
- SWD dept., GCC - Budget

6 Initiate IEC campaigns on constructing RWH systems.

Time Frame

Short Term (2025–30)

Sub Actions:

- Train SHGs to run awareness generation campaigns on the importance of RWH, types of RWH systems, their applicability based on site context and affordability.

Stakeholders

- Lead Role:
- Town planning department, GCC

Supporting Role:

- Storm water management department, GCC
- NULM department at zonal level
- SHGs

Monitoring Indicator

- Percentage of population aware of campaign
- No. of workshops conducted
- List of zone-wise nodal officers
- GCC website to have list of empanelled service providers

Objective #1

An Efficient Storm Water Management System to Prevent Pluvial Flooding

Action 5 *contd* | **Initiate IEC campaigns on constructing RWH systems.**

- Make the list of empanelled service providers for RWH construction on GCC website.
- Deploy a nodal officer at zonal level to ensure implementation of RWH related initiatives and construction of RWH systems.

Alignment with SDGs/ Plans

- SDG 13:- Climate Action
- SDG 15: Life on Land

Wider Benefits

- Environmental benefit through groundwater aquifer recharge
- Reduced pumping costs for ground water
- Creates opportunity for livelihood for RWH workers and NGOs

Possible Funding/ Financing Source

- SWD Dept., GCC – Budget
- Town Planning Dept., GCC-budget
- CSR funding

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Targets

2030	2040	2050
25% of green cover in the city	33% of green cover in the city	35% of green cover in the city

The following action areas have been identified to deliver the City's targets:

1. Develop OSRs as sponge parks, rain gardens, bio-diversity parks, urban forest and other Blue-Green Infrastructure.
2. Demarcate boundaries and initiate actions for eviction and prevention of encroachment on waterbodies and wetlands under Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007.
3. Reserve land for green belt development in 12–15m buffer all along the Adyar and Cooum River, with strict enforcement of "No Development Zone" on both sides for native vegetation plantation.

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

4. Formalise systems for groundwater connections for monitoring of ground water withdrawal.

5. Implement a city level system for water meter and volumetric water charge through policy level interventions.

6. Ensure the preservation of natural drains to maintain natural flow of water covering the entire catchment area.

7. Develop sea wall/ dykes/ bio-fencing along SLR.

Action 1 — Develop OSRs as sponge parks, rain gardens, bio-diversity parks, urban forest and other Blue-Green Infrastructure.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Conduct a gap analysis and mapping of where new green cover could be added and opportunities for existing green spaces to be upgraded to respond to local needs.
- Identify areas to be developed as BGI, by prioritizing them through instances of waterlogging and UHI effect.
- Green up the common spaces through public-private partnership through schemes such as Nammakku Name Thittam' where in the public contributes at least 1/3rd of the project cost and the rest is by the Government which can be encouraged.

Stakeholders

Lead Role:
- Parks & Gardens Department, GCC

Supporting Role:
- Town planning department, GCC

Monitoring Indicator

- No. of reduction in water stagnation points in nearby area
- Percentage Of urban area that is green space

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- SDG 15: Life on Land
- Proposed strategy for 3rd master plan, CMDA
- City's urban nature declaration target under C40 commitment

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 1 *contd*

Develop OSRs as sponge parks, rain gardens, bio-diversity parks, urban forest and other Blue-Green Infrastructure.

- Incentivize creation of green open spaces through town planning tools like Green Cess, TDR, etc.
- Promote projects that focus on the creation of parks and rejuvenation of lakes through Corporate Social Responsibility and Institutional Social Responsibility.
- Involve citizens in preparation and maintenance of open space plans
- Create programmes that allow citizens, RWAs, CSOs to manage and maintain natural resources like lakes, parks, etc., and incentivize these programmes through awards and recognition events.
- Develop support and skills building programmes for green jobs and develop a process for involving vulnerable and marginalized communities in design and implementation and monitoring of the green spaces.

Wider Benefits

- Environmental and social benefit
- Improved air quality
- Provision of accessible parks for all
- Livelihood opportunities
- Increase in green jobs

Possible Funding/ Financing Source

- Parks & Garden dept., GCC – Budget
- Funding under national missions i.e., Smart cities, AMRUT for lake rejuvenation
- Green bonds
- CSR funds

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 2

Demarcate boundaries and initiate actions for eviction and prevention of encroachment on waterbodies and wetlands under Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007.

Time Frame

Medium Term (2030–40)

Sub Actions:

- Identify and list out the waterbodies that may have been encroached upon by illegal development.
- Coordinate with other relevant stakeholder for the removal of encroachment depending on size and type of encroached development.
- Demarcate boundaries of all waterbodies in the GCC and CMA area as per the revenue map to avoid future possibilities of encroachments.
- Restore waterbodies by developing them as social space and maintaining availability of water inside.

Stakeholders

Lead Role:
- Revenue & Disaster Management Department, GoTN
- CMDA

Supporting Role:
- TN Police
- Water Resource Department
- Land & Estate Dept, GCC
- SWD Department, GCC
- TNUHDB
- NGOs

Monitoring Indicator

- Percentage of waterbodies with demarcated boundary
- Percentage of encroachments removed

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- SDG 15- Life on Land
- Advisory committee for Flood risk reduction & mitigation in Chennai
- Coastal Regulation Zone (CRZ) norms

Wider Benefits

- Environmental improvement,
- Improved air quality
- Improved quality of life
- Enhanced preservation of flora and fauna

Possible Funding/ Financing Source

- Budget allocated for administration, Town Planning Dept., GCC
- DoEFCC
- WRD

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 3

Reserve land for green belt development in 12–15m buffer all along the Adyar and Cooum River, with strict enforcement of "No Development Zone" on both sides for native vegetation plantation.

Time Frame

Short Term (2025–30)

Sub Actions:

- Demarcate 12-15 m buffer from the riparian belt to be developed as green belt in the upcoming master plan.
- Coordinate with other relevant stakeholder for the removal of encroachment depending on size and type of encroached development.

Stakeholders

Lead Role:
- CMDA
- Department of Environment, Climate Change and Forest

Supporting Role:
- Town Planning Dept, GCC
- Water Resource Department

Monitoring Indicator

- Percentage of length of river developed with buffer

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- SDG 15: Life on Land
- Urban River Management Plan Framework, NIUA

Wider Benefits

- Improved quality of life
- Improved natural habitat for flora and fauna
- Carbon sequestration and reduced UHI effect

Possible Funding/ Financing Source

- DoEFCC, GoTN
- CMDA
- Town Planning Dept., GCC
- Parks & Garden Dept., GCC- Budget

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 4

Formalise systems for groundwater connections for monitoring of ground water withdrawal.

Time Frame

Short Term (2022–25)

Sub Actions:

- Ensure that individuals and industries obtain permission for extraction under the National Green Tribunal's directions.
- Set systems for citizens to seek formal permission for digging bore wells for ground water extraction.
- Identify nodal officer from water department at zonal level to track the level of ground water extraction in zone.
- Conduct regular assessment of level of ground water at zonal level.

Stakeholders

Lead Role:
- Water Supply Department, GCC

Supporting Role:
- Water Resource Department
- PWD
- CMWSSB

Monitoring Indicator

- Inventory of groundwater connections in the city
- Ground water level

Alignment with SDGs/ Plans

- SDG 13: Climate Action

Wider Benefits

- Environmental benefit through ground water recharge

Possible Funding/ Financing Source

- WRD
- Water Supply Department, GCC - Budget

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 5

Implement a city level system for water meter and volumetric water charge through policy level interventions.

Time Frame

Short Term (2022–25)

Sub Actions:

- Introduce a criterion for installation of water meter under "Building use permission".

Stakeholders

Lead Role:
- Water Supply Department, GCC

Supporting Role:
- CMWSSB
- WRD, GoTN
- Town Planning Dept, GCC

Monitoring Indicator

- Inventory of groundwater connections in the city
- Ground water level

Alignment with SDGs/ Plans

- SDG 13: Climate Action

Wider Benefits

- reduce water losses in the entire water distribution network

Possible Funding/ Financing Source

- WRD, GoTN

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 6

Ensure the preservation of natural drains to maintain natural flow of water covering the entire catchment area.

Time Frame

Midium Term (2030–40)

Sub Actions:

- Manage land-use in catchment area by reserving it as eco-sensitive zones in master plans.
- Prepare a framework for water sensitive urban design for development in catchment areas.
- Mandate EIA of development activities in catchment area.

Stakeholders

Lead Role:
- CMDA

Supporting Role:
- Revenue & Disaster Management Department, GoTN
- Town Planning Dept, GCC
- Land & Estate Dept, GCC
- WRD

Monitoring Indicator

- No. of eco-sensitive areas reserved through master plans
- A framework in place for water sensitive urban design

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- TNSAPCC
- National Water Policy, Central Water Commission
- TN Town & Country Planning Act, 1971 and master plans prepared by CMDA under act

Wider Benefits

- Environmental benefit through improved natural drainage and reduced disaster risks

Possible Funding/ Financing Source

- Town Planning dept., GCC - budget

Objective #2

Conservation of Natural Water Ecosystem and Water Resource Management

Action 7 | Develop sea wall/ dykes/ bio-fencing along SLR.

Time Frame: Midium Term (2030–40)

Sub Actions:

- Identify the most sensitive areas along the coastline through sea-level rise mapping.
- Prioritize the areas which are comparatively sensitive, i.e., informal settlements, residential areas of fisherfolk population, ecologically sensitive areas such as wetlands, waterbodies, rivers

Stakeholders	**Lead Role:** • Revenue & Disaster Management Depart, GoTN **Supporting Role:** • DoECCF
Monitoring Indicator	• No. of sensitive areas identified • Length of sea wall built
Alignment with SDGs/ Plans	• Coastal Zone Regulations (CZR) norms • Chennai Shoreline Re-nourishment and Revitalisation project, SPV of DoECCF
Wider Benefits	• Reduced penetration of salt-water in ground water, freshwater waterbodies, wetlands/ Marshlands • Preservation of flora & fauna
Possible Funding/ Financing Source	• Fundings from SPV of DoECCF

Objective #3

Disaster Risk Reduction

Targets	2030	2040	2050
	100% of the population with access to information on disaster risk reduction measures	100% of the population with access to information on disaster risk reduction measures	100% of the population with access to information on disaster risk reduction measures

The following action areas have been identified to deliver the City's targets:

1. Strengthen data monitoring and ensure consistency to minimize the gaps in local weather forecasting model and tidal changes for sea-level rise, while collaborating with private and non-governmental organizations.

2. Undertake periodical assessment on SLR, extent of areas eroded, saltwater intrusion, disturbance to the eco-diversity, and other impacts of SLR etc.

3. Generate awareness on disaster preparedness and leveraging the support provided for disaster risk reduction in communities.

4. Ensure strict monitoring of all roads to be resurfaced to maintain contour levels of the roads as per the construction plans.

5. Institutionalisation and capacity building of "first responders" for climate emergencies.

6. Assess disaster response readiness of the disaster relief centres.

7. Initiate studies, and on the emerging issues pertaining to SLR and its impacts

Objective #3

Disaster Risk Reduction

Action 1

Strengthen data monitoring and ensure consistency to minimize the gaps in local weather forecasting model and tidal changes for sea-level rise, while collaborating with private and non-governmental organizations.

Time Frame: Short Term (2022–28)

Sub Actions:

- Invest in early warning systems to alert emergency response teams and reach communities on imminent disasters, according to the TNSDMP.
- Re-institutionalize the existing model of C-FLOWS developed by NCCR at GCC to observe long-term trends and act as a decision support system for the disaster management cell, GCC. It will identify:
  - √ Real-time rainfall intensity
  - √ Ward-wise inundation
  - √ Severely affected locations
- Tie-up with private and non-governmental organizations to improve forecasting technologies.

Stakeholders

Lead Role:

Disaster management cell, GCC

CSCL

Supporting Role:

- TNSDMA
- Anna University
- IIT-M
- IMD
- NCCR

Monitoring Indicator

- Improved capacity of disaster management cell to pre-identify risk areas

Alignment with SDGs/ Plans

- SDG 13: Climate Action
- State Disaster Management Plan 2018-2030

Wider Benefits

- Improved access to information, leading to lesser life and economic losses.

Possible Funding/ Financing Source

- TNSDMA
- Disaster management cell, GCC - Budget

Objective #3

Disaster Risk Reduction

Action 2

Undertake periodical assessment on SLR, extent of areas eroded, saltwater intrusion, disturbance to the eco-diversity, and other impacts of SLR etc.

Time Frame

Short Term (2022–28)

Sub Actions:

- Analyse the emerging context of SLR and identify the medium- and long-term initiatives that would have to be taken up under varying emerging contexts.

Stakeholders	**Lead Role:** Disaster management cell, GCC CSCL **Supporting Role:** • NCCR TNSDMA • Anna University • IIT-M • IMD
Monitoring Indicator	• Research publication in public domain • Improved capacity of disaster management cell to pre-identify risk areas
Alignment with SDGs/ Plans	• SDG 13: Climate Action • State Disaster Management Plan 2018-2030 • Coastal Regulation Zone (CRZ) norms
Wider Benefits	• Improved access to information • Economic benefit by saving infrastructure at risk • Reduced impact on eco-diversity
Possible Funding/ Financing Source	• TNSDMA • Disaster management cell, GCC –- Budget • Fundings from research institutions and academia

Objective #3

Disaster Risk Reduction

Action 3

Generate awareness on disaster preparedness and leveraging the support provided for disaster risk reduction in communities.

Time Frame

Short Term (2022–25)

Sub Actions:

- Conduct capacity building programmes for ULB staff on how to take up programmes for awareness generation in community.
- Engage SHG members in awareness generation campaigns to reach out communities.

Stakeholders

Lead Role:
- Disaster management cell, GCC

Supporting Role:
- RWAs / Volunteers from local areas
- Public Health Department, GCC
- TWDC
- NULM (SHGs)
- NGOs

Monitoring Indicator

- No. of initiatives/ campaigns taken up
- Percentage of funds utilized in IEC activities

Alignment with SDGs/ Plans

- SDG 13: Climate Action

Wider Benefits

- Improved access to information
- Improved coping capacity of community

Possible Funding/ Financing Source

- Disaster management cell, GCC - Budget

Objective #3

Disaster Risk Reduction

Action 4

Ensure strict monitoring of all roads to be resurfaced to maintain contour levels of the roads as per the construction plans.

Time Frame: Short Term (2022–25)

Sub Actions:

- Ensure that all concerned agencies maintain levels as per the original design (by scrapping the first layer of road).

Stakeholders	**Lead Role:** Roads department, GCC **Supporting Role:** • PWD
Monitoring Indicator	Reductions in no. of issues related to irregular slopes and road level
Alignment with SDGs/ Plans	SDG 13: Climate Action
Wider Benefits	Improved physical accessibility
Possible Funding/ Financing Source	Roads department, GCC - budget

Objective #3

Disaster Risk Reduction

Action 5

Institutionalisation and capacity building of "first responders" for climate emergencies.

Time Frame

Short Term (2022–25)

Sub Actions:

- Enrol 'first responders' based on different skill sets such as giving primary medical aid, swimming, and boating, who can provide support during extreme climatic events such as flooding.
- Develop skill-based training courses to enhance the specific skills of existing identified people.

Stakeholders

Lead Role:
- Disaster management cell, GCC

Supporting Role:
- TNSDMA
- Public Health Department, GCC
- NGOs
- Volunteers from local areas

Monitoring Indicator

- No. of training provided to the first responders
- No. of first responders trained
- Identification of dedicated department/ cadre of 'First responder'
- Level of enhancement on risk reduction (reduced response time, increased coverage)

Alignment with SDGs/ Plans

- SDG 13: Climate Action

Wider Benefits

- Reduced response time can save many lives

Possible Funding/ Financing Source

- Disaster management cell, GCC - Budget

Objective #3

Disaster Risk Reduction

Action 6

Assess disaster response readiness of the disaster relief centres.

Time Frame: Short Term (2022–26)

Sub Actions:

- Develop an SOP for accessibility.
- Build climate resilient water supply system powered by RE in each disaster relief centre to avoid outrage during disasters.

Stakeholders

Lead Role:
- Disaster Management Department, GCC

Supporting Role:
- PWD
- GCC

Monitoring Indicator

- Reduced number of instances in failure of basic infrastructure system like water supply, electricity

Alignment with SDGs/ Plans

- SDG 13: Climate Action

Wider Benefits

- Economic benefit (Climate proof infrastructure)

Possible Funding/ Financing Source

- Disaster management cell, GCC - Budget

Objective #3

Disaster Risk Reduction

Action 7

Initiate studies, and on the emerging issues pertaining to SLR and its impacts

Time Frame

Short Term (2022–30)

Sub Actions:

- Analyse impact on major infrastructure such as ports, SEZs, desalination plants, etc need to be examined in the context of the SLR projections and the need for project specific adaptation and mitigation requirements

Stakeholders	**Lead Role:** • TNSDMA
Monitoring Indicator	• Addition of sub-component on SLR in the next disaster management plan
Alignment with SDGs/ Plans	• SDG 13: Climate Action
Wider Benefits	• Economic benefit by preventing major loss of infrastructure
Possible Funding/ Financing Source	• Fundings from TNSDMA

Source: Chennai Smart Cities Limited

6.2.6 Vulnerable Populations and Health

Climate change causes more intense and more frequent instances of heat, water scarcity, and flooding. In Chennai, it is expected to adversely impact the residents and increase their vulnerability. Further, *climate vulnerability* is experienced differently by different sections of the population, based on socio-economic conditions as well as access to basic infrastructure and services. Thus, the urban-poor community, with limited access to critical services and lower levels of service coverage, is the most vulnerable to the risks from climate change.

Many low-income urban residents live at untenable locations in precarious informal settlements, characterised by poor-quality housing susceptible to climate risks such as flooding, extreme cold, or extreme heat. Moreover, they often lack access to essential services such as water supply, sanitation, electricity, and health, and tenure security. The situation is exacerbated by other vulnerabilities such as job insecurity, job informality, frequent displacement, migration, and lack of social safety nets to fall back on in times of crisis. Thus, due to higher exposure to hazards as well lower capacities to cope with climate-induced events, the urban poor face higher vulnerabilities. Within the community, women are doubly marginalised, as they face multiple layers of discrimination over access to basic services and livelihoods.

Higher Exposure to Hazards

Informal housing on untenable and environmentally risky areas: According to the SFCPoA,[109] 21 per cent of all slums in Chennai are situated in environmentally risky areas, such as low-lying areas of the floodplains of the river, peripheries of the waterbodies, encroached-upon dried-up waterbodies, and creeks. This makes them highly vulnerable to climatic events such as floods, storm surges, and possible inundation due to SLR.

Poor housing conditions: As of 2022, one of every two slum residents of Chennai lives in a kuccha house. This increases the risks of house collapse or flooding during heavy rains, storms, and floods. The SFCPoA[1] finds that about one-third of all the slum houses use asbestos sheet as a roofing material, which is a heat-trapping material and increases the risk of heat stress and heat-related disease during summers.

Low service level coverage to water and sanitation: About 50 per cent of families in the slums in Chennai do not have a household-level water connection. These households remain dependent on external water sources, such as public taps and tankers, which get disrupted during weather events such as floods or heavy rainfalls, as well as during peak summers. Over 22 per cent of slum households also do not have access to individual household-level toilets and are dependent on public or community toilets, which become inaccessible during floods.

Low coverage of storm water infrastructure: Only 28 per cent of all roads in Chennai have storm water drainage. Moreover, none of the slums in the city has any storm water drainage infrastructure or rainwater harvesting systems.

Higher population density: About 26.5 per cent (approx. 12.5 lakhs) of Chennai's total population lives in densely populated slums. The average density in these slums is 580 persons per hectare, which is almost double the density of the rest of the GCC area. Such dense settlements, with few open spaces and little green cover, increases their susceptibility during climate-induced floods as well as increased temperatures.

Lower Capacity to Adapt and Cope

Slum residents have limited financial capacity to cope with shocks induced directly or indirectly by climate change. Around 73 per cent of the working population in slums are engaged in casual labour activities and are daily wagers. They have low access to formal banking systems, and even those who do have, have low savings. This severely lowers their capacity of coping with climate-induced shocks – the ability to make their houses more climate resilient; moving to safer locations; being able to afford necessities such as water during water scarcity, cooling devices to prevent heat stress, healthcare services; or investing in health and life insurances.

Migrants as a subcategory of the residents of informal settlements are further disadvantaged due to their lack of identity and address proofs. They cannot access basic banking services, even

109 TNSCB & Darshaw. (2014). Slum Free City Plan of Action, Chennai Corporation.

if they have physical access to banks, as they fail to fulfil the Know Your Customer (KYC) norms stipulated by the Reserve Bank of India. Chennai is projected to experience major migration due to climate change impacts.[110]

Lack of tenure security: Tenure insecurity affects the residents' inability to invest in upgrading their houses to better adapt to the impacts of climate change. Moreover, without a house to offer as collateral, slum residents are unable to avail of credit support from formal lending institutions. Consequently, residents of informal settlements are forced to rely on informal moneylenders, who charge exorbitant interest rates, to meet the immediate needs and priorities of the household, such as healthcare or a marriage.

Lack of social infrastructure: Currently, only 15 per cent of Chennai's slum population has access to healthcare facilities within a distance of 400 m (i.e., 5–7 minutes of walking). The rest rely on private healthcare facilities, which are often unaffordable for many.

Key Gaps and Challenges

- Gap in affordable housing demand and supply. Neither the government nor the private sector has been able to provide housing at the scale and adequacy required to accommodate slum-dwellers in Chennai.
- Non-implementation of the Resilient Urban Design Framework, or the alignment with ENS in construction of affordable housing to increase thermal comfort and safeguard from climatic events
- No district level environmental health cell has been put in place to implement actions identified in the "Tamil Nadu State Action Plan for Climate Change and Human Health" (TNSAPCCHH). Thus, the Public Health Department at the GCC level is yet to roll out any initiatives.

Existing Policies

Programmes for Affordable Housing in Chennai

The Tamil Nadu Slum Clearance Board (TNSCB) is responsible for improving the living conditions of slums by providing the residents with basic services and pucca housing. Under the Rajiv Awaas Yojana – "Slum Free Cities" programme in 2013, the TNSCB had identified a total of 896 slums for in-situ upgradation and 235 slums for relocation.[1] Further, under the Pradhan Mantri Awas Yojana – Urban, launched in 2015, the GoTN prepared "Vision 2023" – a strategic long-term plan to provide houses for all urban slum families and make Tamil Nadu cities "slum free" by 2023.[111] Houses built under this plan offer improved infrastructure, with water supply and sanitation, and also provide tenurial security. Thus, these national- and state-level visions for providing housing are a critical step towards reducing climate vulnerability of the urban poor and enhancing their adaptive capacities.

To promote energy-efficient houses, the Ministry of Power and BEE has prescribed the ENS (i.e., the ECBC-R). Further, the GoTN also took steps towards making affordable housing in the state sustainable and climate-resilient by preparing the Resilient Urban Design Framework (RUDF) under the TNSCB. The RUDF serves as a planning and design guide for developing high-quality, sustainable, and climate-resilient structures.[112] The framework also contains guidelines for energy-efficient buildings that adhere to ECBC by the national government.

Programmes for Improving Healthcare in Chennai

Climate change is expected to negatively affect human health in several ways, but the most commonly experienced issues include the increased frequency and intensity of heatwaves, leading to increased heat-related illnesses and deaths; and increased precipitation, floods, droughts, and desertification, leading to fatalities. Significant increase in temperature creates a range of health problems – from mild rashes to fatal heat strokes. Similarly, floods cause the outbreak of water-borne and vector-borne diseases.

Foreseeing the impact of climate change on human health, the GoTN aims to make healthcare facilities climate resilient and compliant with Indian Public Health Standards (IPHS). These facilities should be able to withstand any climatic event and provide functional essential services

110 Climate Change 2022: Impacts, Adaptation and Vulnerability, Working Group 2 contribution to IPCC AR6, 2022

111 http://www.tnscb.org/housing-for-all/

112 Resilient Urban Design Framework, TNSCB. (March 2020). https://tnuhdb.tn.gov.in/storage/ck_uploads/9jPtSDmhTg3EW1VtL2QvBUSTyaYQzWgpeD1HaXc3.pdf

such as water, sanitation, waste management, and electricity during such events.

The Health Mission was included as part of the NAPCC in 2014, to reduce climate-sensitive illnesses through integration with other missions. The MoHFW prepared the National Action Plan on Climate Change and Human Health (NAPCCHH), which formed the basis for the TNSAPCCHH in 2016. The vision is to strengthen healthcare services for all the citizens of the state, especially vulnerable segments, such as children, women, elderly, and tribal communities, against climate-sensitive illnesses.[113]

The TNSAPCCHH has identified the actions needed to create awareness about the impacts of climate change on human health; strengthening the capacity of the healthcare system; improving health preparedness; developing synergy with other missions to ensure representation of health in climate change agenda; and strengthening research capacity to learn the possible impacts of climate change on human health.[114] [115] [116]

The implementation of these actions currently remains limited at the city level.

Ongoing initiatives

Climate resilience is inextricably linked with the city's wider economic and social-development prospects, and its ability to invest in new infrastructure. Access to housing and healthcare facilities improve the urban-poor population's coping capacity in the event of climatic disasters, thus reducing their vulnerabilities.

The disadvantageous physical and socio-economic condition of the urban poor has exacerbated the impacts of climate-induced stress on them. This is a vicious circle that needs to be broken and approached through a converging lens of housing, livelihoods, identity, and linkages with social and financial safety nets.

Chennai has already undertaken a range of initiatives for the provision of affordable housing,

Table 17 List of Ongoing Initiatives for Vulnerable Populations and Health

	Major Focus Areas	Projects/Initiatives
1.	Meeting the affordable housing demand by speeding up the construction	The GoTN has initiated the Tamil Nadu Housing Sector Strengthening Programme with financial support from the World Bank to increase access to affordable housing by strengthening policy, institutions, and regulations of the housing sector and increasing the supply of affordable housing.
2.		Chennai has developed around 1152 houses, which are sustainable, eco-friendly, and disaster-resilient under the Light House Project of Global Housing Technology Challenge (GHTC) with financial support from PMAY-U.[114]
3.		The TNSCB is working towards rehabilitating 65,000 families living in informal settlements along waterways with financial support from the World Bank and ADB.
4.	Ensuring climate resilient and environmentally sustainable housing	The TNSCB has set-up the "Environmental Management Framework" to ensure that the TNSCB's housing project interventions lead to environmentally sustainable outcomes.[115]
5.		The TNSCB has developed the Resilient Urban Design Framework (RUDF), as a manual that can be used as a ready guide to design high quality, sustainable and climate resilient developments.[116]
6.	Making the health system climate resilient	The GoTN has developed the TNSAPCCHH to reduce climate sensitive illnesses through climate resilient health systems.
7.	Making disaster relief centres accessible	The TNSDMA has developed the 'Heat Action Plan', 2019, which provides detailed guidelines and actions to ULBs to mobilise communities to avoid health impacts due to severe heat.

113 Tamil Nadu State Action Plan for Climate Change and Human Health, 2015.

114 Light House Project at Chennai. GHTC, PMAY-U. 2021. https://ghtc-india.gov.in/Content/pdf/16022021/02_LHP_Chennai_Booklet_15Feb2021_final.pdf

115 Environmental Management Framework. TNSCB. 2021. https://tnuhdb.tn.gov.in/storage/ck_uploads GHmuyQZ3JLIGlL8pTLfD5Pz3DtbLU9826bA3YoMI.pdf

116 Resilient Urban Design Framework. TNSCB. March 2020.

healthcare facilities, disaster relief centres, and various other social facilities to improve the quality of life of the urban poor. The initiatives are summarized below.

Sectoral Vision for Vulnerable Population and Health in Chennai

The gap analysis and mapping of the initiatives taken by the GCC and the GoTN through strategic appraisals have been used to identify the challenges and requirements for adaptation. Based on detailed consultations with the government and other stakeholders, the sectoral vision that has been identified – "Climate Proofing for All".In order to realise achieve this sectoral vision for all residents of Chennai, the following objectives and the key actions are given in the Table 18 along with the timeline, responsible stakeholders, monitoring indicators, alignment with plans, wider benefits, possible funding source and targets as follows:

Objective 1: Provision of Climate-Proof Housing for Vulnerable Population

The actions identified for this objective provide a combination of mitigation and adaptation measures for the housing sector and for the disaster relief centres. These measures are particularly important for the vulnerable communities and ensure that the housing for vulnerable communities are flood-resilient, heat resilient, and water- and energy efficient. These concerted actions will help achieve the two targets of 100 per cent slum households with access to safe, resilient, and affordable basic services; and no slums in high-flood risk areas by 2050. The detailed actions include:

- Rehabilitate populations located in floodplains, periphery of waterbodies, low-lying areas, and nearby coastal creeks.
- Conduct periodic assessment of the extent of vulnerability of fisherfolk population.
- Ensure retrofitting of existing slum housing to be heat resilient.
- Implement ECO-Niwas Samhita guidelines for all upcoming affordable housing projects.
- Include heat-resilient, water-efficient, and energy-efficient guidelines in the Tamil Nadu Combined Development and Building Rules (TNCDBR), 2019.
- Conduct assessment of disaster-relief centres that are in climate risk zones to ensure their accessibility and functionality.

Objective 2: Building Climate-Resilient Health Systems for All

The actions identified under this objective ensure community health resilience through decentralised healthcare support and rigorous awareness programmes on the impact of climate change on health. The detailed actions include:

- Prepare an operational framework for implementation of Tamil Nadu State Action Plan for Climate Change and Human Health (TNSAPCCHH).
- Create awareness among citizens, especially among the vulnerable population on impacts of climate change on human health.
- Strengthen healthcare services based on research on climate variables and impact on human health.
- Ensure regular monitoring of health care facilities in context of climate change.
- Development decentralised health services infrastructure (basti clinic) to improve citizens' access to health.
- Implement guidelines to reduce heat related health impacts on workers.
- Assess health facilities in climate risk zones to ensure their accessibility and functionality.

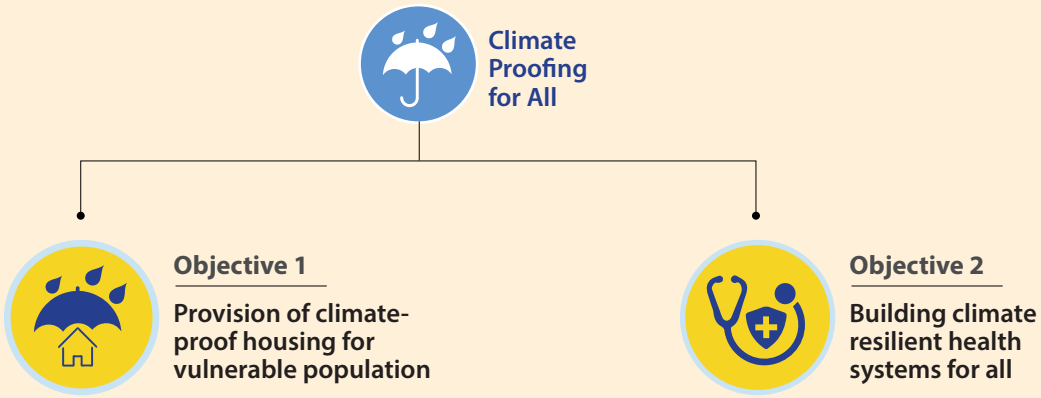


Figure 75: Sectoral Vision for Vulnerable Population and Health in Chennai

Proposed Actions Identified for Vulnerable Population and Health

Table 18 Proposed Actions Identified for Vulnerable Population and Health

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Targets

2030	2040	2050
150 Number of slums located in high-flood risk areas	100 Number of slums located in high-flood risk areas	0 Number of slums located in high-flood risk areas
50% of slum households having access to safe, resilient, and affordable basic services	80% of slum households having access to safe, resilient, and affordable basic services	100% of slum households having access to safe, resilient, and affordable basic services

The following action areas have been identified to deliver the City's targets:

1. Rehabilitate populations located in floodplains, periphery of waterbodies, low-lying areas, and nearby coastal creeks.
2. Conduct periodic assessment of the extent of vulnerability of the fisherfolk population.
3. Ensure retrofitting of existing slum housing to be heat resilient.
4. Implement ECO-Niwas Samhita guidelines for all upcoming affordable housing projects.
5. Include heat-resilient, water-efficient, and energy-efficient guidelines in the Tamil Nadu Combined Development and Building Rules (TNCDBR), 2019.
6. Conduct assessment of disaster-relief centres that are in climate risk zones to ensure their accessibility and functionality.
7. Assess the extent of vulnerability of fisherfolk population periodically.
8. Prepare a framework to ensure accessibility and functionality of disaster relief centres falling in climate risk zones.

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 1: Rehabilitate populations located in floodplains, periphery of waterbodies, low-lying areas, and nearby coastal creeks.

Time Frame: Short Term (2022–30)

Sub Actions:

- Conduct detailed re-survey of the identified 237 informal settlements that are in untenable areas and likely to get inundated as per the projected flood risk maps and rehabilitate those through a consultative process.

Stakeholders

Lead Role:

- Tamil Nadu Urban Habitat Development Board (TNUHDB)

Monitoring Indicator

- No. of households shifted to safer housing colonies

Alignment with SDGs/ Plans

- Slum free city plan of action, TNSCB
- SDG 13 Climate Action

Wider Benefits

- Relocation to safer habitats will ensure improved livelihood, quality of life for slum dwellers

Possible Funding/ Financing Source

- Funds from State & National Disaster management Programmes

Action 2: Conduct periodic assessment of the extent of vulnerability of the fisherfolk population.

Time Frame: Short Term (2022–30)

Sub Actions:

- Update marine fisherfolk census on regular basis with details of their standard of living, income levels and quality of assets.

Stakeholders

Lead Role:

- Tamil Nadu Urban Habitat Development Board (TNUHDB)

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 2 *contd*

Conduct periodic assessment of the extent of vulnerability of the fisherfolk population.

- Assess the actual location of the houses/ colony in relation to mean seal level rise and and distance from the coastal line

Monitoring Indicator
- No. of households shifted to safer housing colonies

Alignment with SDGs/ Plans
- Slum free city plan of action, TNSCB
- SDG 13 Climate Action

Wider Benefits
- Physical access and equal inclusion to a safer place for vulnerable people (equity, accessibility and inclusivity)

Possible Funding/ Financing Source
- Funds from State & National Disaster management Programmes

Action 3

Ensure retrofitting of existing slum housing to be heat resilient.[136]

136 Refer annexure 8.3.6

Time Frame

Short Term (2022–30)

Sub Actions:

- Establish IEC for citizens on adopting sun-reflective white paint, insulation layer, and cool roofs by involving local community workers
- Provide credit support for urban poor population to retrofit their houses through SHGs/ALF mechanisms or micro finance institutions.

Stakeholders

Lead Role:
- TNUHDB

Supporting Roles:
- GCC
- NULM department, GCC
- Credit Societies
- NGOs
- Local community workers

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 3 *contd*

Ensure retrofitting of existing slum housing to be heat resilient.

- Conduct a survey to identify most heat stressed slum housing (i.e., with roof material as asbestos/ metal sheet) and adopt cool roofs.
- Implement pilots for cool roofs in select slums as demonstration projects with support from local NGOs, academia to conduct research distance from the coastal line.

Monitoring Indicator

- No. of houses retrofitted with heat resilient materials
- No. of households who has received financial support under the credit schemes for retrofitting houses

Alignment with SDGs/ Plans

- Slum free city plan of action, TNSCB
- SDG 13 Climate Action
- SDG 3 Good Health and Well-being

Wider Benefits

- Relocation to safer habitats will ensure improved quality of life accessibility towards resilient housing infrastructure (Inclusivity, for fisherfolk
- Access to information can help targeted messaging in times of disaster, reduced loss of life
- Extended benefits in making buildings highly energy efficient

Possible Funding/ Financing Source

- Funds from State & National Disaster management Dept., GCC Budget

Action 4

Implement ECO-Niwas Samhita guidelines for all upcoming affordable housing projects.

Time Frame

Short Term (2022–30)

Sub Actions:

- Prepare guidelines/ advisories for architects and developers to develop energy efficient buildings.
- Conduct capacity building workshops with empanelled architects to follow these guidelines.

Stakeholders

Lead Role:

- Town Planning Department, GCC

Supporting Roles:

- Directorate of Town & Country Planning, GoTN

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 4 *contd*

Implement ECO-Niwas Samhita guidelines for all upcoming affordable housing projects.

Monitoring Indicator

- No. of trainings conducted
- No. of architects/ developers trained on guidelines

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- Energy Conservation and Building codes (ECBC)
- Resilient Urban Design Framework of TNUHDB

Wider Benefits

- Improved coping capacity to heatwaves through thermally comfortable housing
- Savings on electricity bill due to reduced energy demand

Possible Funding/ Financing Source

- Town Planning Department, GCC Budget
- Fundings from national govt. institutions such as MoHUA, MoEFCC.

Action 5

Include heat-resilient, water-efficient, and energy-efficient guidelines in the Tamil Nadu Combined Development and Building Rules (TNCDBR), 2019.

Time Frame

Medium Term (2030–40)

Sub Actions:

- Prepare guidelines/ advisories for architects and developers to develop energy efficient buildings.
- Conduct capacity building workshops with empanelled architects to follow these guidelines.

Stakeholders

Lead Role:
- CMDA

Supporting Roles:
- Town planning department, GCC
- NULM department, GCC

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 5 *contd*

Include heat-resilient, water-efficient, and energy-efficient guidelines in the Tamil Nadu Combined Development and Building Rules (TNCDBR), 2019.

Monitoring Indicator

- No. of housing schemes developed by following ECBC/ Resilient Urban Design Framework for retrofitting houses

Alignment with SDGs/ Plans

- Resilient Urban Design Framework, TNSCB
- TN ECBC codes

Wider Benefits

- Enhanced productivity of home-based workers, increased revenues,
- Improved quality of life for the women and elderly who are mostly depend on home-bound livelihood opportunities
- Improved access to water supply contributing to benefits to women

Possible Funding/ Financing Source

- Fund under National adaptation fund for Climate change
- Disaster management Dept., GCC Budget (slum upgradation)

Action 6

Conduct assessment of disaster-relief centres that are in climate risk zones to ensure their accessibility and functionality.

Time Frame

Medium Term (2030–40)

Sub Actions:

- Determine suitable sites for relief centres based on analysis of projected flood risk.
- Develop guidelines for retrofitting existing disaster relief centres or setting-up new ones.

Stakeholders

Lead Role:

- Disaster Management Department, GCC

Supporting Roles:

- Department of Revenue and Disaster Management, GoTN

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 6 *contd*

Conduct assessment of disaster-relief centres that are in climate risk zones to ensure their accessibility and functionality.

Monitoring Indicator	• Published framework/ bylaws on retrofitting/ setting-up new disaster relief centre
Alignment with SDGs/ Plans	• SDG 13 Climate Action • SDG 3 Good Health and Well-being
Wider Benefits	• Economic benefit (Climate proof infrastructure)
Possible Funding/ Financing Source	• Fund by State disaster response force (SDRF)

Action 7

Assess the extent of vulnerability of fisherfolk population periodically.

Time Frame: Medium Term (2040–50)

Sub Actions:

- Update marine fisherfolk census on regular basis with details of their standard of living, income levels and quality of assets.
- Assess the actual location of the houses/ colony in relation to mean seal level rise and distance from the coastal line.

Stakeholders	**Lead Role:** • Fisheries Dept, GoTN **Supportive Role:** • Tamil Nadu Urban Habitat Development Board (TNUHDB)
Monitoring Indicator	• Regular publication of fisherfolk census • No. of fisherfolk households shifted to safer distance from coastline
Alignment with SDGs/ Plans	• SDG 13: Climate Action

Objective #1

Provision of Climate-Proof Housing for Vulnerable Population

Action 7 *contd* | **Assess the extent of vulnerability of fisherfolk population periodically.**

Wider Benefits
- Physical access and equal inclusion to a safer place for vulnerable people (equity, accessibility and inclusivity)

Possible Funding/ Financing Source
- Funds from State & National Disaster management Programmes
- Welfare fundings from fisheries dept.

Action 8 — Prepare a framework to ensure accessibility and functionality of disaster relief centres falling in climate risk zones.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Determine suitable sites for relief centres based on analysis of projected flood risk.
- Develop ECO-Niwas Samhita guidelines for retrofitting existing or setting-up new disaster relief centres all upcoming affordable housing projects.

Stakeholders

Lead Role:
- Disaster Management Dept., Town Planning Department, GCC

Supporting Roles:
- Dept. of Revenue and Disaster Management
- Town & Country Planning, GoTN

Monitoring Indicator
- Published framework/ by-laws on retrofitting/ setting-up new disaster relief centre
- No. of trainings conducted
- No. of architects/ developers trained on guidelines

Alignment with SDGs/ Plans
- SDG 13: Climate Action
- SDG 3: Good Health and Well-being

Wider Benefits
- Economic benefit (Climate proof infrastructure) Improved coping capacity to heatwaves through thermally comfortable housing
- Savings on electricity bill due to reduced energy demand, especially for low-income groups.

Possible Funding/ Financing Source
- Fund by State disaster response force (SDRF)

Objective #2

Building Climate-Resilient Health Systems for All

Targets

2030	2040	2050
60% of the population with access to health infrastructure	80% of the population with access to health infrastructure	100% of the population with access to health infrastructure
100% of the population with access to information on the impact of climate change on human health	100% of the population with access to information on the impact of climate change on human health	100% of the population with access to information on the impact of climate change on human health

The following action areas have been identified to deliver the City's targets:

1. Prepare an operational framework for implementation of Tamil Nadu State Action Plan for Climate Change and Human Health (TNSAPCCHH).
2. Create awareness among citizens, especially among the vulnerable population on impacts of climate change on human health.
3. Strengthen healthcare services based on research on climate variables and impact on human health.
4. Ensure regular monitoring of healthcare facilities in context of climate change.
5. Develop decentralized health services infrastructure (basti clinic) to improve citizens' access to health.
6. Implement guidelines to reduce heat related health impacts on workers.
7. Conduct assessment of health facilities in climate risk zones to ensure their accessibility and functionality.

Objective #2

Building Climate-Resilient Health Systems for All

Action 1

Prepare an operational framework for implementation of Tamil Nadu State Action Plan for Climate Change and Human Health (TNSAPCCHH).

Time Frame

Short Term (2022–25)

Sub Actions:

- State government will prepare the framework for implementation and circulate to relevant stakeholders.
- Conduct capacity building and trainings of stakeholders for the implementation of TNSAPCCHH.

Stakeholders

Lead Role:
- Department of Health, GoTN
- Supporting Roles:
- Public health department, GCC

Monitoring Indicator

- Preparation guidelines prepared and circulated amongst stakeholders

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- Tamil Nadu State Action Plan for Climate Change
- NAPCCHH, MoEFCC
- WHO operational framework for climate resilient health systems, 2016

Wider Benefits

- Improved community health and coping capacity
- Access to quality health infrastructure

Possible Funding/ Financing Source

- Funding from Department of Health, GoTN
- Public Health Department, GCC - Budget

Objective #2

Building Climate-Resilient Health Systems for All

Action 2

Create awareness among citizens, especially among the vulnerable population on impacts of climate change on human health.

Time Frame

Short Term (2022–30)

Sub Actions:

- Identify a nodal agency responsible for undertaking IEC campaign.
- Develop IEC material on health impacts of climate change in collaboration with Department of Health, GoTN as per the guidelines of National Centre for Disease Control (NCDC).
- Conduct IEC drive through engaging local community workers and SHGs in developing community understanding on health impacts such as water-borne disease, vector borne disease, and extreme heat.

Stakeholders

Lead Role:
- GCC

Supporting Roles:
- Local community workers
- Public health department, GCC
- Department of Health, GoTN

Monitoring Indicator

- No. of local community workers identified
- No. of wards where awareness campaigns has been organised

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- SDG 3 Good Health and Well-being
- Tamil Nadu State Action Plan for Climate Change and Human Health

Wider Benefits

- Equal access to information for all. (Inclusivity, equity)

Possible Funding/ Financing Source

- GCC Climate Budget
- CSR

Objective #2

Building Climate-Resilient Health Systems for All

Action 3

Strengthen healthcare services based on research on climate variables and impact on human health.

Time Frame: Short Term (2022–26)

Sub Actions:

- Create database of professionals, researchers and institutions engaged in studies of impact of weather and climate on health.
- Identify best practices in implementation of measures to combat the effect of climate change.
- Engage with public health researchers on changing disease trends (as induced by climate change).

Stakeholders

Lead Role:
- Department of Health, GoTN

Monitoring Indicator

- List of professionals, researchers and institutions engaged in studies of impact of weather and climate on health at the state and district level
- List of 'best practices' in implementation of measures to combat the effect of climate change

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- SDG 3 Good Health and Well-being
- Tamil Nadu State Action Plan for Climate Change and Human Health

Wider Benefits

- Health benefit
- Access to information for all

Possible Funding/ Financing Source

- Funds under international banks like World Bank, ADB, etc.
- CSR

Objective #2

Building Climate-Resilient Health Systems for All

Action 4

Ensure regular monitoring of healthcare facilities in context of climate change.

Time Frame

Short Term (2022–26)

Sub Actions:

- Conduct critical review of existing health care facilities in alignment with Indian Public Health Standards (IPHS).

Stakeholders

Lead Role:
- Department of Health, GoTN

Supporting Roles:
- Public Health Department, GCC
- All health care facilities

Monitoring Indicator

- Percentage of health care facilities abiding to the standards

Alignment with SDGs/ Plans

- SDG 13
- SDG 3
- Tamil Nadu State Action Plan for Climate Change and Human Health

Wider Benefits

- Access to quality health services to all

Possible Funding/ Financing Source

- Fundings from Department of Health, GoTN

Objective #2

Building Climate-Resilient Health Systems for All

Action 5

Develop decentralized health services infrastructure (basti clinic) to improve citizens' access to health.

Time Frame

Short Term (2022–30)

Sub Actions:

- Identify slums and other vulnerable settlements with limited access to health service.
- Conduct rapid landscape study of existing models of community-level health services (Mohalla Clinic, Basti Clinic, etc.).
- Prepare engagement modalities of existing practitioners to provide health services at the basti level.
- Conduct IEC campaigns for residents to avail services at these health centres.

Stakeholders

Lead Role:
- Department of Health, GoTN

Supporting Roles:
- Public Health Department, GCC

Monitoring Indicator

- No. of Basti clinics set-up in city
- Percentage of wards with Basti clinics

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- SDG 3 Good Health and Well-being

Wider Benefits

- Accessibility at basti level
- Equity & Inclusivity as basti clinics will be available & cater to all

Possible Funding/ Financing Source

- GCC Health department Budget

Objective #2

Building Climate-Resilient Health Systems for All

Action 6: Implement guidelines to reduce heat related health impacts on workers.

Time Frame: Short Term (2022–30)

Sub Actions:

- Develop IEC for reconsidering working hours and on-site management of heat related issues in industries and, construction sites and avoid health impact on workers/ labours.
- Involve NGOs and SHGs to conduct IEC sessions, targeting site workers through contractors, and site engineers.

Stakeholders

Lead Role:
- Industrial association

Supporting Roles:
- Nodal agency for IEC
- Public health department, GCC
- Department of Health, GoTN

Monitoring Indicator

- No. of industries where awareness campaigns has been organised

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- SDG 3 Good Health and Well-being
- Heatwave action plan, TNSDMA

Wider Benefits

- Improved health of site workers
- Economic benefit for employers

Possible Funding/ Financing Source

- CSR
- GCC health Dept Budget

Objective #2

Building Climate-Resilient Health Systems for All

Action 7

Conduct assessment of health facilities in climate risk zones to ensure their accessibility and functionality.

Time Frame: Medium Term (2030–40)

Sub Actions:

- Carry out site analysis to understand potential climate related hazards for each PHC.
- Develop site specific retrofitting or relocation plan.

Stakeholders

Lead Role:
- Department of Health, GoTN

Monitoring Indicator

- Published by-laws on siting of new health care facilities

Alignment with SDGs/ Plans

- SDG 13 Climate Action
- SDG 3 Good Health and Well-being

Wider Benefits

- Accessibility to health facilities
- Economic benefit (Climate proof infrastructure)

Possible Funding/ Financing Source

- Fund by State disaster response force (SDRF)

6.2.7 Cross-cutting priorities on IEC & Capacity Building

There is a critical need for climate change adaptation and mitigation of GHG emissions to be embedded in the planning, design, and implementation processes involving all stakeholders, including citizens. To this end, practitioners and stakeholders must develop an understanding of both climate science and the link between climate impacts and city systems. This understanding must inform all appropriate decision-making.

Raising awareness and building knowledge about the expected impacts of climate change and the need to adapt would be the starting point of capacity-building efforts. Such efforts will include observations, predictions, and projections about existing and expected weather- or climate-related events or slow-onset events (e.g., increasing temperatures, water scarcity, loss of biodiversity, forest degradation, sea-level rise, etc.), damage statistics, and information on possible adaptation actions. Further, targeted capacity-building efforts will be required for sub-groups of stakeholders engaged in a specific sector, focusing on a particular climate risk and/or sector, or dealing with a multi-sector and multi-risks perceptive. These models of capacity-building efforts have been categorised as:

- Education (e.g., through schools, universities, other education service providers)
- Training programmes for practitioners (government and professionals, through courses, seminars, webinars, e-learning)
- City-to-city partnerships, peer-to-peer learning through C40, ICMA, and city networks

Similarly, an overarching, comprehensive, and specific communications campaign needs to be prepared for varied stakeholders. Specifically, there is a need to debunk myths regarding climate science and provide clear actionable steps to people. It is also critical to communicate climate science in a manner that makes it easier for non-scientific audiences to understand and makes it more relevant to their lives and experiences.

The principles for an IEC campaign will be:

- Messaging to be adapted to the context of each section of the society (e.g., children, women, men, across economic and social classes)
- Messaging to relate to the problems of Chennai and its people, so that people can relate based on their day-to-day experiences.
- Clear actionable/to-dos to be provided, along with the benefits of climate change adaptation and mitigation of GHG emissions for different sections of the citizens.
- Engagement of influencers/message multiplier.
- Engagement of elected representatives, NGOs, and CSOs.
- IEC to be treated as an ecosystem approach (all government stakeholders communicate the same vision and objectives).

Following is some of the generic actions recommended for IEC and capacity building:

- Conduct a Rapid Training Needs Assessment of stakeholders to be trained.
- Identify training providers for different stakeholders; devise methodologies with adult learning pedagogies.
- Design a training calendar focusing on inter-department groups.
- Conduct a sensitization programme for elected representatives.
- Create a communication strategy that has key messages for each segment of the audience and the modes of communicating to them.
- Design a communication campaign.
- Identify influencers and message multipliers and engage them in the strategy.
- Conduct school- and college-level competition, e.g., essay writing, debates on climate change.
- Include adaptation indicators in real-estate competitions, awards, and recognition.
- Media sensitization workshop for them to allocate space and air time.

Sector-specific IEC/capacity-building activities are discussed below in the Table 19, Table 20, Table 21, Table 22 and Table 23.

Solid Waste Management

Key Messages

- Waste segregation at source to enable the GCC to process efficiently
- Establishing the link between inefficient SWM and climate change
- Composting at source to reduce transportation emissions
- Reducing usage of single-use plastic

Table 19 Communication Strategy for Solid Waste Management

Sr. No.	Actions	Implementation Stakeholders	Target Group	Communication Modalities	Suggested Frequency
1	Generic SWM awareness campaign for the entire city to establish the identity for the SWM facilities provided by the GCC • An anchor character with plenty of humorous messages to depict people from all classes involved in littering • Establishing the link between SWM and climate change	• GCC SWM Dept.	• All citizens of GCC	• Posters, print media, media workshops to sensitize journalists/radio jockeys, billboards	• Rigorous campaign for the first 6 months
2	Interpersonal IEC initiatives aimed at citizens to segregate waste at source Recognize individuals as community champions who segregate at source	• Residential Welfare Associations • SHGs in slums/informal settlements • Market associations • GCC, SWM Dept.	• Households (including slum residents) • Residents' Welfare Associations • Bulk Waste Generators • Commercial Establishments	• Engagement of NGOs / SHG members • Print media, social media, radio	• Initial 6 months: interpersonal contact on a daily basis, then could be tapered off • Every quarter: Champions to be recognized quarterly
3	IEC campaign in schools and colleges • Introducing solid waste management practices in school & college curriculum (establishing the link between SWM and climate change) • Set up dry waste banks in schools &colleges • Composting units in schools and college (with canteens and hostels) as demonstration units	• Education Department, Govt. of TN • GCC, Education Department • GCC, SWM Dept.	• School going children • Youth	• Designating a few teachers in each school/college as sanitation coordinator • SOP for setting up waste banks and composting units	• Initial 6 months: establish pilot school and college • Scaled up to all government schools in 1 year • Scaled up to private schools in year 2

Transport

Key Messages

- Shifting from private vehicles to public transport or non-motorized transport
- Opting for electric vehicles over fossil fuel-based vehicles

Table 20 Communication Strategy for Transportation

Sr. No.	Actions	Implementation Stakeholders	Target Group	Communication Modalities	Suggested Frequency
1	Conduct campaigns with role models who advertise to use public transport, cycling, carpooling. Identify role models who are relevant to adolescents and youth as change ambassadors. Offer recognition award/ incentives for people who walk/cycle to work to promote NMT.	• GCC (and partnership with private players) • MTC • CMRL • MRTC	All citizens of GCC	• Multi-media campaigns • Print media • Social media campaigns	Rigorous campaigns in the first six months
2	Establish model walk to schools/walk to colleges at zonal level.	• GCC • NGOs	• Education Department • School going children and their parents • Youth	• Through engagement of schools, educational institutes, NGOs	Twice a month initially
3	Promote car sharing/ pooling and cycling to work-related trips. For example, posters, wall paintings showing "emissions per person", etc. in business parks/ offices.	• GCC • Private offices	• Youth, college going students • Office goers • Private offices	• Wall paintings • Posters • Social media • Radio	Once a week, initially
4	Organize car-free days across the city.	• GCC • NGOs	• All citizens of GCC	• Multimedia campaign • Social media • Radio	Once a week initially

Building Energy, Electrical Grid, and Renewable Energy

Key Messages

- Financial advantages of solar rooftops
- Financial advantages of investing in energy efficient appliances
- Socializing the ECBC Code among architects and builders

Table 21 Communication Strategy for Building Energy, Electrical Grid and Renewable Energy

Sr. No.	Actions	Implementation Stakeholders	Target Group	Communication Modalities	Suggested Frequency
1	Redesign electricity bills with more information about usage, thus nudging citizens to reduce usage.	• TANGEDCO	• All citizens of GCC, with focus on consumers with high energy usage- corporate offices etc.	• Pictorial/graphical representation	Monthly/ bimonthly months bill
2	Offer recognition programmes/incentives at community/ ward level for using solar panels. › Provide tags on the houses showing pride in installing solar panels.	• GCC • Community Management • TEDA • TANGEDCO • Smart City cell	• All citizens of GCC • Resident Welfare Associations • real-estate developers	• Competitions among real estate developers	Every six months
3	Roll out IEC Campaign for socializing the methods for installing solar rooftops.	• GCC • TEDA	• All citizens of GCC • Resident Welfare Associations • real-estate developers	• Conducting community level programmes • Workshops • Social media	Once a week
3	Raise awareness about benefits of passive design strategies in schools. › Add topics pertaining to climate change in school curriculum.	• GCC • Education Department • School Authorities	• Education Department • Association of private schools	• Workshops • Wall painting competitions • Social media • Conducting debates	Twice a month
4	Disseminate information on the advantages of energy-efficient materials/ appliances.	• GCC • Private Business owners	• All citizens of GCC • Resident Welfare Associations	• Advertisements, posters through social media • GCC and TEDA • Seminars, workshops, conferences that can be shown on local television channels.	Constant
5	Socialize the ECBC Code among architects, builders.	• TEDA • GCC • CMDA	• Architects • Real Estate Developers/ builders	• Seminars, workshops, conferences targeted to architects, builders, construction sector engineers	Twice a month

Urban Floods and Water Scarcity Management

Key Messages

- Dos and Don'ts before, during, and after floods and water-scarcity periods
- Stopping/reducing pollution of water bodies
- Enhancing/protecting green cover in the city
- Setting up and maintaining rainwater harvesting structures

Table 22 Communication Strategy for Urban Floods and Water Scarcity Management

Sr. No.	Actions	Implementation Stakeholders	Target Group	Communication Modalities	Suggested Frequency
1	Develop flood risk education and awareness programme for high-risk communities	• GCC • NGOs • Educational Institutes • Research Institutes	• Residents in high flood risk zones, • Schools and colleges	focus group discussion at community level	Once a week
2	Conduct trees plantation drives at community level to increase green cover and reduce surface runoff.	• Smart City Cell • GCC • NGOs • Educational Institutes • CSR	• All citizens of GCC • Resident Welfare Associations	Plantation drives at community/ society level	Once a week
3	Provide recognition programmes/incentivize citizens to practise rainwater harvesting.	• GCC • (Stormwater drainage department)	• All citizens of GCC • Resident Welfare Associations	• Conducting programmes at community level	Once a month
4	Use wall paintings, posters, social media, to make people aware about conserving water resources. For example, Instagram pages of Jal shakti, advertisements showing climate change and water scarcity. › Use Mobile messages. › Create messages printed on the inside and back cover of textbooks and notebooks or utilising water resources carefully.	• GCC • Water Department • Private Educational Authorities • Private Players	• All citizens of GCC • Resident Welfare Associations	• Area covered within city limit with wall paintings, posters etc.	Perpetual/ Constant
5	Organise audio spots/ jingle broadcast through radio for tree plantation and water conservation.	• GCC • Smart City Cell	• All citizens of GCC • Resident Welfare Associations	• Social media • Radio • Traditional folk songs	Perpetual
6	Conduct street plays to promote desirable behaviour towards making people aware about response towards climate hazards.	• GCC • CMDA • Smart City Cell • NGOs • CSR	• All citizens of GCC • Resident Welfare Associations	• No. of street plays conducted	Once a week

Vulnerable Population & Health

Key Messages

- Understanding early warnings
- Using low-cost methods to tackle extreme heat in slums/informal settlements

Table 23 Communication Strategy for Vulnerable Population and Health

Sr. No.	Actions	Implementation Stakeholders	Target Group	Communication Modalities	Suggested Frequency
1	Empower vulnerable communities to better understand early warning system.	• GCC • Smart City Cell	• slum residents • SHGs • schools and colleges	• Interpersonal communication • Awareness campaign	Once a week
2	Conduct community health resilience trainings.	• NGOs • Educational institutes • Research Institutes	• slum residents • schools and colleges • SHGs	• Focused group discussions	Once/twice a week
3	Conduct awareness walks (Walk for Health), especially for women and children.	• NGOs • Educational institutes • Research Institutes • GCC	• Women and children of GCC	• Inter-personal communication	Twice a month
4	Focus on children as communication agents to spread awareness about health and hygiene in schools.	• School Authorities • GCC • NGOs • CSR	• School Going Children, • teachers in schools • college going students	• School workshops • Essay competitions • Book side covers	Once a week
5	Spread awareness on how to respond during heat waves	• Local Community Workers • GCC • NGOs • CSR	• All residents of GCC with focus on Slum residents • Resident Welfare Associations • Industries • Real estate developers • Street vending association • SHGs	• Focused group discussions • Awareness campaigns	Once a week

Influence-Interest Grid

The objective of the influence-interest grid is to identify the level of influence specific change-makers and target stakeholder have, to work towards IEC and capacity-building.

For example, Figure 76 identifies stakeholders in four categories:

Category 1 are the stakeholders with the highest level of influence in affecting a change in attitude towards the climate crisis. They may have less of an interest in doing so, because of reasons such as lack of awareness towards climate change issues or lack of will power. Since this category has more potential to bring change – e.g., mass media, famous auto-mobile industries, elected representatives – they can be considered for IEC.

Category 2 are the stakeholders with a high level of influence and interest. Most in this category are those already working as change-makers. The rest can be targeted for support in capacity-building towards climate change, such as research institutes and RWAs. Category 2 is also important for IEC.

Category 3 are the stakeholders with low influence and low interest. They may not be aware of the climate-change impacts and the actions that can be taken to mitigate them, e.g., vulnerable populations.

Similarly, Category 4 are the stakeholders with a high interest but low influence. For example, SHGs that are interested in making a change but do not have major influence across the city, compared to, say, stakeholders in Category 1.

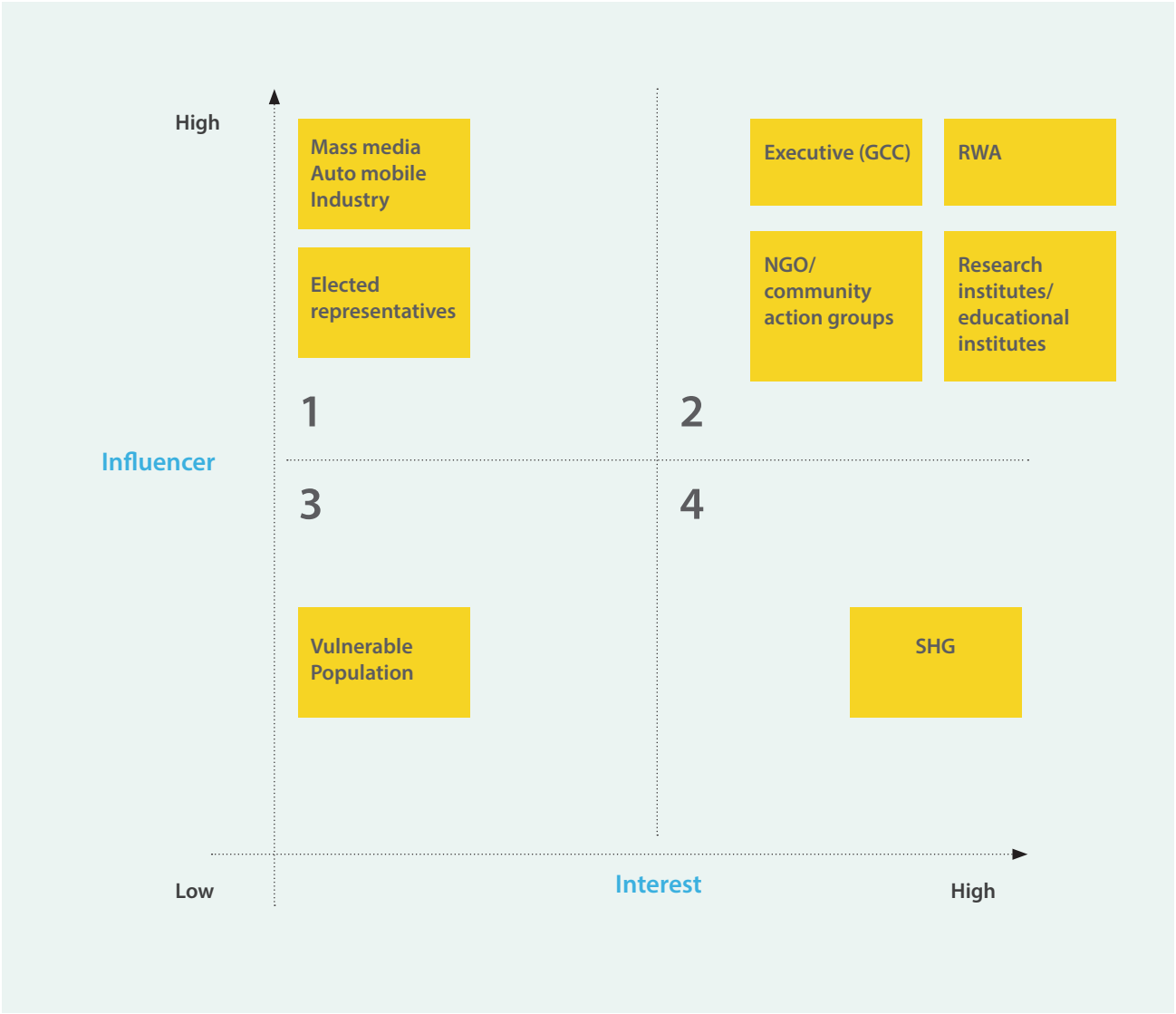


Figure 76: Identification of Stakeholders in Four Categories

Source: Urban Management Centre

CHAPTER

7

Implementing the Climate Actions

This chapter provides an overview of the current institutional landscape at the state and ULB level that is currently undertaking climate actions. It also details out the proposed institutional and governance changes in order to ably implement all the actions highlighted in chapters above.

7.1 Existing Organization Structure of the GCC impacting Climate Change in Chennai

This section details the existing governance structure of the Greater Chennai Corporation- its elected and administrative wings and various committees that currently play an important role in undertaking or influencing climate actions.

Elected Wing

The council of the GCC has 200 Councillors elected by citizens from each ward in the city. These 200 Councillors elect the Mayor from amongst them along with the Deputy Mayor. The Mayor is the Presiding Officer in the Council Meeting and assumes office for a period of five years. The Council ordinarily meets once a month. The Mayor is also the ex-officio member of every Standing Committee, Ward Committee, and Joint Committee constituted under the provisions of the act, but is not eligible to be elected as the Chairman of any committee. Each of the 15 Zones of the GCC has a Ward Committee, and the Councillors of respective zones are its members. One Councillor is elected as Chairman of the Ward Committee. The Ward Committee passes resolutions and sends them to the Council meeting for approval. There are six standing committees in the elected wing:

1. Taxation and Finance Committee

2. Works Committee

3. Health and Family Welfare Committee

4. Town Planning Committee

5. Education (Parks and Play fields) Committee

6. Accounts and Audit Committee


Source: iStock Photo

These Standing Committees are responsible for representing the concerns of their respective department in the monthly meeting. The Chairman of each Standing Committee is elected from among the members of such Committee. The standing committees have a statutory role and consist of 15 members each. The Standing Committee convenes a meeting every month and passes Resolutions and sends them to Council for Approval. The Hon'ble Mayor is the Chairperson of the Appointment Committee, which comprises two elected Councillors and the Commissioner as members. This Committee is convened every month and deals with all establishment and administration matters of the GCC.

Executive Wing

The executive wing is headed by the Municipal Commissioner (MC), who is responsible for developing and maintaining civic infrastructure of the city, including roads, water supply, sewerage, storm water drainage, solid waste management, health services, disaster management, and various other basic services to citizens of the Chennai city. There are four Joint Commissioners (JC)/ Deputy Commissioners (DC) deputed under the MC to look after Works, Health, Education and Revenue & Finance. The General Administration and Public Grievances (GA&P) is looked after by an Assistant Commissioner.

GCC provides its services through the following 17 departments:

1. Council Department
2. General Administration
3. Financial Management
4. Land & Estate
5. Revenue
6. Works
7. Town Planning
8. Mechanical Engineering
9. Electrical
10. Solid Waste Management
11. Buildings
12. Storm Water Drain
13. Bridges
14. Health
15. Family Welfare
16. Education
17. Parks & Play Fields

The administrative structure and reporting pattern with inter-linkages is provided in the Figure 77. The chief engineers look after multiple departments, while broadly, each department is headed by a superintending engineer.

Overall, the GCC works on implementation of maintenance, policy formulation, and finance related to city provisions, such as roads, water supply, sewerage, storm water drainage, solid waste management, health services, disaster management, and various other basic services. However, in the sectors of energy generation, regional and city transport, urban flood, and water scarcity management, the capacities of the GCC are limited and other state-level departments are responsible.

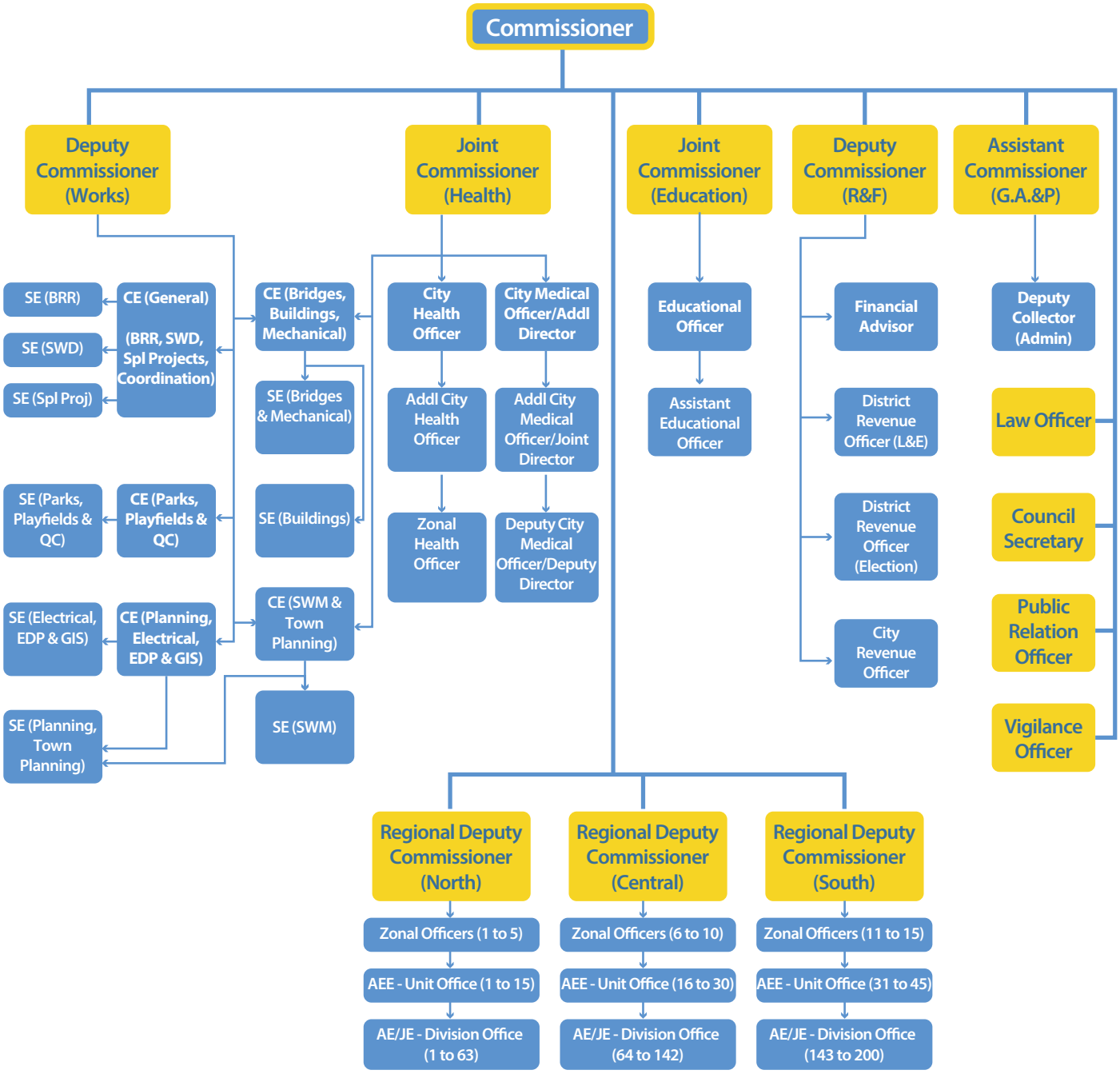


Figure 77: Administrative Structure of GCC

7.2 Existing Institutional Structure for Climate Governance at the State, District and City Level

The state of Tamil Nadu has taken the issues around climate change very seriously from both adaptation and mitigation strategies. The state government has set up state- and district-level institutions to lead these actions. Currently, there is a very limited coordination agency for climate planning development between state, district and GCC level.

Institutional Barriers

Limited Purview of GCC: GCC has a well-developed and time-tested governance structure for addressing the complex requirements of an ever-

Table 24 Existing Institutional Structure for Climate Governance in Tamil Nadu, Chennai District and City Level

State Level	District Level	City (GCC) Level
Tamil Nadu Governing Council on Climate Change **Chair:** Hon'ble Chief Minister, Tamil Nadu Comprises 22 members representing various State Departments/Institutions, as well as eminent personalities from the field and NGOs. Providing policy directive to the Climate Change Mission, advise on adaptation and mitigation activities, approve Tamil Nadu State Action Plan on Climate Change, and provide guidance to the Tamil Nadu State Action Plan on Climate Change, and guide the implementation strategy for climate action*. **State Disaster Management Authority (SDMA)** **Chair:** Hon'ble Chief Minister, Tamil Nadu Supported by State Executive Committee (SEC), it works for coordinating response to disasters and reducing risks, guidance, and supervision of all measures for mitigation, preparedness, response and recovery, approval of State Disaster Management Plan and District Disaster Management Plans. **State Relief Commissioner – State Commissioner of Revenue Administration** Undertakes all activities relating to disaster management and mitigation, besides managing relief and rehabilitation activities for any disaster in the state. **Revenue Administration and Disaster Management Department – Nodal Department** Policymaking and issuance of government orders based on approvals accorded by the SDMA. **State Advisory Committee (SAC)** An expert committee. Concerns of diverse sectors are taken into account while formulating strategies for risk reduction,	**District Climate Change Mission (DCCM)** Aimed at strengthening the climate response of the Government at grass root level. The DCCM is headed by the District Collector, with the District Forest Officer designated as the District Climate Officer for districts under their jurisdiction. The DCCM will function under the overall supervision of the TN Climate Change Mission and Tamil Nadu Green Climate Company (TNGCC), focusing on climate change adaptation and mitigation activities with financial outlay provided through funding from Environment Management Agency of Tamil Nadu (EMAT) and the Government of Tamil Nadu. The DCCM would have one technical field staff appointed on a short contract at the district to coordinate and design a calendar of events pertaining to capacity building and training, and to document the success stories from the programme. The DCCM would have a Project Management Unit, with Green Fellows appointed at district level under the Chief Minister's Green Fellowship Programme, and other local institutions, agencies, etc. shall involve various stakeholders – departments, agencies, institutions and NGOs in the adaptation and mitigation activities. The Green Fellows would disseminate information and ideas with the PMU of the TNGCC. Towards implementation of the State Action Plan at the district level, the DCCM would inter-alia comprehensively facilitate coordination with all departments, deliver information on mitigating negative effects of climate change, monitor performance against targets, communicate relevant issues among stakeholders and coordinate for implementation of TNCCM programmes, and enhance development planning through workshops on integrating climate change adaptation and mitigation at the grass roots level. An amount of Rs 10 lakh has been sanctioned from EMAT to each	Relief Committee, GCC Chair: Municipal Commissioner, GCC. It monitors major thrust areas for disaster mitigation, with multi-institutional support from Collector, CMWSSB, MRTS, Police department, Fire services, PWD, and other relevant departments. This also takes care of eviction of encroachments from waterbodies, and flood plains to maintain free flow of rainwater. Identifies new drainage systems and interlinking, existing drainage systems for efficient discharge of rainwater during monsoon period. Control Room in GCC Operates 24x7 during disaster times. Coordinates with other line departments such as TANGEDCO, CMWSSB, Fisheries, PWD, Fire and Police.

* Government of Tamil Nadu, Environment, Climate Change and Forest (EC.2) Department, Government Order No.G.O.(D) No.242, dated 21.10.2022 on Constitution of the Tamil Nadu Governing Council on Climate Change.

State Level	District Level	City (GCC) Level
including identification of funding sources for projects. **Climate Change Steering Committee** **Chair:** Chief Secretary It is the apex authority for initiating all the strategic decisions on climate change for the state. The operating arm of the Council is the Executive Council chaired by the Chief Secretary. With Director of Environment as the member Secretary, the Committee is further represented by Principal Secretaries to Government in the Departments of Environment and Forests; Finance; Energy; Industries; Public Works; Health & Family Welfare; Rural Development; Agriculture; Principal Chief Conservator of Forests; CMD, TEDA; Director, CCCAR, Anna University; and Director, Madras School of Economics. **Department of Environment, Climate Change and Forest** Preparation of State Action Plan on Climate Change (SAPCC), nodal agency for implementing SAPCC. Establishment of TN Climate Change Cell, to find ways through "Climate Change Governance" to develop modalities to implement State Action Plan on Climate Change (SAPCC) for each sector. **Tamil Nadu State Mission on Strategic Knowledge** Aims to build a greater understanding of the climate change processes, its implications on various sectors, and vulnerabilities associated with the same to enable sustainable adaptation to climate change. SPV – TN Green Company formed to oversee the 3 missions of TN CC Mission, Wetlands Mission, and Green TN Mission at the state level, and the District Climate Mission at district level. The TNGCC is supported by a Project Management Unit (PMU) at the state level.	of the district for conducting training programmes, capacity-building workshops, providing salary of technical/field staff, and developing related infrastructure. **District Disaster Management Authority (DDMA) for Chennai** Acts as the district planning, coordinating, and implementing body for disaster management. Takes all measures in accordance with the guidelines laid down by the SDMA.	

growing and dynamic city. The graded spatial structure covering its headquarters and regional administrative machinery, as well as its sectoral coverage (with placement of structures both at its headquarters as well as its regional structures extending up to wards) is comprehensive. This structure is functionally capable of undertaking the city management requirements, and the terms of reference engage the members actively to focus on day-to-day functions and ensure implementation of identified climate actions. However, the requirements for comprehending climate actions, conceiving programmes, and ensuring their coordination among internal departments as well as external institutions related to sectors such as energy generation, building energy, transport, urban flooding, and water scarcity management are too complex for each of the departments.

The GCC's departments fully cover critical sectors of water supply, sewerage, drainage, solid waste management, health, education, special projects, etc. This has helped in adequate and appropriate coverage of sectoral requirements, in terms of infrastructure development as well as delivery. Provision and access of critical infrastructure and services being the focus, in which the departments

have been substantially successful, it is critical to ensure alignment with climate-change imperatives and vision, as well as climate-change-linked sectoral actions through which the city's climate vision can be incorporated in all sectoral and spatial initiatives.

Multi-Level Institutional Approach for Climate Initiatives: It is clear that in the context of the GCC, the sectoral actions pertaining to climate change would require support and engagement by multiple external institutions. For instance, supply from the grid being the primary source, its decarbonization would require most actions from TANGEDCO on energy generation. Similarly, for reducing emissions from transport, multiple engagement with and by institutions dealing with renewable energy, MTC, TEDA, RTO, etc. would be required. Flood management and mitigation would require state- and regional-level association for catchment-area related actions. It is evident that each department within GCC may have to engage with the same external institutions for addressing their sectoral climate actions.

A few critical samples of how spatial and non-spatial actions/policies may require extensive and intense support from other departments of the state government/institutions are indicated here.

In the context of the active focus of sectoral departments and structures, and the evolving need for an intense and consistent interaction and engagement with external institutions to sustainably address the climate actions and implement the CCAP, it is imperative to establish a new, dedicated department within the GCC, i.e., a specialized Cell for Climate Change Initiatives that undertakes climate initiatives. This department may evolve inter-departmental strategies and actions as part of climate change vision of the city and embed climate agenda in sectoral initiatives, actions, and budget. Further, there is a requirement for a new dedicated department within the GCC to undertake climate initiatives.

Table 25 Policy Aspects

Aspects	Spatial policies/actions with a larger role for institutions in addition to the GCC	Non-spatial policies over which GCC does not have determining influence
Shift to solar power generation and use in buildings.	Enforcing rooftop solar panel installation for larger buildings of various use and providing technical guidance. Action required by CMDA.	Need for financial enablement in the form of subsidy/concessions for rooftop installation, as well as credit availability, technical guidance for a larger understanding and wider adoption. Support may be needed from Dept. of Energy; Dept. of Environment, Climate Change, and Forests; Department of Finance; and TEDA.
Modal shift by private vehicle owners to rail- or road-based public transport.	Designation of no-parking zones, park and walk zones, organized parking facilities near metro/major bus terminals for park and travel and cost for the same, luxury point-to-point services connecting employment locations at correct timings, parking charges for private vehicles, ensuring last mile connectivity – MMDA, CMRL, Sub-Urban Rail System, City Traffic Police, and MTC (in addition to GCC) would have to play a major role	Policies on Private vehicle registration. RTO.
Shift by private liquid fuel-based vehicle owners to electric/battery operated vehicles.	Availability of charging stations in buildings, parking areas, and at reasonable locations on city roads and bus terminals, as the public vehicles may have a limitation of about 200–300 km of travel/charge, reorienting travel lengths to short-distance options. CMDA, Suburban Rail, CMRL, and MTC may have a larger role to play in facilitating this.	Promotional policies for non-polluting personal vehicles manufacturing, registration, and usage; mechanism and policy for storage and dealing of waste batteries/storage material. State level.
Integrated water/flood management for the city, taking into account the regional/catchment areas perspective.	Capacity increase of regional lakes/storage facilities, periodical maintenance to retain the capacity of storage, maintenance linking of storages to ensure a regulated flow of flood waters, maintenance of adequate/natural flood plains to ensure water balance and regulated flow. WRD, CMDA, TNUHDB.	Regional water/flood management planning, linking of storage/lakes for ensuring regulated flow. State-level PWD dept/WRD.

7.3 Proposed Governance Structure for the Implementation of the CCAP

The Department of Environment, Climate Change, and Forest is the coordinating agency at the state level, but the implementation of actions identified as part of CCAP will require the GCC to play a predominant convening role. Hence, it is critical to create a dedicated department within the GCC, which will strengthen inter-departmental coordination, mainstream climate actions within existing priorities, and plan for effective implementation.

The predicaments to guide institutional strengthening for climate action include the following:

1. Climate change is not a sectoral subject to be dealt on a standalone basis by one department on a focused theme. It deals with a multitude of aspects that affect the survival of the city – the coverage and ramifications only partly understood.
2. In the metropolitan city context, wherein Chennai has a symbiotic relationship with its environs, most solutions lie in its vicinity and are beyond the jurisdiction of the GCC.
3. Climate change as an issue needs to be all pervasive in the various governance and administration levels of institutional structures.
4. To ensure comprehensive efforts, it is necessary that climate-change thinking be made an institutional culture and is reflected in the institutional spirit. "Think Development, Think Carbon Neutrality" should guide the city's development.

To make an appreciable impact, an integrative mechanism at the highest level of the state government will be required. While the current structures – the Tamil Nadu Governing Council on Climate Change (chaired by the Hon'ble Chief Minister of Tamil Nadu) and the Climate Change Steering Committee at the state level (chaired by the Chief Secretary) – does represent the requirements, in the context of larger urban centres in general and Chennai district in particular, the contribution to climate change must be more substantial and calls for pro-active, coordinated actions. Accordingly, it is proposed that an "Inter-departmental Coordination Structure" with the following composition (see Figure 78) be put in place to focus on climate-change initiatives in Chennai.

i. State-Level Reforms in Climate Governance

a. Tamil Nadu Governing Council on Climate Change (TNGCCC) to be expanded

The newly constituted TNGCCC (on 21.10.2022) is a major step towards ensuring coordinated implementation and monitoring of climate actions in the State. It incorporates representations from the departments of Finance & Human Resource Management; Industries; Forests, Environment & Climate Change; Industries, Investment Promotion and Commerce, Municipal Administration & Water Supply, Energy, Rural Development & Panchayat Raj, Housing and Urban Development, Animal Husbandry, Dairying, Fisheries and Fishermen Welfare; Agriculture & Farmers Welfare and the State Planning Commission.

In the context of contributors to GHG emissions, in urban areas in general and more particularly in larger cities, it is evident that the transport sector significantly contributes through vehicular emissions, and similarly the role of Revenue Administration & Disaster Management and Water Resources assumes greater importance in large urban areas such as Chennai in view of the potential impact on the densely built-up areas and population concentrations. Accordingly, it is proposed that the TNGCCC may be expanded to incorporate representation from Transport as well a Revenue Administration & Disaster Management Department.

b. Climate Change Steering Committee at the State Level to be Expanded

In the context of Chennai (and other larger cities at a later date), the Climate Change Steering Committee at the state level, headed by the Chief Secretary, may be expanded (by addition or co-option) to include the departments of Revenue Administration & Disaster Management, Municipal Administration & Water Supply, Housing & Urban Development, Water Resources, and Transport.

c. Management Board of TNGCC to be Expanded

To execute the major actions required to ameliorate conditions concerning large urban areas, particularly Chennai, the Management Board of TNGCC (which comprises the Addl. Chief Secretary ECC&F as Chairperson and Managing Director and is represented by Addl. Chief Secretaries of Departments of Finance, Energy, Municipal Administration & Water Supply, Agriculture and

Proposed Institutional Strengthening for Implementation of Climate actions identified under CCAP

	Expansion of: Tamil Nadu Governing Council for Climate Change	Expansion of: Steering Committee for Implementation of TNSAP	Expansion of: TNGCC Management Board
State Level	**Hon'ble Chief Minister, Tamil Nadu** **Present Members: Represented by state depts. of:** Environment, Climate Change & Forests; Finance; Industries; Investment, Promotion and Commerce, MAWS; Energy; Rural Development & Panchayati Raj; H&UD; Animal Husbandry, Dairies & Fisheries' Fisherman welfare; Agriculture and farmers' welfare; TNSPC; Eminent experts from the field; NGOs **To be expanded incorporating depts of:** Revenue Administration & Disaster Management; Transport; Water resources	**Chief Secretary, GoTN** **Present Members: Represented by state depts. of:** Environment, Climate Change & Forests; Finance; Public Works; Energy; Industries; Health and Family Welfare; Agriculture; Rural Development & Panchayati Raj; PDSI; Forests; and representatives from TEDA; Anna University (2); MSE; NABARD **To be expanded incorporating depts of:** Revenue Administration & Disaster Management; MAWS; HU&D; Water Resources; Transport	**Addl. Chief Secretary, Dept of Environment, Climate Change & Forests** **Present Members: Represented by state depts. of:** Finance; Public Works amd Water Resources; Energy; MAWS; Agriculture and Farmers' Welfare; Forests **To be expanded incorporating depts of:** Revenue Administration & Disaster Management; HU&D; Transport; Industries
District/ GCC Level	**Area Sabhas and Ward Committees to act as grassroot level instruments of climate change initiatives** Incorporation of an agenda on climate change issues in council meeting	**Modify and Expand: District Climate Change Mission** To be chaired by GCC-Commissioner (instead of District Collector); To act as a Coordination Committee for climate change with all internal depts and external concerned agencies invited	**New: Establish a Dept of Climate Change Initiatives** R&D, Implementation Facilitation and Monitoring & Evaluation Wings

Figure 78: Proposed Institutional Strengthening for Comprehensive Implementation of Climate Actions Identified under the CCAP

Farmers Welfare, Public Works and Water Resources, and Principal Chief Conservator of Forests, Tamil Nadu Forest Department) must be expanded to include representations of departments of Revenue Administration & Disaster Management Housing & Urban Development, and Transport.

ii. District/GCC Level

a. Public Participation as Hallmark of Climate Change Initiatives

To broad base the climate agenda, its understanding, and its pursuance at the grass root level, the following are proposed:

i. Area Sabhas and Ward Committees to act as grass root level instruments for climate-change initiatives:

The GCC is set to have about 2,000 Area Sabhas, to make suggestions for new projects in their respective areas. These will include residents from respective areas and will meet once in three months. The Ward Committee would have one member from each area, with the councillors representing the ward concerned heading the committee. These structured governance structures can act as the grass root level mechanisms for observation, identification, and support in implementation of climate change initiatives. These instruments can be used to mainstream ground level realities and inclusive issues, into development agenda and to holistically focus on climate change, inter-sectoral coordination and underscore priority actions in the city's overall development agenda and work plan.

ii. Incorporation of a mandatory agenda
on climate change issues- status, actions and progress in the Council meetings, Standing Committee meetings, and Ward Committee meetings. This would help mainstream the climate agenda and to appropriately make it inclusive in adaptation and mitigation efforts.

b. Executive Levels

i. The new District Climate Change Mission for Chennai needs to be chaired by the Municipal Commissioner, GCC. In the form of a Coordination Committee for Climate Change at the Chennai District level, it may be an inter-departmental committee with participation from other state departments/sectoral agencies and all concerned departments of the GCC as well. Mainstreaming the climate agenda and ensuring appropriate placement, management, and implementation of the climate agenda would be its main responsibility. This Committee may coordinate with external agencies – central, state, and foreign agencies, as well, by inviting their participation as required.
This Committee shall ensure aligning GCC's initiatives in line with state and national stipulations, and appropriately report to the institutional structures at these levels. This Committee would focus on institutional initiatives for minimization of emissions and preventive actions, efforts to reduce the impact, and effect of projects and activities of various departments on climate change agenda.

ii. New Department of Climate Change Initiatives:

In the context of complexity of evolution of climate change, occurrence, and impact, it is necessary that a reliable and permanent institutional system is put in place for undertaking a variety of functions concerning climate change actions including that of the District Climate Change Mission. This may operate under the leadership of Deputy Commissioner (Works)/ Deputy Commissioner (Climate Change).

Broadly, the primary responsibility of the department may include:

- Enabling a larger understanding of the imminent climate issues;
- Engaging with multiple internal and external departments/institutions/agencies for coordinated efforts for climate impact mitigation and adaptation, activity would cover comprehending the climate change issues;
- Evolving potential solutions in collaboration with the concerned departments/ institutions;
- Encouraging the responsible for action by providing standardised and feasible frameworks for assessment of appropriateness of actions, implementation, and climate audit of actions/projects by concerned departments/institutions; and

Informing/reporting to the Council, Standing Committee and the Commissioner on progress and monitoring.

7.3.1 Roles and Responsibilities of Proposed "Department of Climate Change Initiatives"

1. Review and update the GHG inventory.
2. Lead the preparation of localised zonal/ward level plans for managing climate risks and reducing carbon emissions.
3. Assess the progress of actions and realign sectoral priorities.
4. Ensure proper guidance and advice so that the Ward Sabhas and Ward Committees evolve as grass root instruments for implementation of climate change initiatives through facilitation by the climate officers at ward and zonal levels.
5. Advise external institutions on sectoral priorities through the District Climate Change Mission.
6. Periodically empower the internal departments of GCC as well as external stakeholders.
7. Analyse the implications of proposed major actions/projects by external institutions and take them up through TNGCC and State Coordination Committee as well as the proposed TN Climate Change Council.
8. Facilities parallel taking up of projects by multiple departments for common adaptation/ mitigation action.
9. Identify and advocate for local/national/ international funding opportunities for climate actions/ projects including carbon credit mechanisms.
10. Guide and facilitate climate budgeting within and outside GCC to ensure priority is accorded.
11. Ensure periodical Reporting and Evaluation at local, national, and international requirements to enable timely policy and action orientation to climate change initiatives.
12. Evolve as a storehouse and knowledge base on local, national, and international climate initiatives and best practices to guide other cities.
13. Other responsibilities include:

i. Research and Development:

- Undertake intense studies on various facets of climate change, in general and specific to Chennai city to forecast potential disasters and decipher the likely impact.
- Periodical updation of the Climate Action Plan to forecast alternate scenarios of risk perceptions under varying degree of disaster intensity. Periodical GHG assessment would be a routine function of this department.
- Strengthen relations & forge alliances with international/global institutions such as C40 so as to be updated on developments, guidance, and validation of efficacy of initiatives.
- Avail quality knowledge, exposure, and experience available with IIT-M, Anna University and such other institutions based in Chennai for innovation promotion and encouraging focused research.

ii. Adherence:

- Act as the nodal department within GCC for disaster management including regular updation and implementation of the City Disaster Management plan.
- Ensure adherence at GCC level to national and state level frameworks for climate change initiatives.

iii. Facilitation and Coordination

- Coordinate with related GCC departments as well as inter-institutional linkages for collective understanding and appreciation of risks as well as potential collective actions for disaster mitigation and adaptation, with reference to vulnerable communities.
- Ensure mainstreaming of climate change initiatives/actions as part of action agenda & work programme of each department by appropriately highlighting the relevant requirements periodically in line with the updated results of studies/conclusions.
- Enable a common understanding among all departments and spatial structures on the need to incorporate climate change mitigation and adaptation linked projects as feasible ways, incorporation of climate resilience focus in each department's action plan, climate budget, and have a climate resilience analysis of all the proposals and incorporate climate audit as a prerequisite for approvals.
- Firm up guidelines and frameworks to ensure that every new project is assessed for potential emission with carbon budgeting appraisal and carbon budgeting at departmental and GCC level.

iv. Undertake Pilot Projects and Handhold Implementation

- Undertake impact assessment studies

at project and GCC level to report to the Coordination Committee for directions and guidance; advise sectoral departments on taking up the actions as detailed in this CAP as well as those which may emerge in the coming years.

v. Enable Sustainability and Feasibility of Climate Actions

- Analyse the options for carbon credits and also alternate funding options for implementation of projects that would enable moving towards climate neutrality.

vi. Building Capacities on "Carbon Literacy"

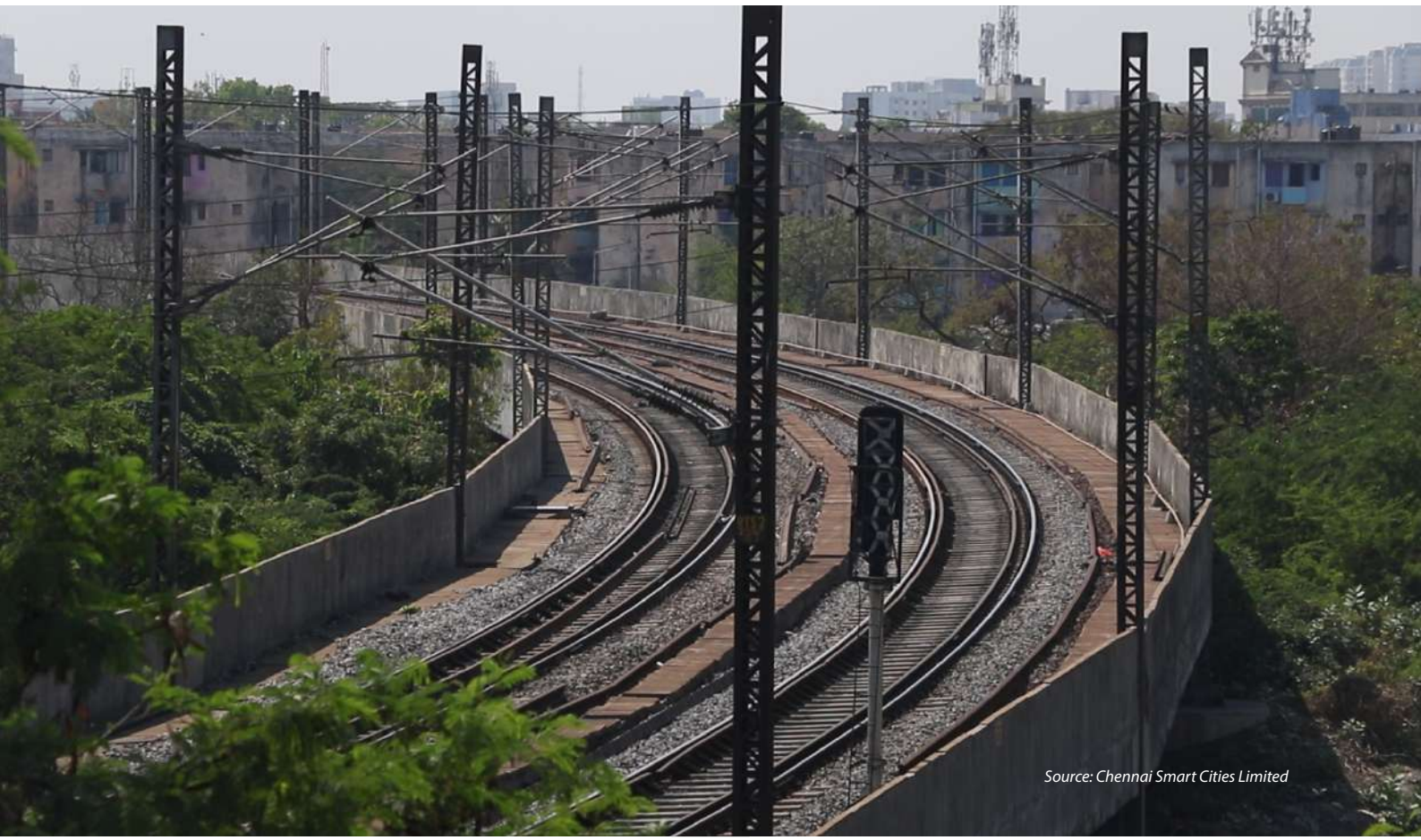
- lead the design and implementation of training programmes for GCC staff to enable them to implement actions in responding to climate change. The department will help identify the training pedagogy, assessment frameworks, training institutions and phasing of training programmes.

vii. Sensitization Programmes and IEC on Climate Change

- Sensitise civil society organisations and citizens at large through appropriate modes of training for individual as well as collective actions.
- Focus on enthusing the interest of youth at large and specifically school and college students on climate change initiative conception, implementation and monitoring, incorporation of climate agenda as part of course curricula at various levels.
- Evolve strategies to convert the inherent willingness to join disaster mitigation efforts among the public into a mass movement for climate change impact mitigation and adaptation.
- Evolve and disseminate focused IEC initiatives with the involvement of corporates, philanthropists, and climate enthusiasts at large.

viii. Annual Reporting

- Sharing of research findings, effectiveness of approaches at varied situations across departments and organisations and with citizens at large.



Source: Chennai Smart Cities Limited

7.3.2 Composition of the Proposed "Department of Climate Change Initiatives"

- The department should be headed by Deputy Commissioner (Works), GCC. DC (Works) being a head, ensures representation and internal coordination from all the departments of GCC.
- It should have **research & development, implementation facilitation and monitoring & reporting wings** which will enable a comprehensive and exclusive focus on climate change mitigation and adaptation measures. The existing staff/ human resource of these departments will be utilised to carry out the responsibilities of the Dept. of CCI.
- **Climate Officers at Zonal and Ward level** to be nominated from among the existing employees, who would assist the Ward/ Zonal Committee on climate agenda aspects by facilitating collection and provision of information on related aspects to the proposed new department in HQ.

7.4 Financing Climate Actions

Municipal budget in the GCC is formulated by respective departments, headed by the Deputy Commissioners in the administrative wing. Currently, the GCC's consolidated budget is prepared based on aggregated projects and budgets from each department. The budget for GCC for FY 2020–21 was approximately Rs 3,324 crores. The following graph presents the department-wise capital and revenue expenditure for 2020–21. The departments represented here are the ones likely to get aligned with proposed climate actions as detailed in the earlier sections.

Climate budget is a governance system that offers a way for cities to turn their climate commitments into funded and measurable actions and projects. It embeds climate targets, measures, and considerations into decision-making as part of a city's ordinary budgeting process. Climate budget is an essential tool for providing specialised focus on climate change projects under concerned departments – by identifying and allocating definite funding sources towards achieving the city's climate goals and targets. This requires the budget exercise to be taken up through the coordinated effort of the proposed Department of Climate Change Initiatives (CCI). The Department of CCI firmly structures the

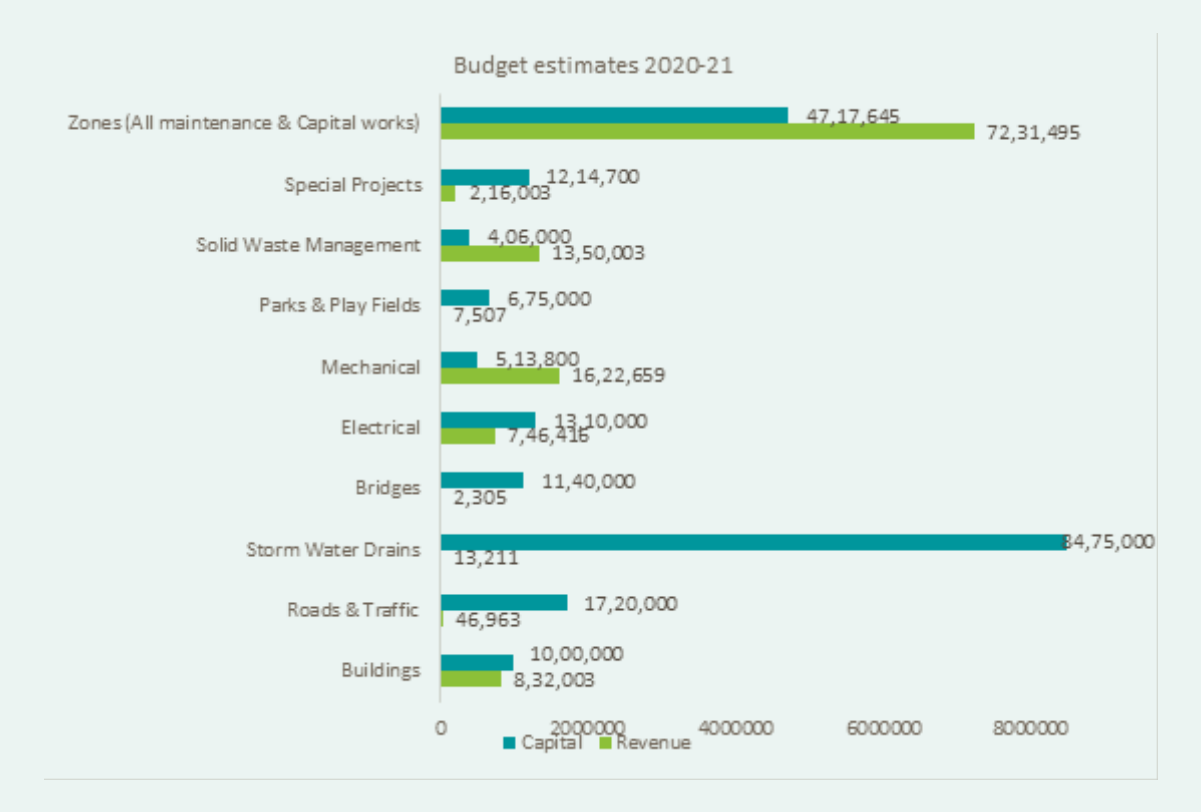


Figure 79: Major Department-Wise Percentage of Capital Expenditure and Percentage of Revenue Expenditure

Source: Urban Management Centre

inter-departmental activities and expenditure patterns proposed; it also identifies the related priority actions by concerned external departments along with their budgetary requirements. This further facilitates a coordinated identification of projects and allocation of funds for synchronised implementation of integrated projects.

Broadly, the climate budgeting will help in the following:

- Enlist the climate change relevant projects under/proposed for implementation in each of the departments within GCC.
- Enable a clear understanding of the relative importance of various departments in terms of the projects/plans being identified for implementation.
- Relate the identified projects in relation sectoral GHG emission inventory for the city and identify the gaps in sectoral focus.
- Provide indications of future orientation in project identification for implementation in relation to sectoral priorities.

Enlist potential opportunities for availing funds from alternate sources including state, national and international funding sources for projects with high climate change relevance.

The proposed department of Climate Change Initiative (CCI) will pool in required funding from various national and state schemes, such as AMRUT, SBM 2.0, DAY-NULM, FAME, NCAP, SMART cities, and 15th Finance Commission. This department will also be responsible for availing of international funding from the GCF, WB, ADB, and other multi-lateral finance and CSR funds.

"Carbon Credits" are a potential source of funding that not only enable local governments to support decarbonization beyond their own carbon footprint (hence accelerating the transition towards carbon neutrality), but also help finance projects that can enable better adaptation and reduction of GHG emissions. For example, ULB Indore Municipal Corporation, through consistent efforts in solid

and liquid waste management, earned close to Rs 9 crores in the form of 70,000 Carbon Credits in 2020-21. The GCC and Chennai Smart Cities Ltd. are also in the process of setting up a framework for Carbon Credits.

The other potential sources of funding for specific projects will be leveraging Corporate Social responsibility (CSR) or Institutional Social Responsibility (ISR) support of state- and local-level corporates. The Department of CCI could set up a desk to invite support from CSR/ ISR heads to partner with GCC in the implementation of projects. This will also give active corporates and citizen groups a platform to participate in and contribute towards a carbon-neutral future.

As the GCC's consolidated budget is prepared based on aggregated projects and budgets from each department, it is envisaged that the proposed Department of CCI will prepare a specific budget required for actions not accounted for by the implementing department. This will include overarching capacity building efforts as well as IEC.

The C40 is already implementing a climate budget pilot programme. Led by the city of Oslo, the 11 pilot cities are exploring feasibility (in their respective contexts) and investigating, developing,

Financing Climate Actions through Green Bonds – Cape Town, South Africa

What are Green Bonds?

A green bond is a debt security issued by an organization for the purpose of financing or refinancing projects that contribute positively to the environment and/or climate. It is also known as a "Climate Bond". Green bonds are becoming an increasingly common feature of urban climate initiatives.

In 2017, Cape Town issued its first municipal Green Bond, which was used to invest in projects that align with the city's mitigation and adaptation sustainability goals, funding low carbon transport, water management, coastal protection and energy efficiency projects across the city. The bond issuance raised 1 billion Rand (the equivalent of approx. $76 million USD).

The Green Bond is the first in South Africa to meet the stringent Climate Bond Initiative (CBI) taxonomy requirements, which ensures that projects are aligned with global Paris Agreement and its climate commitments. There were instances where the bond was oversubscribed 4x due to high investor uptake, demonstrating the immense potential of city-led green finance and investor appetite for this financial approach.

The bond has facilitated mainstream environmental sustainability across the city council and has been an important tool in diversifying the city's funding portfolio.

Green Bond
(private sector issuance)

Financial instrument:

1 bn Rand
(approx. $75 million)

Cost:

Commercial Banks, International Finance Institutions

Funding source:

Lay a foundation for innovative climate finance

Objective:

Cape Town managed to increase investor interest by:

- Maintaining a high credit rating;
- Developing a pipeline of projects linked to adaptation and mitigation; and
- Implementing a robust project tracking and information system

implementing, and improving the use of the climate budget to tackle GHG emissions. For example, Cape Town in South Africa has financed their climate actions using green bonds.

In Chennai, the effort may be spearheaded by the proposed Department of CCI, in association with the finance/budget department, which will be in consonance with the urgency for climate actions that the CCAP underscores and the GCC deserves.

7.5 Tracking Progress

A structured, integrated, and system-driven monitoring, evaluation, and reporting framework of climate initiatives is a pre-requisite for ensuring the successful, goal-oriented, and spatially and sectorally integrated implementation of climate change mitigation and adaptation initiatives. Particularly in the context of Chennai, where the determinants of GHG emissions are dynamic in relation to emerging policy and implementation contexts.

Tamil Nadu is frontrunner in climate change mitigation and adaptation initiatives, which has generated several opportunities for data collection, assimilation, and collation to facilitate informed decision-making. As a follow up to the TNSAPCC, several related initiatives have been taken up, which can support better data assembly and integration at various levels. A few such initiatives include the establishment of the TNGCC, the launch of three state missions related to climate change, the institution of a mechanism at the district level (the District Climate Change Mission), the formation of an SPV for shoreline revitalization (by the Department of Housing & Urban Development), and the creation of a special advisory to the TNHB and THUHDB for incorporating provisions concerning thermal transmittance in all ongoing and new projects (affordable housing developments for mainstreaming energy efficiency, climate resilience, etc.).

7.5.1 Monitoring, Evaluation, and Reporting for Climate Change in GCC

The three pillars of effective monitoring, evaluation, and reporting are: i) Specifying sectoral goals specification and identifying related data/ information sources, ii) Ensuring structured mechanism for information inputting/receipt through an automated system involving relevant stakeholders, and iii) Assembling, collating, integrating, interpreting, and translating for action

Source: Urban Management Centre

identification and assessment in relation to goals.

The MER framework for the CCAP aims to address these requirements. The GCC, through the proposed Department of Climate Change Initiatives (CCI), will develop a comprehensive portal for climate change-related data/information, called the "Chennai City Climate Change Information System" (C4IS). The C4IS is intended to facilitate information assembly and analysis, as well as outline action indications. It will also help in periodical monitoring, evaluation, and reporting.

The indicators have been detailed in the sectoral action plans. Additionally, emphasis has been placed on ensuring that these indicators align with the data that GCC is already collecting as part of its reporting to the state or national levels.

Monitoring

While the state-level initiatives are indeed comprehensive, the intensity and variety of climate impacting aspects – the buildings, transport, and waste in a mega-city context – underscores the need for evolving city-specific forecast models that can adequately cover and address the special requirements of a mega city.

The C4IS will collate information on GHG emissions from sectoral institutions. Concerned institutions such as TANGEDCO, CMRL, MTC, Suburban Rail, TEDA, CMDA, TNUDHB, and CMWSSB will update their progress periodically on the C4IS. Thereafter, the C4IS will collate information on the development initiatives towards climate resilience. The SWD department, Parks & Gardens department, Town Planning department, Water Supply department, Disaster Management department, and Public Health department will update their progress regularly on the C4IS.

The system will also enable collation of existing information from sources, such as ENVIS, IMD, TNSAPCC Cell (in DoE), Climate Service Information System (CSIS) Portal, TNGCC, Climate Studio, the three special state missions, and H&UD SPV on Shoreline Revitalization. Finally, it will aggregate information from special studies by various research Institutions including IIT, Anna University, Remote Sensing Centre, ICCR, Sectoral NGOs, and international Institutions such as WB, ADB, and KfW.

The proposed CCI department will be responsible for collation, analysis, and representation of the data as per the required frequency and the indicators framework. For monitoring the progress at a sub-city level, the CCI will be supported by the Climate Officers at zonal and ward levels, as well as from the

fellows in the District Climate Change Mission.

Such an integrated MIS portal for institutions to report and monitor their GHG emissions and measures taken for improving resilience is proposed to be created. The frequency of the information flow from institutions/other sources shall be bi-annual, to ensure capturing any significant change in the patterns, while the GHG inventory and climate-risk assessment shall be updated annually. The bi-annual results of the inventory will also be provided to concerned departments/sectoral institutions for corrective actions. A MIS platform for institutions to report their GHG emission is yet to be structured. Institutions will need to structure the requirements and upload them on their respective websites, so that the information on the C4IS is updated regularly and automatically. The information flow from institutions/other sources can be bi-annual, to ensure significant change in the patterns, while the GHG inventory and climate-risk assessment

Table 26 Sectoral Key Performance Indicators

Buildings and Energy				
Action Area	**Key Performance Indicators**	**2030**	**2040**	**2050**
Increasing renewable energy in the grid	Percentage of renewable energy in the grid mix	39.0%	67.0%	93.0%
	Percentage of total residential & commercial buildings with solar PV installed	2.00%	5.00%	10.00%
	Revision in the net-tariff policy	yes		
Energy-efficient appliances	Percentage LED lighting in commercial and residential buildings	10%	50%	80%
	Percentage of High efficiency appliances in existing and new commercial buildings	40%	60%	100%
	Percentage of High efficiency appliances in existing residential buildings	40% Mid & 5% High	60% Mid & 10% High	80% Mid & 20% High
	Percentage of High efficiency appliances in new residential buildings	20% Mid & 20% High	30% Mid & 40% High	40% Mid & 60% High
	Commercial cooling system technology (% of high efficiency chillers)	40%	80%	80%
	IEC communications strategy prepared and disseminated	yes		
	No. of households provided credit support for upgrading appliances to energy efficient ones	1000	5000	25000
Green buildings	Notification of the ECBC Code and cadre of trained professionals ready	yes		
	Cadre of trained service providers for retrofitting existing building stock	yes		
	Percentage of new eligible buildings as per ECBC-compliance	100%	100%	100%
	Public database of certified energy usage created		yes	
	Percentage of new residential buildings with Solar Water Heating Systems installed	30%	50%	70%
Passive design and thermal comfort	Percentage of new affordable housing which is climate resilient	100%	100%	100%

Transport				
Action Area	**Key Performance Indicators**	**2030**	**2040**	**2050**
Public transport	Percentage of population within 400m walk of public transportation option (e.g., bus, metro, light rail)	60%	100%	100%
	Percentage of residents using public transport or walking/cycling	40%	60%	80%
	Integrated road design standards developed	yes		
Non-motorized transport	Percentage of mode share	28%	32%	36%
	DPRs for Development of dedicated bicycle highways	yes		
Fuel Shift	Percentage of electric vehicles in the city	3%	10%	20%
	Percentage of private vehicles dependent on ethanol blending	13%	22%	23%
Waste Management				
Action Area	**Key Performance Indicators**	**2030**	**2040**	**2050**
Waste diverted from dumpsites and landfills	Percentage of recyclable waste diverted from dumpsites Plastic waste	80%	90%	100%
	Paper waste	20%	50%	100%
Efficient door to door collection systems	Percentage of households with reliable door to door collection service	100%	100%	100%
	Percentage of households providing segregated waste	75%	100%	100%
	IEC strategy prepared and disseminated	yes		
Dumpsite remediation and scientific disposal	Percentage of legacy waste remediated	100%	100%	100%
Urban Flooding & Water Scarcity Management				
Action Area	**Key Performance Indicators**	**2030**	**2040**	**2050**
Increased capacity and coverage of storm water drainage	Percentage reduction in water stagnation locations	100%	100%	100%
	Percentage of arterial and sub-arterial roads covered with storm water drainage network as feasible	50%	100%	100%
	Percentage of properties connected to sewer network	100%	100%	100%
Increasing in permeable surfaces	No. of blue and green infrastructure sites developed	25	50	75
	Percentage increase in per capita green space	25%	33%	40%

Rainwater harvesting systems built	Percentage of properties with rainwater harvesting systems as feasible	100%	100%	100%
Flood and Disaster Resilience	Percentage of population trained to respond to hazard risks	100%	100%	100%
	Percentage of population with access to disaster relief centres within their ward	100%	100%	100%
	Percentage of disaster relief centres turned climate resilient	100%	100%	100%
Vulnerable Population and Health				
Action Area	**Key Performance Indicators**	**2030**	**2040**	**2050**
Heat resilience	Increase in no. of households availed credit/loan via credit societies for heat resilient housing	2%	5%	8%
Health management	Percentage of population made aware of climate-related health impact	100%	100%	100%
	Percentage of population with access to affordable health services (basti clinics)	35%	60%	100%
	Percentage of health facilities turned climate resilient	100%	100%	100%

can be updated annually. The bi-annual results of the inventory may be provided to concerned departments/sectoral institutions to orient the focus of their action plans, and the annual results can be used as an interim guiding support.

The KPIs for priority action areas are listed in Table 26. As part of the monitoring process, sectoral KPIs for identified priority areas will be specified. The final KPIs and action areas may vary over the years, depending on the changing policy and implementation contexts.

Reporting

The CCI will report the annual sectoral progress as per the above indicator framework to the State Steering Committee through the CSIS of DoEon. This will ensure that the progress is integrated in the DoECC&F's reporting to the state government and the MoEFCC.

Annual reporting to state-level authority will also help in issuing appropriate directives to the concerned department for expediting/reorienting actions towards climate-change mitigation and adaptation.

Review and Revision of the CCAP

The GHG inventory and the CCRA shall be revised annually. The proposed CCI department will take the lead in ensuring that all data required for this updation is captured in the C4IS. The CCAP, as a comprehensive exercise, will be reviewed and updated on a five-year cycle.

Table 27 Distribution of Responsibilities for Review and Revision of the CCAP

Major Sources of Information	Data Integration and Portal	Data Sharing & Reporting
GCC Departments Institutional Sources TANGEDCO CMRL MTC Suburban Rail TEDA CMDA TNUDHB CMWSSB **State Network Sources** ENVIS IMD TNSAPCC-Cell Climate Service Information System (CSIS) Portal TNGCC CSIS Climate Studio Three Special State Missions H&UD SPV on Shoreline Revitalization **Special Studies Research Institutions** IIT Anna University Remote Sensing Centre ICCR Sectoral NGOs & Consultancy Organization International Institutions – WB, ADB, KfW	**GCC** Department of Climate Change Initiatives (including District Climate Change Mission) C4IS (Chennai City Climate Change Information System) Supported by ward-level nominated climate officers and fellows engaged as part of the District Climate Change Mission	**GCC** Coordination Committee Council Citizen facing dashboard and information **State** DoECC&F - CSIS Portal TNGCC Board State Steering Committee on Climate Change State Disaster Management Authority State Council for Climate Change

Source: Urban Management Centre

CHAPTER

8

Annexures

8.1 Methodology Followed to Determine Chennai's GHG Emission Footprint

The citywide GHG inventory is crucial to climate action planning. It uses a standardised methodology to estimate the sources and sinks of GHG emissions in the city. Through city-specific activity data, proxy indicators, and well-documented calculations, it creates a sectoral and temporal map of how much the city is contributing to climate change. This data can then be used to compare Chennai with global and regional cities and assess their strengths and challenges. This allows cities to formulate evidence-based mitigation actions and policies and is a powerful tool for monitoring progress towards climate goals.

The GPC is built on the principles of relevance, completeness, consistency, transparency, and accuracy. It is also accepted by the World Bank, the United Nations Environment Programme, and UN Habitat as the standard methodology for assessing city-level GHG emissions.

The framework adopted by the GPC to allocate emissions to the city is known as the "City Induced" framework. The following diagram summarises the sectoral and geographical boundaries that comprise a comprehensive city-induced emissions inventory. The framework allows for 2 levels of reporting, BASIC and BASIC+. The BASIC+ reporting level more closely matches the national reporting framework of the Intergovernmental Panel on Climate Change (IPCC), while the BASIC inventory level is more representative of the local level sources and sinks. The BASIC standards cover scope 1 and scope 2 emissions from stationary energy and transportation, as well as scope 1 and scope 3 emissions from waste.

A summary of the elements of the BASIC level inventory are as follows:

This inventory was possible because of the generous support of stakeholder from across Chennai and Tamil Nadu. The list of stakeholders reached out

Source: Urban Management Centre

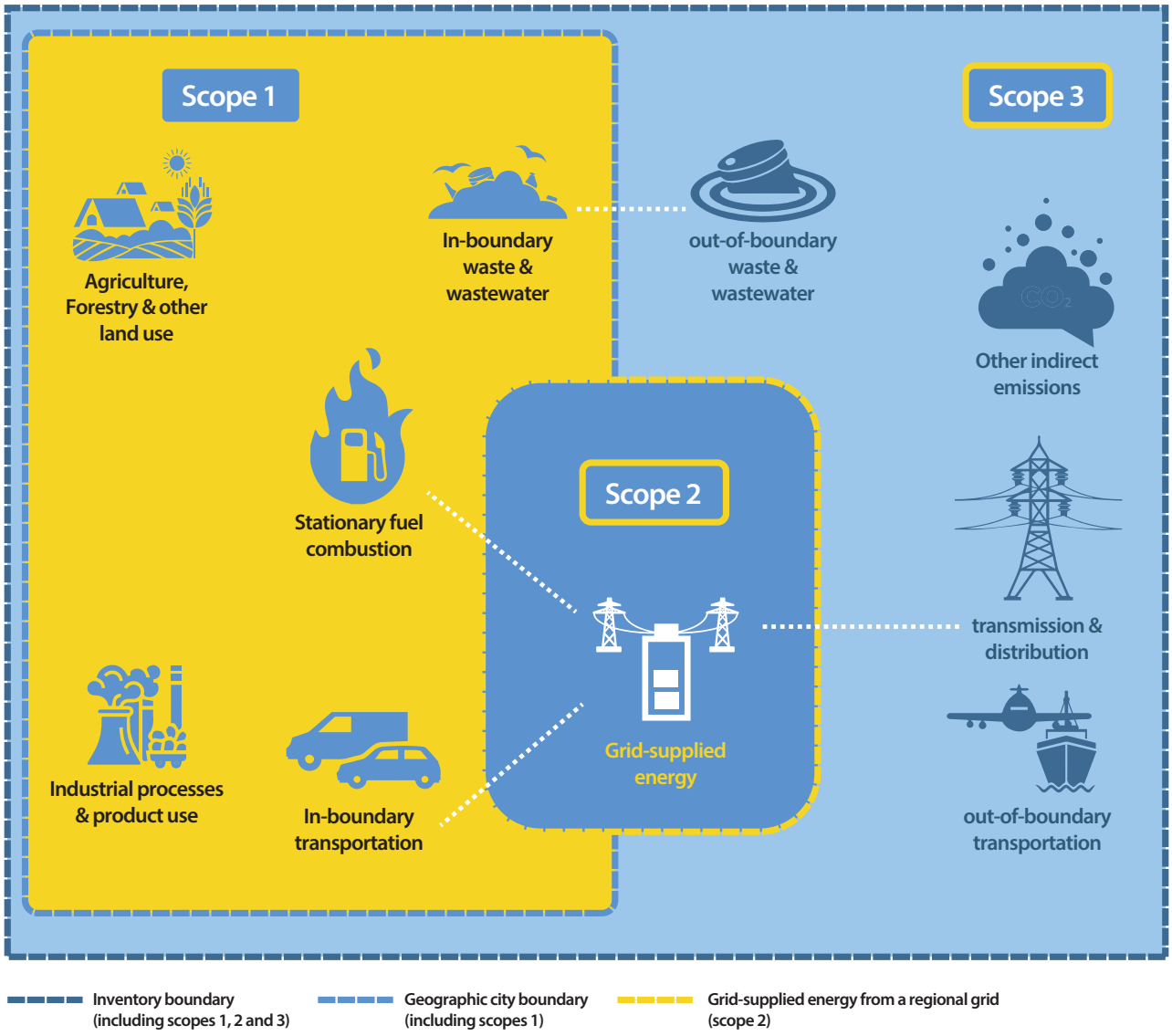


Figure 80: Elements of the BASIC-Level Inventory*

* Global Protocol for Community-Scale Greenhouse Gas Inventories, C40 Cities, WRI, ICLEI

Emission sources and scopes included in BASIC totals:

All scope 1 emissions from Stationary Energy sources, such as emissions from residential, commercial, institutional buildings, manufacturing and construction industries, and energy industries (excluding energy production supplied to the grid, which shall be reported in the scope 1 total)

All scope 1 emissions from Transportation sources. such as emissions from in-boundary public transportation, private transportation, and intermediate public transport (IPT)

All scope 2 emissions from Stationary Energy sources and transportation.

All scope 1 emissions from Waste sources, such as solid waste and wastewater (excluding emissions from imported waste, which shall be reported in the scope 1 total)

Scope 3 emissions from treatment of exported waste.

to is given in the annexure 8.4. The City Inventory Reporting and Information System (CIRIS) tool[117] developed by C40 Cities was used to prepare the inventory.

8.2 Summary of Prioritized Key Risks Per Hazard Theme As per Rapid CCRA

Summarized and prioritized list of key risks		
Hazard theme	**Key risks**	**Rank/prioritisation**
FLOODS & STORMS	Damage of physical and social infrastructure due to flash floods	Very high risk
	Increase in water borne diseases due to loss of basic sanitation infrastructure	Very high risk
	Reduced economic productivity due to inundated zones	High risk
	Loss of shelter and food security due to floods	High risk
	Loss of green cover due to cyclonic storms and river floods	High risk
	Decreased access to drinking water and food in slum areas due to inundated zones	High risk
HEAT	Increasing temperature may reduce the yield of surface water	Very high risk
	Reduced work productivity due to extreme heat stress	Very high risk
	Severe health impacts due to heatwaves resulting in reduced work productivity	Very high risk
	Increased demand for freshwater consumption may create inequality in vulnerable communities	High risk

117 C40 Cities (https://resourcecentre.c40.org/resources/reporting-ghg-emissions-inventories), Retrieved on 27 August 2022

Summarized and prioritized list of key risks		
Hazard theme	**Key risks**	**Rank/prioritization**
DROUGHT	Water scarcity due to drying up of major surface waterbodies	Very high risk
	Reduced quality of hygiene and sanitation due to water scarcity	High risk
	Closure of schools and education facilities due to lack of water and sanitation facilities	High risk

Summarized and prioritized list of key risks		
Hazard theme	**Key risks**	**Rank/prioritization**
Other themes (e.g., winter storms, sea-level rise)	Coastal flooding due to sea level rise	Low risk
	Saltwater intrusion in rivers replacing freshwater	Low risk
	Economic loss due to replacement of ports and power plants required because of sea lever rise	Low risk
	Coastal flooding may hinder biodiversity	Low risk
	Coastal flooding due to sea level rise and flooding impacting coastal livelihoods	Low risk

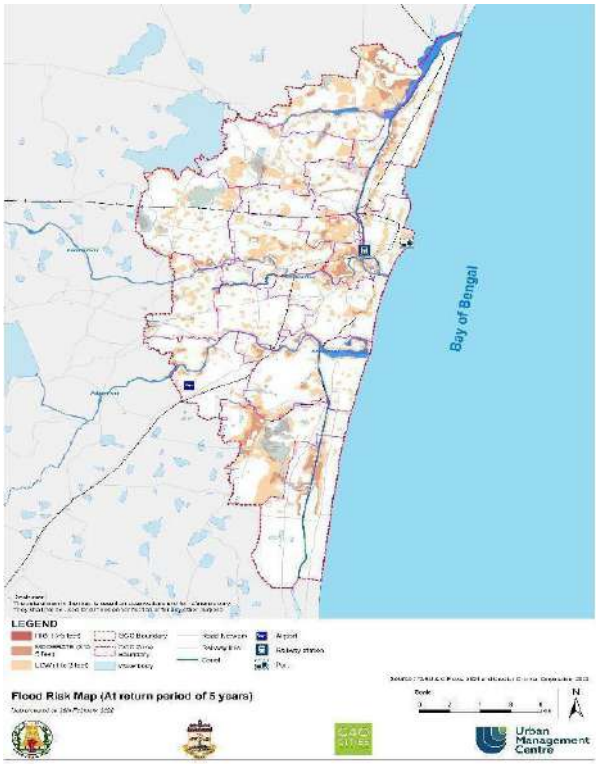
Source: Urban Management Centre

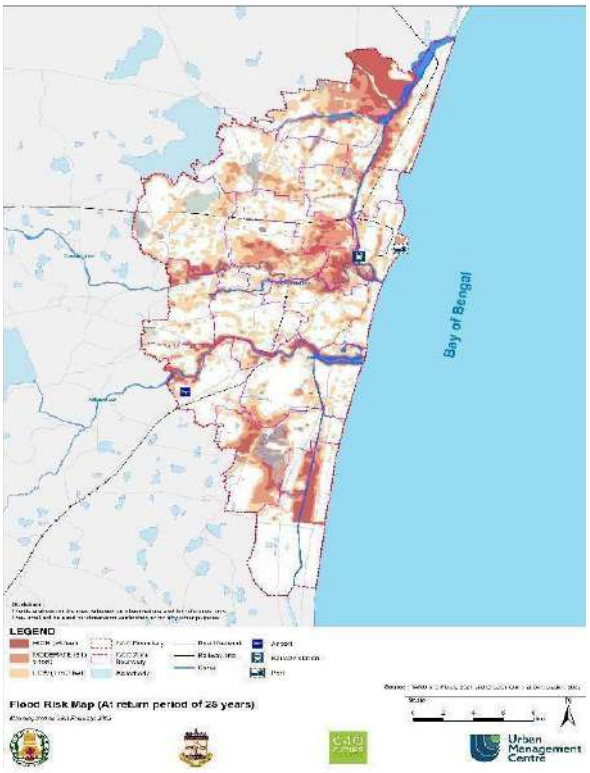
8.3 Maps Representing Chennai's Climate Vulnerabilities

8.3.1 Areas at the risk of Flooding at Return Period of 5 Years, 25 Years, 50 Years, 100 Years

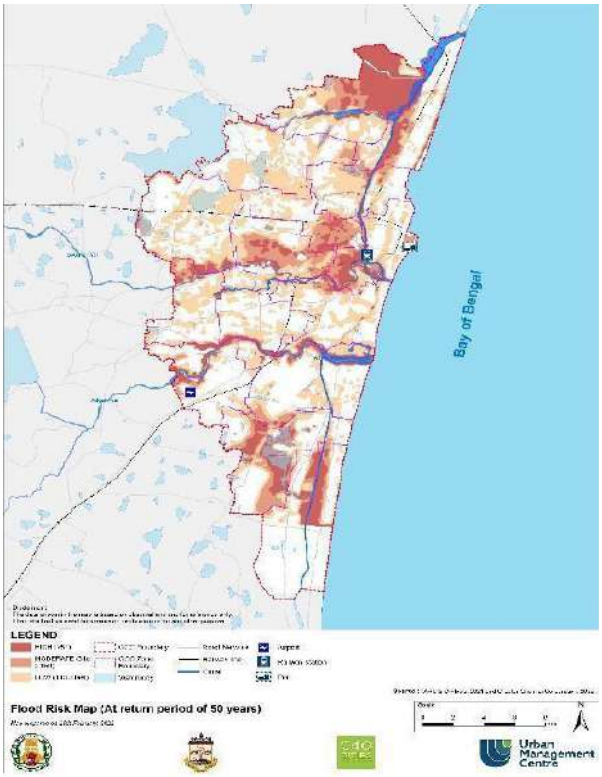
Table 28 Area projected to be under Prone to Flood Risks at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

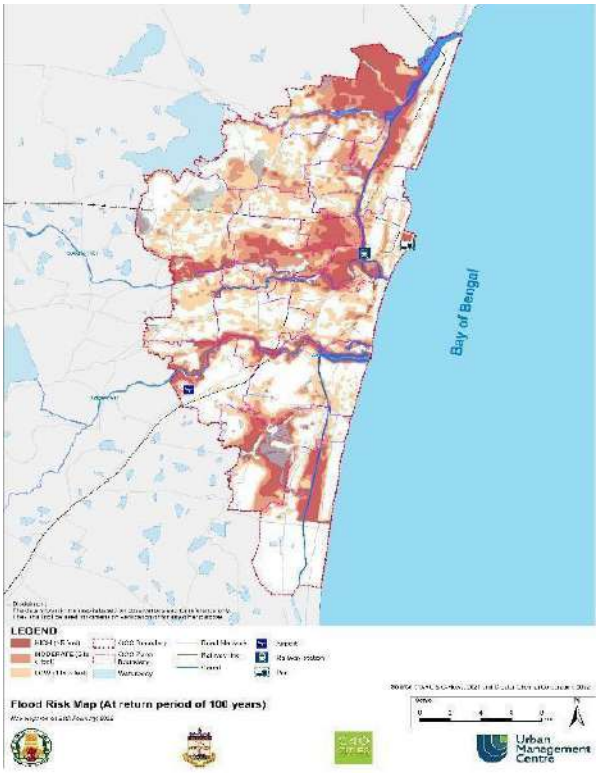
Risk of flooding





	Flood vulnerability at return period of 5 years		Flood vulnerability at return period of 25 years		
	Area inundated (sq.km)	Total population affected	Area inundated (sq.km)	Total population affected	
High (> 5 ft)	15.32	233891	42.36	629679	
Moderate (3-5 ft)	21.25	333279	53.22	1045868	
Low (1-3 ft)	92.27	1778522	107.91	2268479	





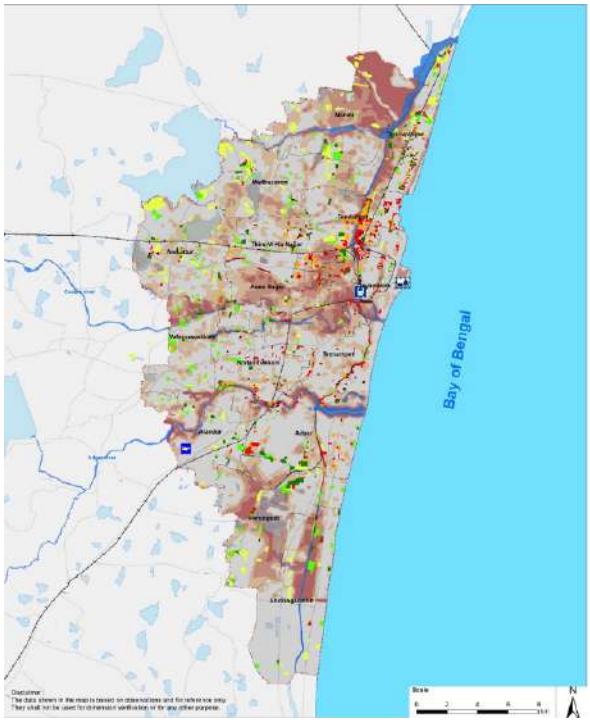
	Flood vulnerability at return period of 50 years		Flood vulnerability at return period of 100 years	
	Area inundated (sq.km)	Total population affected	Area inundated (sq.km)	Total population affected
	58.32	867886	76.48	1260982
	54.77	1125070	59.18	1217679
	127.79	2703099	114.47	2526545

**Each category of risk zones is exclusive and not overlapping with each other.*

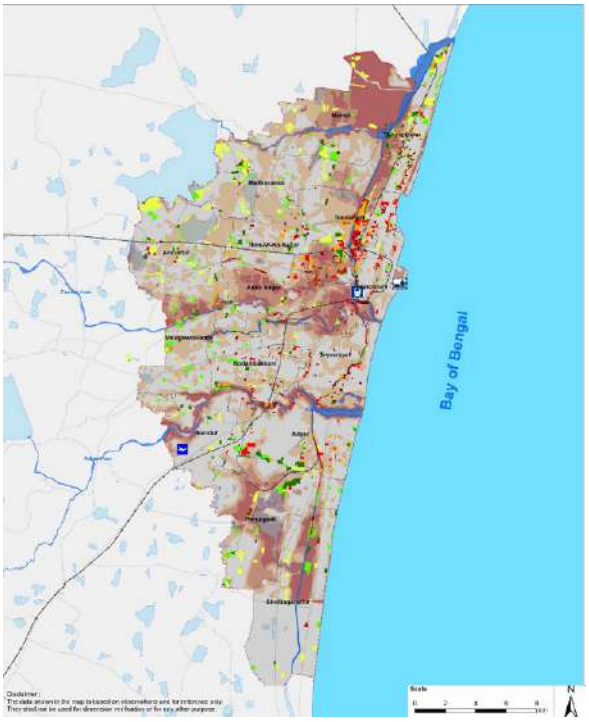
8.3.2 Slums at the risk of Flooding at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

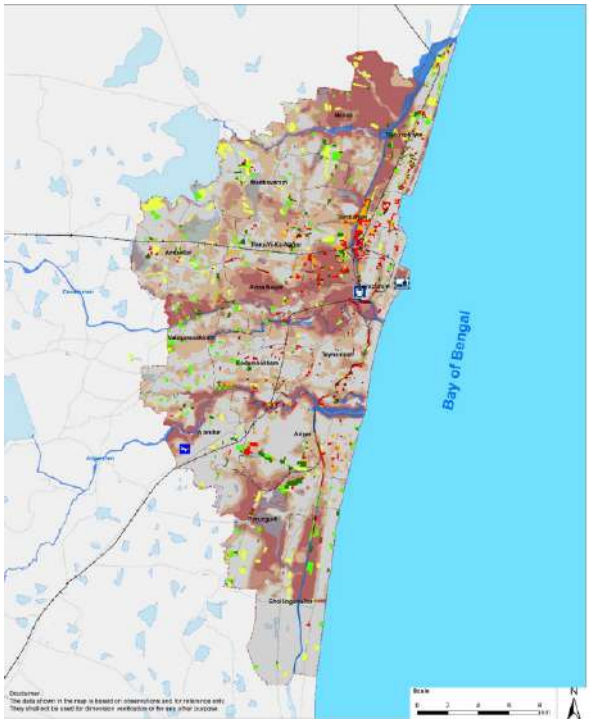
Table 29 Slums projected to be vulnerable to floods at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

Risk of flooding



	Flood vulnerability at return period of 5 years		Flood vulnerability at return period of 25 years	
	No. of flood inundated slums	Total population affected	No. of flood inundated slums	Total population affected
High (> 5 ft)	494	609873	721	831338
Moderate (3-5 ft)	414	502262	549	598375
Low (1-3 ft)	332	385320	390	438956





	Flood vulnerability at return period of 50 years		Flood vulnerability at return period of 100 years	
	No. of flood inundated slums	Total population affected	No. of flood inundated slums	Total population affected
	764	900151	818	942774
	562	632193	561	612746
	388	453546	384	416319

*Each category of risk zones is exclusive and not overlapping on each other.

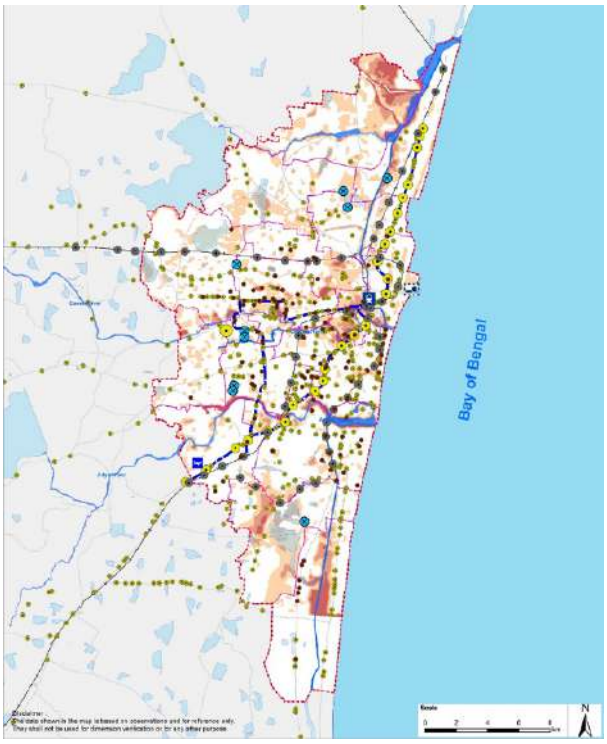
*Numbers given here for each category of risk zones are cumulative.

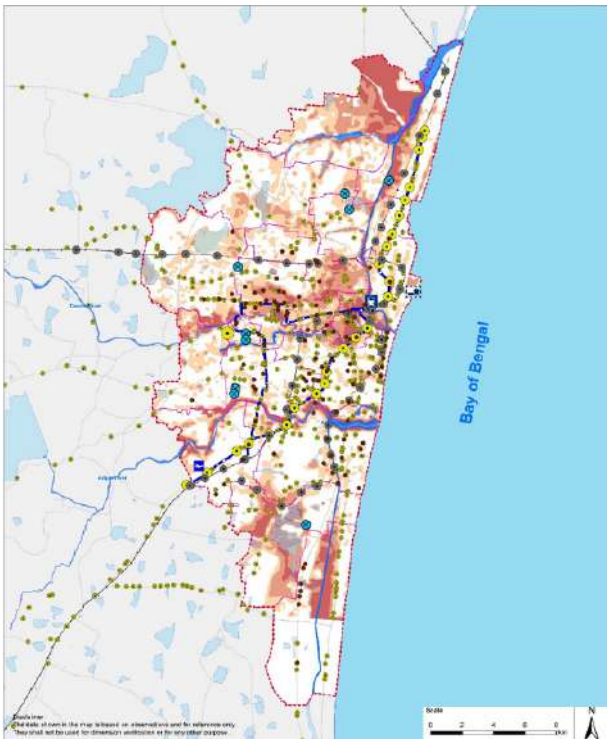
8.3.3 Physical Infrastructure at the risk of Flooding at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

Table 30 Physical Infrastructure projected to be vulnerable to floods at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

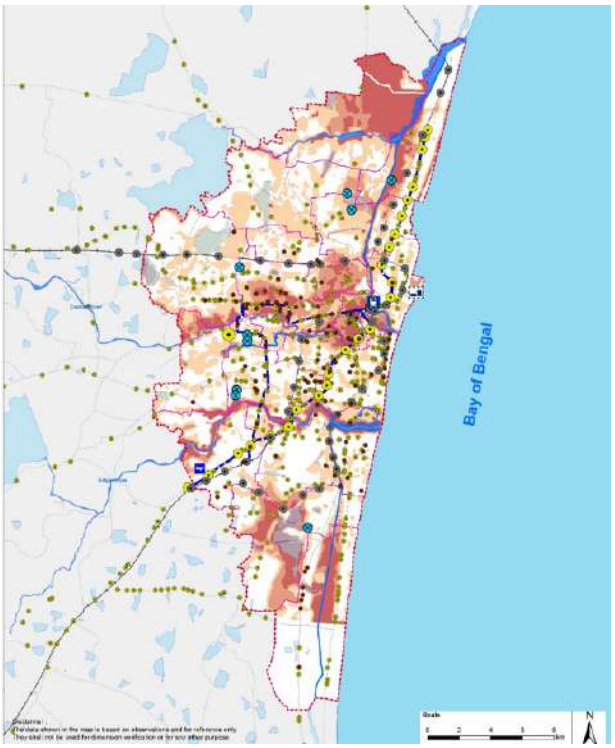
Details of flood vulnerable physical infrastructure at the return period of 5 years, 25 years, 50 years, 100 years

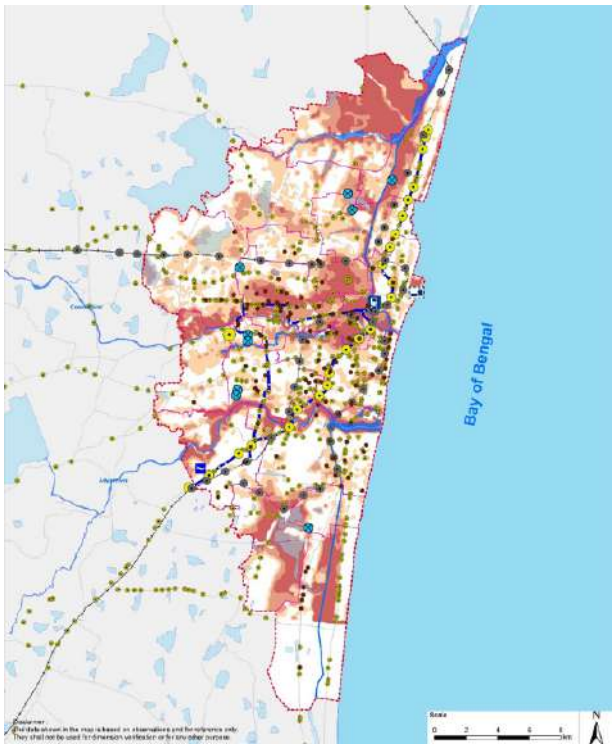
Risk of flooding





	Flood vulnerability at return period of 5 years					Flood vulnerability at return period of 25 years				
	MTC stops	CM-RLSStns	SRSs	STPs	PCI	MTC stops	CM-RLSStns	SRSs	STPs	PCI
High (> 5 ft)	65	6	13	2	8	127	9	23	5	12
Moderate (3-5 ft)	58	6	13	2	8	112	9	22	4	11
Low (1-3 ft)	49	5	12	2	8	77	6	9	4	8





	Flood vulnerability at return period of 50 years					Flood vulnerability at return period of 100 years				
	MTC stops	CM-RLSStns	SRSs	STPs	PCI	MTC stops	CM-RLSStns	SRSs	STPs	PCI
	151	10	22	2	17	169	15	30	7	16
	129	9	19	1	15	131	13	24	6	13
	90	8	10	0	11	87	10	14	4	9

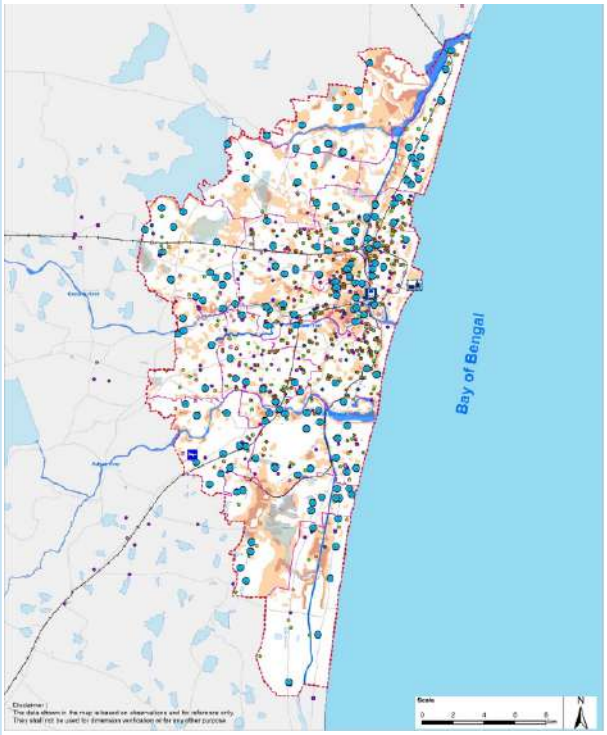
**Numbers given here for each category of risk zones are cumulative.*

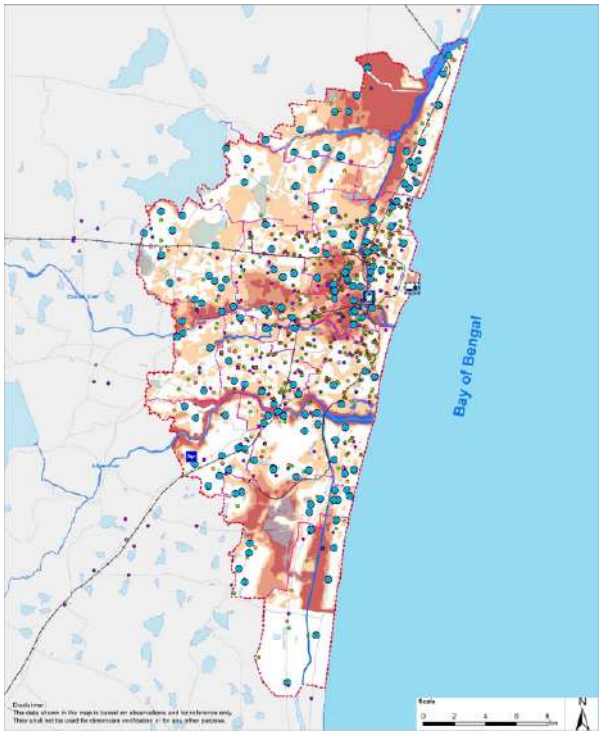
SRS – Suburban Railway Stations, STP – Sewage Treatment Plants, PCI – Power Charging Infrastructures (Electric Vehicle Charging Stations)

8.3.4 Social Infrastructure projected to be vulnerable to floods at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

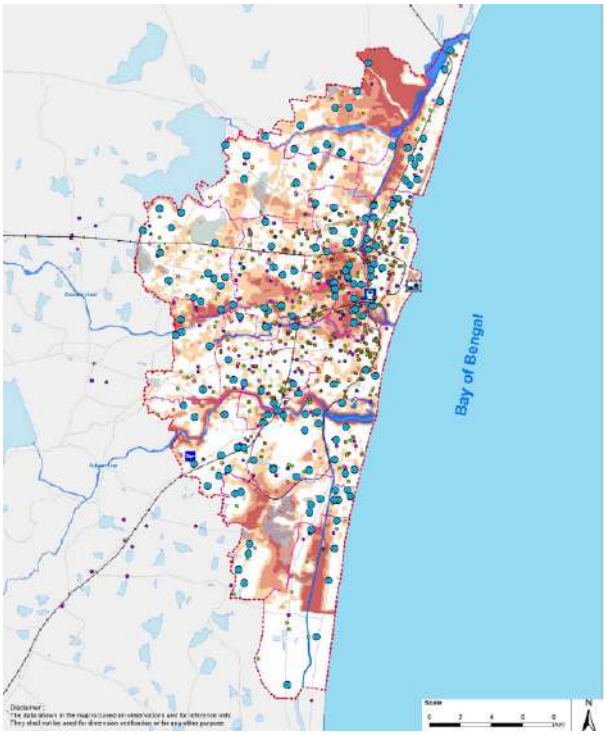
Table 31 Social Infrastructure projected to be vulnerable to floods at the Return Period of 5 Years, 25 Years, 50 Years, 100 Years

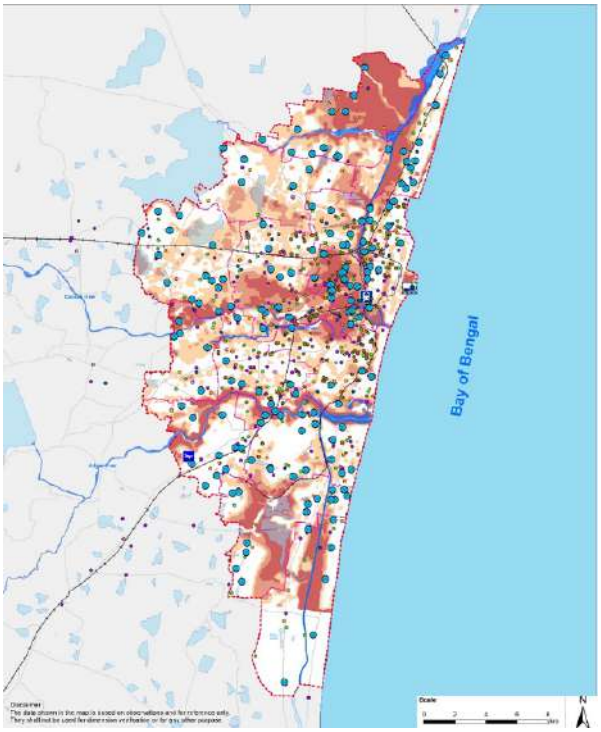
Risk of flooding





	Flood vulnerability at return period of 5 yrs							Flood vulnerability at return period of 25 yrs							
	UHC	DRC	SH	G.SL	CH	FS	PS	UHC	DRC	SH	G.SL	CH	FS	PS	
High (> 5 ft)	39	39	8	75	27	9	26	78	59	17	135	47	21	50	
Moderate (3-5 ft)	38	35	7	69	27	9	24	73	47	11	116	38	18	44	
Low (1-3 ft)	33	25	3	57	21	6	20	52	25	9	75	26	15	31	





	Flood vulnerability at return period of 50 yrs							Flood vulnerability at return period of 100 yr						
	UHC	DRC	SH	G.SL	CH	FS	PS	UHC	DRC	SH	G.SL	CH	FS	PS
	89	72	20	149	57	25	63	109	84	23	174	62	28	65
	80	55	14	123	47	22	55	87	58	16	125	45	23	50
	60	32	11	79	29	17	39	65	38	11	83	25	16	36

**Numbers given here for each category of risk zones are cumulative.*

UHC – Urban Health Centres, DRC – Disaster Relief Centres, SH – Shelter Homes, G.SL – Government Schools, CH – Community Halls, FS - Fire Stations, PS – Police Stations

8.3.5 Untenable Slums in Chennai

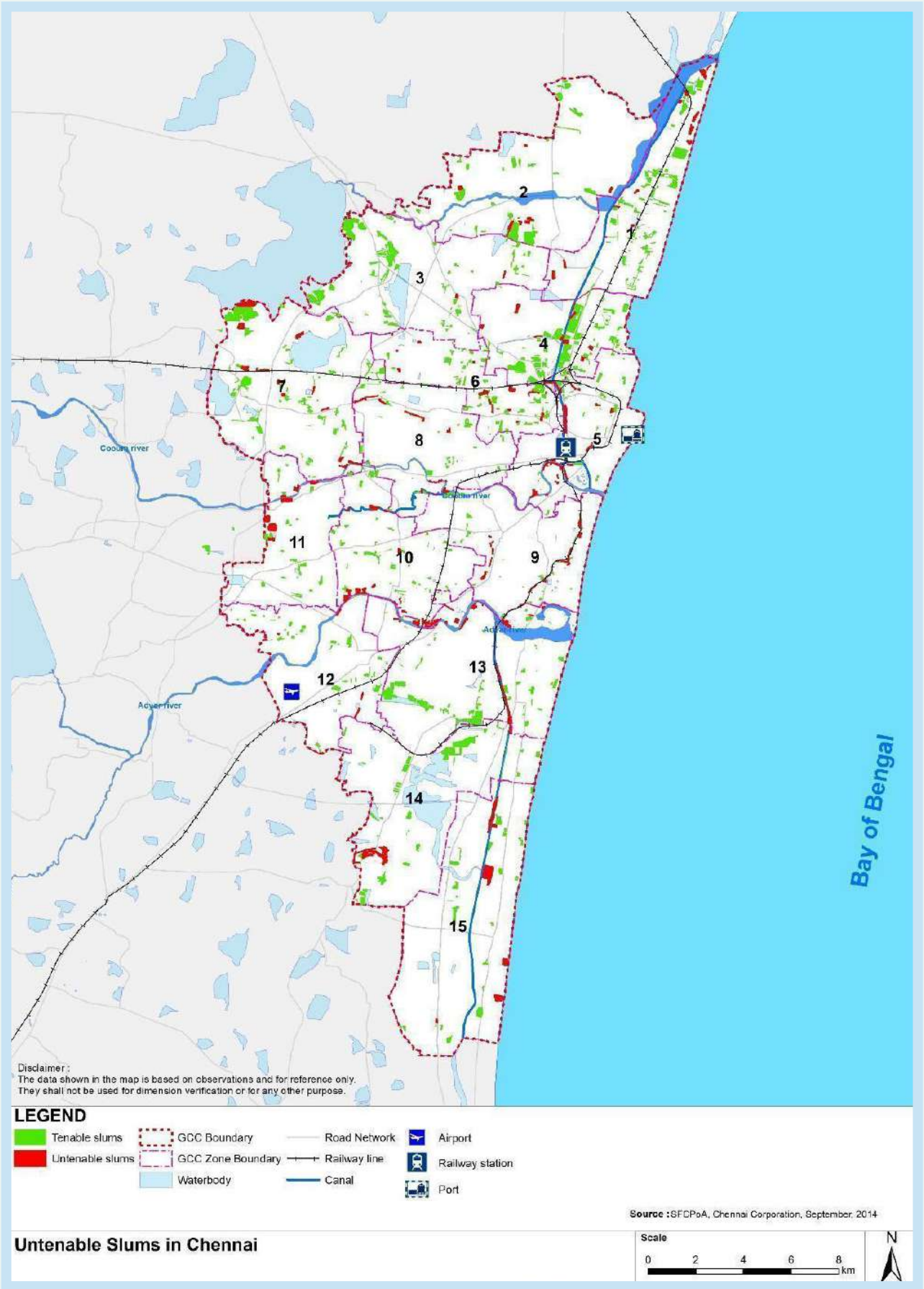


Figure 81: Untenable slums in Chennai

8.3.6 Slums and Urban Heat Islands

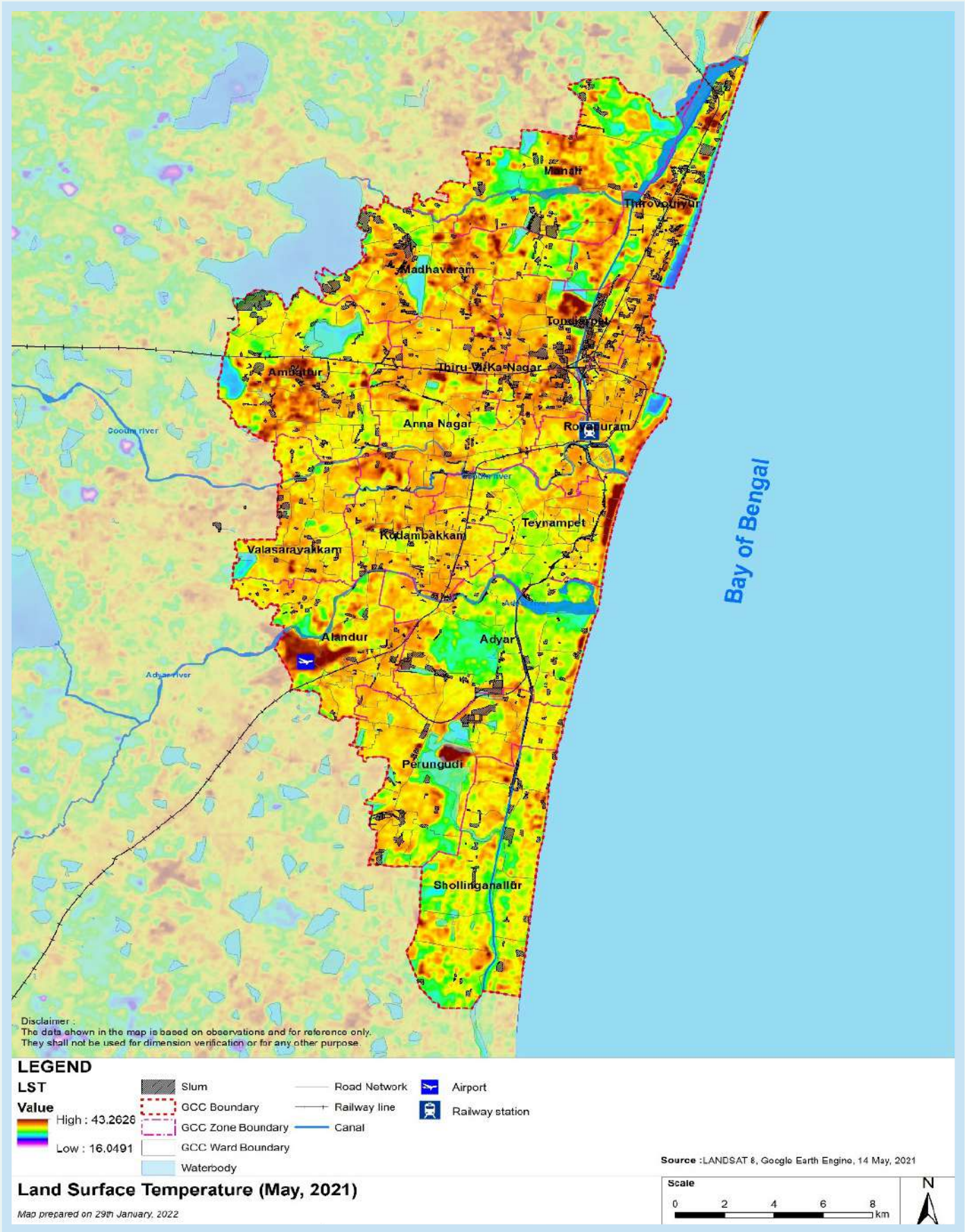


Figure 82: Slums and Urban Heat Islands in Chennai

8.4 Details of Various Stakeholder Consultations Held During the Preparation of the CCAP

i. Stakeholder Consultations Workshop for Strategic Appraisal, CCAP on 21/12/2021

Table 32 Details of Stakeholder Consultations Workshop for Strategic Appraisal, CCAP on 21/12/2021

List of Participants	
1	Chief Engineer, SWM Dept, GCC
2	Superintending Engineer, Planning, GCC
3	Park Superintendent, GCC
4	Superintending Engineer, SWD, GCC
5	Superintending Engineer, SWM Dept, GCC
6	Superintending Engineer, Buildings, GCC
7	Assistant Manager, Projects, MTC
8	VC, CMDA
9	Chief Data Officer GCC
10	Chairman, TANGEDCO
11	Managing Director, CMWSSB
12	City Health Officer, GCC
13	Manager, Design, CMRL
14	CEO, CSCL
15	Lead Consultant- DRR, Taru
16	Consultant, Taru
17	Representative, Environmentalist Foundation of India (E.F.I)
18	Representative, ITDP
19	Environmental Specialist, CSCL

ii. Stakeholder Consultation Workshop for Climate Change and Risk Assessment (CCRA), CCAP on 20/04/2022

Table 33 Details of Stakeholder Consultation Workshop for CCRA on 20/04/2022

List of Participants	
1	Chief Engineer, SWM Dept, GCC
2	Chief Engineer, Buildings and Bridges
3	Chief Engineer, General
4	Chief Engineer, TANGEDCO
5	Chief Engineer, Planning
6	City Health Officer, GCC
7	Representative, Environmentalist Foundation of India (E.F.I)
8	Assistant Manager, Projects, MTC
9	Lead Consultant- DRR, Taru

List of Participants	
10	Consultant, Taru
11	DGM-II, TEDA
12	Officer, TNFRS
13	Managing Director, TNUIFSL
14	CEO, CSCL
15	Representative, World Bank
16	Head of Department i/c & Professor, Dept. of Planning, SAP, Anna University, Chennai
17	HOD, TNSPC
18	Member Secretary, TNPCB
19	DRM, Southern Railways
20	Revenue Officer, GCC
22	Representative, ADB
23	Representative, Care Earth
24	Scientist, IMD
25	Officer, TNUHDB

iii. Details of One-on-One Stakeholder Consultation Workshop for Action Identification for the CCAP

Table 34 One-on-One Stakeholder Consultation Workshop for Action Identification for the CCAP

Sr. No.	Name of Stakeholders	Date of Meeting
1	Chief Engineer, SWM Dept, GCC	08/06/2022
2	Deputy General Manager, TEDA	08/06/2022
3	Chief Engineer, Town Planning (Electrical) Dept, GCC	08/06/2022
4	Chief General Manager, CMRL	09/06/2022
5	Superintending Engineer, TANGEDCO	09/06/2022
6	Chief Engineer (General), SWD Dept, GCC	09/06/2022
7	City Health Officer, Public Health Dept, GCC	09/06/2022
8	Deputy Planner, CMDA	10/06/2022
9	General Manager (Planning), IOCL	10/06/2022
10	Superintending Engineer, CMWSSB	10/06/2022
11	General Manager (Operations), MTC	21/06/2022
12	DC (Works), GCC and CEO, CSCL	05/07/2022
13	Additional Chief Secretary, Department of Environment, Climate Change and Forest	15/07/2022

iv. Details of Stakeholder Consultations Workshop for Technical Experts on the CCAP on 08/08/2022

This workshop was held under the chairpersonship of the Deputy Commissioner, Works, GCC

Table 35 Stakeholder Consultations Workshop for Technical Experts on the CCAP

List of Participants			
S. No.	Name	Designation	Organization
1	Mr Prasanth MS (IAS)	Deputy Commissioner, Works	Greater Chennai Corporation (GCC)
2	Mr Raj Cherubal	Chief Executive Officer (CEO)	Chennai Smart City Limited (CSCL)
3	Ms Keerthi Sureshbabu	Environment and social officer	Chennai Smart City Limited (CSCL)
4	Mr Akira Matsunaga	Project Officer (Integrated Urban Flood Management for the Chennai-Kosasthalaiyar Basin Project)	Asian Development Bank (ADB)
5	Ms Seetha Raghupathy	City Planning Labs Coordinator	World Bank
6	Mr Sourav Biswas	Director of Regional Planning, Resilient Infrastructure, and Spatial Analytics	Sponge Collaborative
7	Dr Jayshree Vencatesan	Trustee	Care Earth Trust
8	Dr Kurian Joseph	Professor	Centre for Environmental Studies, Dept of Civil Engineering, CEG Campus, Anna University
9	Mr Yuvaraj E	Lead Consultant- DRR	Taru
10	Mr Binu Mathew	Chief Operating Officer	Taru
11	Mr Gokul Suresh	Consultant	Taru
12	Mr Krishna Mohan Ramachandran	Chief Resilience Officer	Resilient Chennai
13	Mr Askshaya Ayyangar	Representative	Resilient Chennai
14	Ms Parama Roy	Representative	Resilient Chennai
15	Mr Achuthan	Representative	Institute for Transportation and Development Policy (ITDP)
16	Mr Ganapathy Rajakesari	Partner/ Director	Siriska
17	Mr Sabareesh Suresh	Representative	World Resources Institute (WRI)
18	-	Representative	KFW-TDFC
19	Ms Alpana Jain	Programme Lead - Cities	The Nature Conservancy Centre (TNC)
20	Ms Nisha Priya Mani	Project Manager - Cities	The Nature Conservancy Centre (TNC)
21	Ms S. Saroja	Executive Director	Citizen Action Group (CAG)
22	Ms Mala Balaji	Researcher - Environment and Climate Action	Citizen Action Group (CAG)
23	Ms Sumana Narayanan	Senior Researcher	Citizen Action Group (CAG)
24	Mr Shankar Prakash	Researcher - Environment and Climate Action	Citizen Action Group (CAG)
25	Mr G. Sundarrajan	Managing Trustee	Poovulagin Nanbargal (Friends of Earth)
26	Ms Surjyatapa Ray	Associate - Urban Design	Jana Urban Spaces Foundation
27	Mr Satheesh Lakshmanan		

List of Participants			
S. No.	Name	Designation	Organization
28	Mr Vivek Venkataramani		
29	Mr Ryan Green	Senior Technical Manager, Climate Action Planning (Mitigation)	C40
30	Ms Shruti Narayan	Regional Director	C40
31	Mr Benjamin MJ	City Advisor	C40
32	Ms Manvita Baradi	Director	Urban Management Centre (UMC)
33	Ms Meghna Malhotra	Deputy Director	Urban Management Centre (UMC)
34	Dr P. Jayapal	Team Lead - CCAP	Urban Management Centre (UMC)
35	Mr Kaninik Baradi	Strategic Initiatives Officer	Urban Management Centre (UMC)
36	Ms Sweta Delwadia	Project Associate	Urban Management Centre (UMC)
37	Ms Sakshi Sharma	Project Associate	Urban Management Centre (UMC)
38	Mr Vinod Kumar	State Programme Manager	Urban Management Centre (UMC)
39	Ms Pooja Auropremi	Project Associate	Urban Management Centre (UMC)

8.5 City's Powers Assessment

Objective: Assess the city's power and capacity to implement climate action in key sectors, which will help identify potential barriers to climate action implementation and key external stakeholders to be involved in the process.

Tasks: Review the city's powers/authority/mandate to influence, control, or implement sectoral targets/ actions, using a High/Medium/Low qualitative indicator. Identify where responsibility or authority lies. If owned by an external stakeholder, please also include. When assessing a responsibility owned by an external stakeholder, please score the power and capacity *from a city perspective*. Capture the assessment in the proposed table.

Outcomes: High-level overview of the city's power and capacity assessment.

Table 36 High-level overview of the city's power and capacity assessment

High-Level Overview of the City's Power and Capacity Assessment				
City Powers Category	**Who Owns the Main/ Primary Responsibility?**	**City Power**	**City Capacity**	**Comments/Improvement Opportunities**
Decarbonizing the electricity grid	Tamil Nadu Electricity Board (TNEB)/Tamil Nadu Generation and Distribution Corporation Limited (TANGEDC0)	L	L	TANGEDCO is responsible for power generation and distribution. TNEB is responsible mainly regulation and policy preparation at the state level. Power is mainly a state function. The state has been progressive in meeting its Renewable Purchase Obligation (RPO) and has also pioneered many rooftop solar policies.
Optimizing energy use in buildings	GCC- Town Planning and Electrical dept.	H	H	As building permissions (up to 1000sqmt) are given there is more scope in making sure energy efficient fixtures are used, buildings are designed with thermal comfort and roof-top solar is adopted.
	CMDA	H	H	As building permissions (above 1000 sq. m) are given there is more scope in making sure energy efficient fixtures are used, buildings are designed with thermal comfort and roof-top solar is adopted.
	TANGEDGO/ Tamil Nadu Electricity Regulatory Commission	M	M	Opportunity to integrate smart metering

Enabling next generation mobility	State Transport Authority (Chennai Region)	H	M	Mainly regulatory and policy making body. Can play more of a coordination role with MTC, CMRL, MRTS, CMDA & GCC in implementation of projects focussed on decarbonising transport modes used.
	Metropolitan Transport Corporation	H	H	Owns the bus fleet. Has huge opportunity in transitioning bus fleet towards EVs as the city has a high ridership on buses when compared to metro. Shifting bus operations completely to ITS.
	Chennai Metro Rail Ltd	H	H	As Metro is in the process of finalising the CTTS, findings/ data points from the study can be integrated into the CAP. Going ahead CMRL, MTC and GCC will have to work in tandem especially with respect to last mile connectivity to the metro etc.
	MRTS Rail	M	M	Medium, as it is suburban rail which is more for the regional commuters than just the city.
Improving solid waste/ wastewater management	GCC- Solid Waste Management dept	H	H	Singular agency responsible for managing SWM, there can be lots of new initiative taken up especially with respect to nudging civic behaviour towards segregating waste at source etc.
Enhancing climate resilience (structurally reducing and preventing impacts from identified climate risks) *(Note: add other hazard themes if not included)*	**Flood and Storms**			
	Tamil Nadu State Disaster Management Authority	M	M	Power stated as M as state govt. needs to liaise with local government for the implementation/ monitoring of specific projects. Capacity could be strengthened with more resources
	Department of Environment, Climate Change and Forests, Govt of Tamil Nadu	M	M	Power stated as M as state govt. needs to liaise with local government for the implementation/ monitoring of specific projects. Capacity could be strengthened with more resources
	GCC	H	H	
	CMDA	M	M	Post the 2015 floods, several studies have pointed to development taking place in areas that were once water bodies/ low lying. Building permissions must be given keeping local hydrology in consideration especially for large projects.
	Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB)	H	M	The storm water drains are always clogged with garbage, inter-departmental coordination required to address this issue.
	Heat			
	Tamil Nadu State Disaster Management Authority	M	M	Power stated as M as state govt. needs to liaise with local government for the implementation/ monitoring of specific projects. Capacity could be strengthened with more resources
	Department of Environment, Climate Change and Forests, Govt of Tamil Nadu	M	M	Power stated as M as state govt. needs to liaise with local government for the implementation/ monitoring of specific projects. Capacity could be strengthened with more resources
	GCC- Parks	H	M	More greening programmes for reduction of heat waves
	CMDA	H	M	More greening programmes for reduction of heat waves

Enhancing climate resilience (structurally reducing and preventing impacts from identified climate risks) ..... continued	**Drought**			
	Department of Environment, Climate Change and Forests, Govt of Tamil Nadu	M	M	
	Tamil Nadu State Disaster Management Authority	M	M	
	Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB)	H	H	Implementation of IUWM projects which look at the water cycle in a holistic manner.
	Department of Environment, Climate Change and Forests, Govt of Tamil Nadu	M	M	Responsible for Climate Mitigation and Adaptation at the state level
Emergency management during extreme weather events (e.g., cyclones, tsunamis, extreme rain, heat, or drought)	**Flood and Storms**			
	Tamil Nadu State Disaster Management Authority	M	M	Capacity could be strengthened with more resources
	GCC	M	M	Capacity could be strengthened with more resources. Often the challenge is too large for the city to manage especially if it rains very heavily.
	Heat			
	Tamil Nadu State Disaster Management Authority	M	M	Capacity could be strengthened with more resources
	GCC	M	M	Capacity could be strengthened with more resources
(Note: add other hazard themes if not included)	**Drought**			
	Tamil Nadu State Disaster Management Authority	H	M	Capacity could be strengthened with more resources
	GCC	H	M	Capacity could be strengthened with more resources

8.6 Methodology followed by Chennai Flood Warning System (CFLOWS) – NCCR for mapping of Flood Vulnerable Areas

CFLOWS[118] developed in 2018, using LiDAR DEM[119] (2009) with the DEM resolution of 1 m. Regional forecast models available with IMD and NCMRWF were used for precipitation forecasts and regional statistical downscaling was done on the model datasets. The tide-surge simulations were carried out using ADvanced Circulation (ADCIRC) model, hydrological modelling was carried out using HEC-HMS. Inundation scenarios were generated using MIKE FLOOD and a data bank of 796 scenarios resulting from rainfall extremes corresponding to different return levels, the tide of different levels of severity, and past conditions of rainfall were generated. Flooding scenarios for various rainfall return periods[120] were converted into GIS files and overlaid with all administrative boundaries at ward level along with infrastructure details to serve as a ready reckoner along with rainfall prediction by IMD and NCMRWF, for planning and mitigation operations.

The spatial coverage of the outputs from this model is limited to the GCC area (36 per cent of CMA). Further, the flood inundations of this output have been shown for return periods of 5 years, 10 years, 25 years, 50 years, 100 years, and 200 years. As per

118 The Chennai flood warning system (C-FLOWS) is a flood forecasting system which is developed with an active involvement of Indian Institute of Technology (IIT) Bombay as the lead, IISc, Bangalore, IIT- Madras, IRS, Anna University, along with the partnership of institutes of Ministry of Earth Sciences namely India Meteorological Department (IMD), National Centre for Medium Range Weather Forecasting (NCMRWF), National Centre for Coastal Research (NCCR), Indian National Centre for Ocean Information Services (INCOIS). The C-FLOWS is a disaster preparedness decision support system for urban and coastal flooding in urban areas

119 DEM means Digital Elevation Model

120 A Return period is the time over which it is likely that a particular magnitude flood will occur, e.g., a '50–year flood' is defined as a flood that can occur on average once every 50 years.

Table 37 Area that may get Inundated due different Rainfall Intensities (in sq.km.)

Risk of Flooding	Area that may get Inundated due different Rainfall Intensities per hour (in sq.km.)					
	5 years return period (20 cm rainfall)	10 years return period (30 cm rainfall)	25 years return period (38 cm rainfall)	50 years return period (42 cm rainfall)	100 years return period (47 cm rainfall)	200 years return period (52 cm rainfall)
High (> 5 ft)	15.32	23.86	42.36	58.32	76.48	87.37
Moderate (3 to 5 ft)	21.91	47.21	60.62	64.11	63.35	65.24
Low (1 to 3 feet)	92.38	102.25	118.9	131.3	128.64	123.4

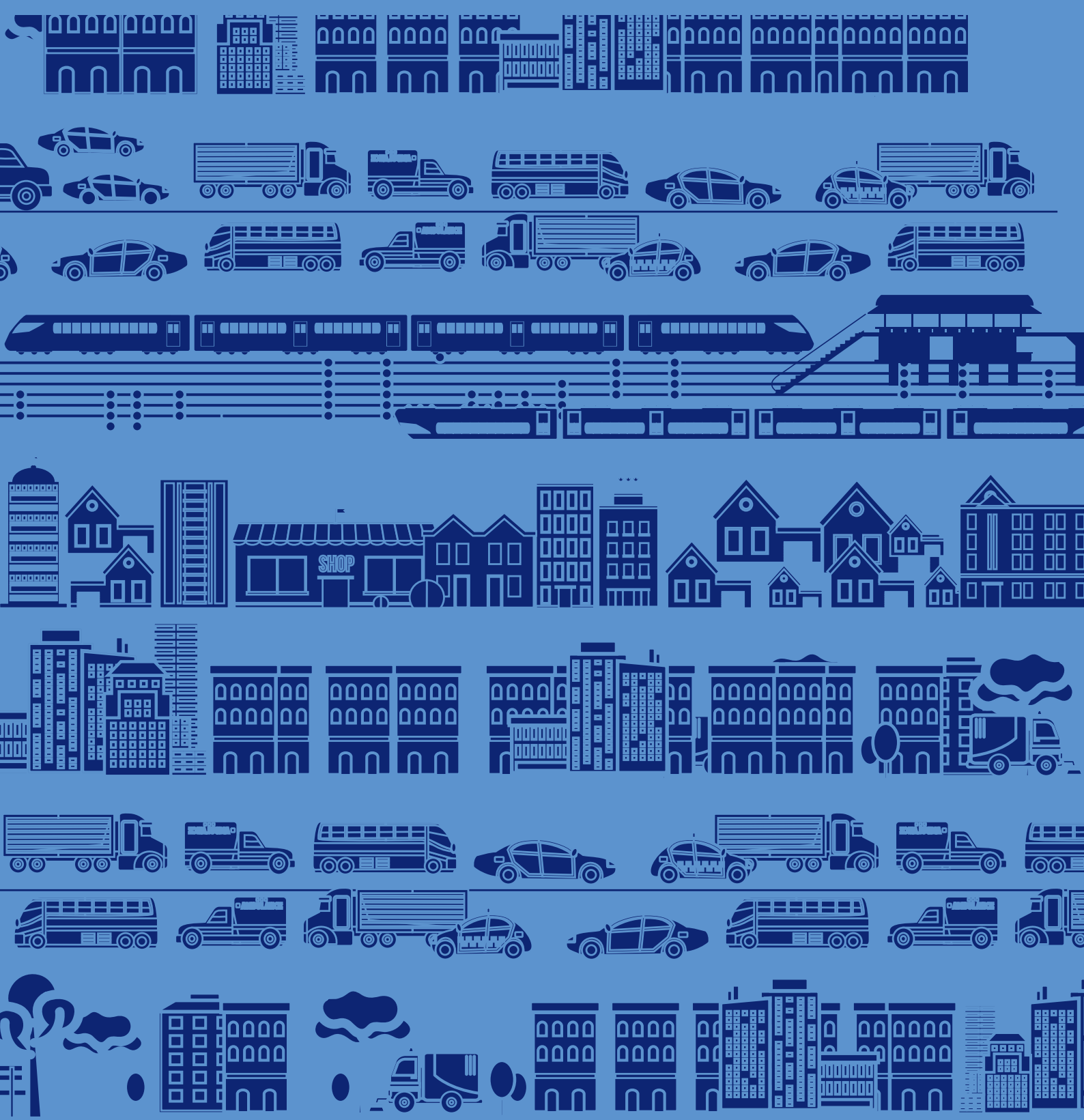
the hazard classification adopted for this model, the three inundation categories are the high inundation (above 5 ft) class, the moderate inundation (3ft - 5ft) class, and the low inundation (1ft - 3ft) class. The following Table 37 gives the area falling under different inundation classes for the considered return periods:

The model has certain limitations such as the extended area of Chennai was covered using coarse resolution SRTM DEM, where the high-resolution DEM data is not available. So, the accuracy of the prediction is less in those areas. The high resolution of the model mostly covers Chennai City. The year of the LiDAR data of the model is 2009, but many mitigation measures like storm water drainages and riverbank extension happened after the 2015 flood.

8.7 Methodology followed for Sea Level Rise Maps

The Sea Level Rise maps for the Chennai Climate Action Plan have been adopted from various existing climate studies and researches. These maps indicate high risk zones as predicted under a high-emission scenario (RCP 8.5) by year 2100. A research published in the Journal of Coastal conversation in 2017 by A. Ramachandran and K. Palanivelu also projects the SLR of 77.88 cm (medium intensity) and 134.69 cm (high intensity) for RCP 8.5 scenario by year 2100. Another assessment on shoreline retreat in response to Sea Level Rise - Chennai coast conducted by NCCR in 2020 projected the SLR of 77.88 cm (medium intensity) and 134.69 cm (high intensity) for RCP 8.5 scenario by year 2100. Applying the 'Brunn Rule' on these statistical projections for Chennai coast, the horizontal inundation is estimated as ~1.6 km. Both research here has followed the RCP scenarios, which are the GHG concentration trajectories adopted by the IPCC in order to project the SLR for Chennai. These research provided only the statistical information on SLR in Chennai, and not the spatial information. Hence, the spatial maps were prepared based on inundating the areas below contour level of 134.69 cm using ARCGIS and Digital Elevation Model (DEM) of LANDSAT, keeping it aligned to the projections done by IPCC at global level and verifies the horizontal inundation of ~1.6 km as per the Brunn Rule.

Source: Urban Management Centre


SHOP