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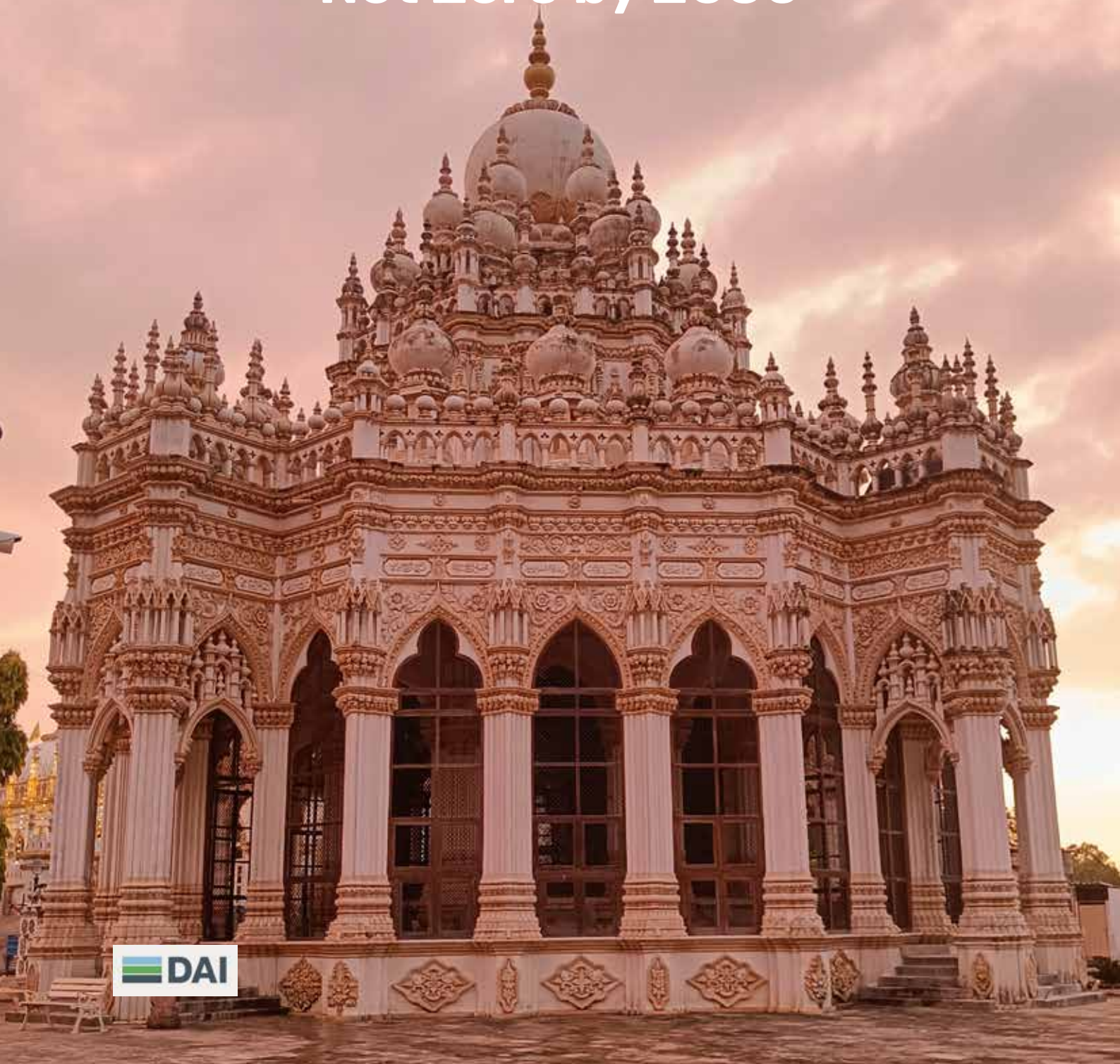
Junagadh City Climate Action Plan

Net Zero by 2050



DAI

Climate Centre for Cities

GLOBAL COVENANT of MAYORS for CLIMATE & ENERGY SOUTHEAST ASIA

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Junagadh City Climate Action Plan

Net Zero by 2050

DAI


BUILDINGS

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Message

Dr. Debolina Kundu
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It is with immense pride that I present the City Climate Action Plan (CAP) for Junagadh, a significant step forward in building climate resilience and sustainable urban development. Junagadh, with its rich cultural heritage and unique environmental challenges, is well-positioned to lead the way in creating a future that is not only sustainable but also adaptable to the impacts of climate change. This plan is a result of collaborative efforts, and I would like to thank the Global Covenant of Mayors for their critical support, the European Union for their generous financial backing, and the Junagadh Municipal Corporation for their active participation throughout this process.

The Junagadh Climate Action Plan lays out a comprehensive framework designed to mitigate the city's climate vulnerabilities, including water scarcity, urban flooding, and the increasing threat of extreme temperatures. The plan sets ambitious goals to make Junagadh a net-zero emissions city by 2050, while simultaneously building resilience to climate risks through a range of mitigation and adaptation strategies. This is not just a document but a clear roadmap for transitioning towards a climate-resilient future. However, we must acknowledge that preparing the CAP is only the first step—its implementation is where the real challenge lies.

The successful realization of this plan requires strong coordination among all stakeholders, from government bodies to private sector entities, civil society, and citizens. Local organizations, businesses, NGOs, and community members have all been invaluable in shaping this CAP. Their contributions in providing data, sharing local knowledge, and participating in consultations have ensured that this plan is grounded in local needs and realities.

Junagadh is especially vulnerable to the effects of climate change, with over 43% of the city's total area at high to very high flood risk, making flood management and green infrastructure critical components of the plan. The revival of natural water bodies and the promotion of solar energy projects are pivotal strategies outlined in the plan, aimed at reducing the city's carbon footprint while safeguarding its natural resources .

The plan aligns with the ClimateSmart Cities **Assessment Framework (CSCAF)**, introduced by the **Ministry of Housing and Urban Affairs (MoHUA)** under the **Smart Cities Mission** in 2019. This framework helps ensure that city-level actions are consistent with national priorities and contribute to the **Sustainable Development Goals (SDGs)**.

At the National Institute of Urban Affairs (NIUA), we are committed to scaling up Climate Action Plans across India. We aim to empower cities like Junagadh with the tools, knowledge, and networks they need to implement these plans successfully. Our collaboration with the Global Covenant of Mayors and other partners will continue to foster sustainable urban development across the country.

In conclusion, I would like to extend my heartfelt thanks to all the stakeholders, partners, and citizens who contributed to the development of this CAP. Together, we are shaping a future that is both sustainable and resilient, and I look forward to seeing the vision of the Junagadh Climate Action Plan realized through continuous collaboration and action.

Message

Dr Om Prakash
Municipal Commissioner
Junagadh Municipal Corporation

It is with great pride that I present the City Climate Action Plan (CAP) for Junagadh, a vital blueprint for our city's journey toward sustainability and resilience in the face of climate change. Junagadh, with its rich heritage, vibrant ecosystems, and diverse economic base, is uniquely positioned to lead in implementing sustainable urban practices. This Climate Action Plan is a significant step in preparing our city for the challenges ahead, and I extend my sincere gratitude to the Global Covenant of Mayors, the European Union for their financial backing, and the National Institute of Urban Affairs (NIUA) for their expertise in developing this comprehensive plan.

The Junagadh CAP outlines a robust framework aimed at addressing the most pressing climate vulnerabilities our city faces—such as water scarcity, rising temperatures, urban flooding, and the degradation of green spaces. These issues require urgent and coordinated action. The plan provides targeted mitigation and adaptation strategies, from expanding renewable energy projects to improving our stormwater management systems. The ultimate goal of achieving net-zero emissions by 2050 will only be possible through sustained commitment from all sectors of society.

The preparation of this plan involved extensive collaboration with key stakeholders, including local NGOs, business associations, religious organizations, and civil society. I want to extend my heartfelt thanks to all those who provided their valuable inputs, expertise, and resources during this process. Your contributions have ensured that this plan reflects Junagadh's unique challenges and opportunities.

As a city, we are particularly vulnerable to climate risks, with over 43% of our total area classified as high to very high risk for floods, underscoring the critical need for robust disaster preparedness strategies . The revival of natural water bodies, improvements in urban green cover, and enhanced waste management systems are central to our resilience efforts. Moreover, Junagadh has immense potential in harnessing solar energy to reduce our carbon footprint and boost our city's energy independence.

However, while this plan provides a clear roadmap, its success depends on its effective implementation. The Municipal Corporation is committed to leading this effort, but it is only through community participation, capacity building, and continued collaboration that we can achieve the ambitious targets set in this CAP.

I encourage all citizens, government agencies, businesses, and organizations to actively participate in the implementation of this Climate Action Plan. Together, we can make Junagadh a model for climate resilience and sustainable development, ensuring a safer and more prosperous future for generations to come.

Message

Piero Roberto Remitti
Co-managing Director
Global Secretariat, Global Covenant of Mayors

As Junagadh steps forward with its Climate Action Plan, I am proud to witness a city with a deep historical legacy paving the way for a sustainable future.

This plan not only reflects Junagadh's strategic vision to reduce emissions and adapt to climate impacts, but also its unwavering dedication to improving the quality of life for its residents.

This effort highlights the importance of regional leadership in the global fight against climate change. I am confident that this plan will enable Junagadh to become a model for other mid-sized cities as they too rise to face the climate challenge.

Message

Victor R. Shinde
Head, Climate Centre for Cities
National Institute of Urban Affairs (NIUA)

With great satisfaction, I present the City Climate Action Plan for Junagadh, a critical step in building the city's resilience against climate change. This plan not only identifies the key climate vulnerabilities such as flood risks and water scarcity but also outlines effective mitigation and adaptation strategies to address these challenges. I would like to extend my gratitude to the Global Covenant of Mayors, the European Union, and all local stakeholders for their invaluable contributions to this effort. As we move forward, the successful implementation of this plan will require the continued collaboration of all sectors, ensuring that Junagadh becomes a model for sustainable urban development.

Executive Summary

Climate Action Plan (CAP)

Well-designed urban climate action plans have the potential to significantly advance sustainable development and enhance community well-being. Globally, the most rapid increase in urban vulnerability and exposure is observed in cities and settlements with limited adaptive capacity, particularly in unplanned and informal areas within low- and middle-income countries, as well as in smaller and medium-sized urban centers (IPCC 2022). While Indian cities are currently addressing existing challenges, they have yet to adequately prepare for future urbanization trends. The impacts of climate variability, rising GHG emissions, and environmental changes have already led to severe effects such as cyclones, floods, heatwaves, and droughts in many Indian cities. The implementation of a city climate action plan presents an opportunity to set a benchmark for sustainability, efficiency, inclusivity, and proactive measures in Indian urban areas.

India has committed to fulfilling 50% of its energy needs with renewable sources by 2030 and has set a goal to reach "net zero carbon" by 2070, as pledged at COP26. Additionally, Gujarat state and Junagadh city are putting efforts to cut global GHG emissions, targeting a reduction by 2030 and striving to become net-zero in emissions by 2050.

Baseline

Junagadh city is located in western Gujarat and is surrounded by Arabian sea and forest area. The city faces varying degrees of flood risk, with medium risk areas being the most extensive, covering over half of the city's area (52.2%). High-risk areas also account for a substantial portion, at 42%, while low and very high-risk areas constitute 3% and 0.9%, respectively. This distribution underscores the necessity for robust flood management strategies to mitigate potential damage, particularly in the medium and high-risk zones. In terms of vulnerable entities, numerous Anganwadi centers, public and urban health centers, and slums are at risk, with a notable concentration in the medium and high-risk categories. Specifically, 44 Anganwadi centers are at high risk, and 126 are at medium risk, indicating a significant portion of the city's social infrastructure is vulnerable to flooding.

The green cover in Junagadh has seen a marked decrease from 2011 to 2021, dropping from 22.3% to 15.1% of the city area. This reduction may be attributed to urban expansion or other anthropogenic activities leading to the loss of green spaces. The ward-wise analysis reveals a disparity in green cover distribution, with Ward 14 having the highest coverage at 26.2%, while some wards, like Ward 7, have almost no green cover. This uneven distribution calls for targeted greening initiatives to ensure more equitable green space availability across the city. Waterbodies and rivers within the Junagadh Municipal Corporation play a crucial role in the city's water management. The Hasnapur Dam, Narsinh Mehta Lake, and other smaller waterbodies collectively cover an area of 0.17 sq km. Additionally, the Lol, Sonrekh, and Kalva rivers span a total length of approximately 18.8 km. Effective management of these water resources is essential to mitigate flood risks and maintain ecological balance.

In conclusion, Junagadh faces significant flood risks, particularly in medium and high-risk zones, and has experienced a considerable decline in green cover over the past decade. Addressing these challenges requires comprehensive flood management strategies and initiatives to restore and enhance green spaces, ensuring sustainable urban development and resilience against environmental hazards.

With respect to mitigation, Junagadh's baseline emission inventory for 2021-22 reveals a total emission of 4,22,512 metric tons of CO_2 equivalent ($MTCO_2e$), equating to a per capita emission rate of 0.96 $MTCO_2e$. The largest contributor is stationary energy, comprising 63% of emissions, followed by transportation at nearly 25%, and waste contributing 12%. Projections indicate a significant rise in emissions, expected to increase 2.6 times by 2050. During this period, transportation emissions are forecasted to escalate to 37%, surpassing stationary energy's anticipated decrease to 52% and a marginal decline in waste sector emissions to 11%. These projections underscore the critical need for targeted emission reduction strategies across sectors to achieve sustainable development goals and mitigate Junagadh's carbon footprint growth over the coming decades.

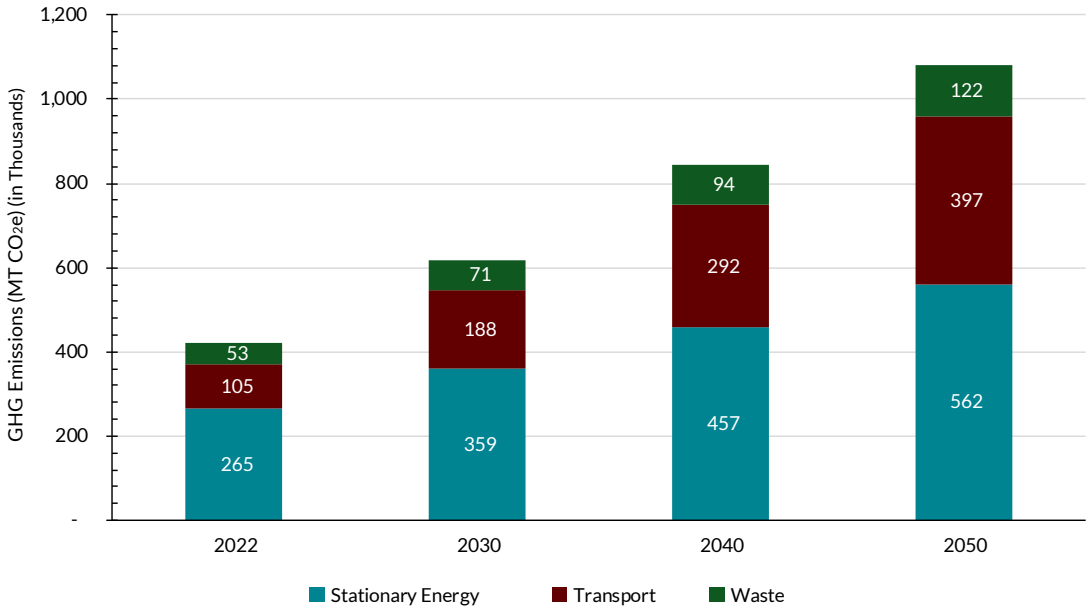

Figure 1: Projected GHG growth in Junagadh

Recommendations

The climate action plan outlines a strategic roadmap for Junagadh to achieve a 'Net Zero' and 'Climate Resilient' status by 2050, focusing on both mitigation and adaptation objectives. This comprehensive vision, developed in consultation with the public, representatives, and administration, underscores the region's commitment to environmental stewardship and resilience in its long-term development strategy. By embracing this forward-looking approach, Junagadh aims to safeguard its natural resources and cultivate a sustainable future for generations to come.

The mitigation actions for Junagadh are categorized into three groups: Existing & Planned Actions, Ambitious Actions, and Extended Scenario, collectively aiming to reduce emissions by 10,79,834 metric tons of CO2 equivalent by 2050. Existing & Planned Actions encompass ongoing national, state, and local initiatives, while Ambitious Actions involve realistic strategies informed by stakeholder consultations and departmental inputs. Although these actions can yield substantial emission reductions, additional measures are necessary to achieve the net zero emissions target. The "Extended Scenario" outlines these supplementary strategies, which currently face significant political, institutional, technological, or financial hurdles.

To establish the pathways and targets essential for realizing Junagadh's Climate Vision, four distinct scenarios have been modelled:

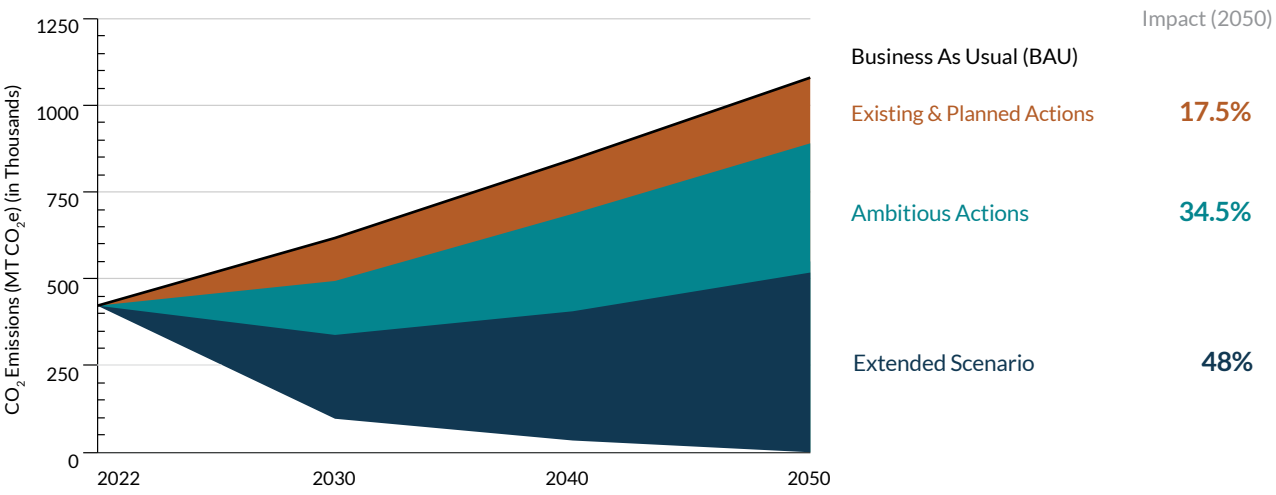

Figure 2: Categorisation of mitigation scenarios under Junagadh CAP

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List of Abbreviations

AT&C: Aggregate Technical & Commercial losses

BAU: Business As usual

BEE: Bureau of Energy Efficiency

BLDC: Brushless Direct Current

BMC: Biodiversity Management Committee

BOD: Biochemical oxygen demand

C-Cube: Climate Centre for Cities

C&D: Construction and Demolition

CAP: Climate Action Plan

CCAP: City Climate Action Plan

CH4: Methane

CNG: Compressed Natural gas

CO2: Carbon Dioxide

COD: Chemical Oxygen Demand

COP: Conference of parties

CPHEEO: Central Public Health and Environmental Engineering Organisation

CR: Critically Endangered

CSCAF: ClimateSmart Cities Assessment Framework

DPR: Detailed Project Report

ECBC: Energy Conservation Building Code

ECSBC: Energy Conservation Sustainable Building Code

EN: Endangered

ENS: Eco Niwas Samhita

E**SR:** Elevated Surface Reservoirs

EV: Electric Vehicle

EWS: Early Warning System

FOD: First Order of Decay

GBH: Girth at Breast Height

GDCR: General Development Control Regulations

GCoM: Global Covenant of Mayors

GDP: Gross Domestic Product

GHG: Green House Gas

GIDC: Gujarat Industrial Development Corporation

GPCB: Gujarat Pollution Control Board

GSR: Ground Service Reservoirs

GSRTC: Gujarat State Road Transport Corporation

HPCL: Hindustan Petroleum Corporation Limited

HT: High Tension

HVRA: Hazard, Vulnerability and Risk Assessment

IEC: Information, Education and Communication

IMD: Indian Metrological Department

IOCL: Indian Oil Corporation Limited

IPCC: Intergovernmental Panel on Climate Change

IPT: Intermediate Public Transport

JAU: Junagadh Agricultural University

JUDA: Junagadh Urban Development Authority

JuMC: Junagadh Municipal Corporation

LBSAP: Local Biodiversity Strategy and Action Plan

LED: Light Emitting Diode

LEZ: Low Emission Zone

LiFE: Lifestyle for Environment

LPG: Liquified Petroleum Gas

LT: Low Tension

MBBL: Model Building Bye-Laws

MLD: Million Litres per day

MoHUA: Ministry of Housing and Urban Affairs

MSMEs: Micro, Small, and Medium Enterprises

MTPD: Metric Tonnes per day

MW: Mega Watt

N2O: Nitrous Oxide

NAPCC: National Action Plan on Climate Change

NDC: Nationally Determined Contribution

NGO: Non-government Organization

NIUA: National Institute of Urban Affairs

NMSH: National Mission on Sustainable Habitat

NMT: Non-motorized Transport

NRCG: National Research Centre for Groundnut

NRW: Non-Revenue Water

PAT: Perform, Achieve and Trade

PBR: People's Biodiversity Register

PGVCL: Paschim Gujarat Vij Company Ltd.

PM: Particulate Matter

RL: River Length

RTO: Regional Transport Office

RTS: Rooftop Solar

SA: Surface Area

SCADA: Supervisory Control And Data Acquisition

SCM: Smart Cities Mission

SDGs: Sustainable Development Goals

STP: Sewage Treatment Plan

$MtCO_2e$: Metric Tonnes of Carbon Dioxide Equivalent

TCPO: Town and Country Planning Organisation

TPD: Tonnes per day

UNFCCC: United Nations Framework Convention on Climate Change

VU: Vulnerable

WSS: Waste Segregation at Source

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01 Introduction

Project Background
Need for City Climate Action Plan
India's Climate Journey
CSCAF

1.1 Project Background

The anthropogenic impacts of climate change affect 80% of the land area where more than 85% of the world's population currently reside. Almost 3.6 billion (~44%) live in areas highly susceptible to climate change. Cities, which house more than 4.2 billion people, are particularly vulnerable to these impacts where urban form and socio-economic activities can amplify vulnerabilities. Cities face intensified challenges, grappling with the urban heat island effect, increased vulnerability to floods and storms, and strained resources. The impact extends beyond physical infrastructure, affecting health, economies, and emergency response capabilities. Mitigation and adaptation measures are crucial to enhancing urban resilience and addressing the complex interplay between climate change and city life. Parallelly, cities consume 60-80% of all energy and contribute 75% of the planet's carbon emissions.

India, as per the Intergovernmental Panel on Climate Change's (IPCC) Sixth Assessment Report (IPCC, 2021), is on the brink of experiencing severe impacts of climate change. These include increased flood damage to infrastructure, heat-related human mortality, and exacerbated drought-related food and water scarcity. The country ranks second to Puerto Rico in terms of extreme weather deaths (2736 deaths) and severe economic losses (USD 13.8 billion). It is also ranked 6th among the ten most affected countries in the world as per the Global Climate Risk Index, 2016. Urban centres, which house a third of India's population and contribute to 63% of the nation's GDP, are particularly vulnerable to these climate disasters. These disasters are projected to put at least 4.5% of the GDP at risk by 2030, while extreme heat stress alone is projected to kill 15 lakh more Indians annually by 2100. Indian cities also disproportionately contribute to Greenhouse Gas (GHG) emissions. While the national average per capita emissions is around 1.8 $MTCO_2e$ per year, the average in urban areas can be as high as 4.79 $MTCO_2e$.

In collaboration with the National Institute of Urban Affairs, the Ministry of Housing and Urban Affairs (MoHUA), the Government of India, has established the Climate Centre for Cities (C-Cube). Since its inception, C-Cube has been instrumental in coordinating an ecosystem development process to create synergy across all climate actions (both mitigation and adaptation) being undertaken by various stakeholders in Indian cities. As part of this, C-Cube, in partnership with the Global Covenant of Mayors and the European Union, has led the development of City Climate Action Plans. These plans aim to streamline climate actions undertaken by cities and align them with national and international targets and commitments.

1.2 Need for City Climate Action Plan

While India has set national-level priorities and targets to address climate change, it is crucial to translate these into actionable interventions at the local level. A city climate action plan serves this purpose by defining the city's climate visions and developing pathways for implementing mitigation and adaptation actions (policies, plans and projects) that the city can take to reduce its GHG emissions and increase climate resilience. The plan develops emission inventories and conducts climate vulnerability assessments to identify and prioritise the actions that will need to be taken by the city.

1.3 India's Climate Journey

India's climate journey which began in 2008 has been turbo charged since 2016 when India became a signatory to the Paris climate agreement. Since then, India has taken various actions to fulfill its commitments under the NDCs. The details of these actions are below.

2008

8 Missions NAPCC

The Prime Minister's Council on Climate Change, GoI, launched the National Action Plan on Climate Change in 2008 with 8 sub-missions representing the multi-pronged, long-term, and integrated strategies to mitigate and adapt to the adverse impacts of climate change. The plan aims at fulfilling India's developmental objectives with a focus on reducing the emission intensity of its economy. Eight missions under NAPCC are as follows:

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

2016

Paris Agreement and India's NDC

As a signatory to the Paris Agreement, India is bound by the terms of the landmark international treaty on climate change, adopted by 196 nations at the Conference of Parties (COP) 21 in Paris. The Agreement's overarching objective is to curb global warming to well below 2°C, ideally 1.5°C, compared to pre-industrial levels. To achieve this, India submitted its intended Nationally Determined Constributions (NDC) to the UNFCCC which included eight goals, aiming at increased non-fossil fuel capacity, reducing emissions intensity, and creating additional carbon sinks by 2030

2019

ClimateSmart Cities Assessment Framework

The Ministry of Housing and Urban Affairs (MoHUA) launched CSCAF as a city-level framework to promote climate-resilient and low-carbon development across urban India under the Smart Cities Mission (SCM). The first round of the assessment evaluates 96 cities.

2020

Climate Centre for Cities

MoHUA and NIUA launched C-Cube to institutionalise climate actions in Indian cities, focusing on an ecosystem development process for synergising all climate initiatives nationwide.

2020

CSCAF 2.0

The second round of the assessment expanded the evaluation to 126 cities and included cities that were not part of the Smart Cities Mission.

2021

COP26 (Net Zero 2070)

At COP26 in Glasgow, India reaffirmed its commitment to intensify climate action by presenting five key elements, referred to as 'Panchamrit'. It includes increasing non-fossil fuel capacity by 500GW, achieving 50% of energy requirements from renewable sources, reducing total projected carbon emissions by one billion tonnes, lowering the carbon intensity of the economy by 45%- all by 2030. It was an update to its climate targets through which India declared a long-term goal of achieving net-zero emissions by 2070, crucial to the environmental challenges it faces as a developing country

2022

CSCAF 3.0

The current round of CSCAF expands the assessment to 226 cities across India.

2022

National Mission on Sustainable Habitat (NMSH)

India's GHG emissions surged by 144%, from 1,311.29 $MtCO_2e$ in 1994 to 3,202 $MtCO_2e$ in 2014 (WRI CAIT). Effectively managing carbon footprint of urban habitats and ensuring their resilience to climate change poses a challenge for India, especially with its growing urban population and an amplified demand for land. To mainstream climate change mitigation and adaptation measures into urban planning and policy frameworks, the Government of India launched NMSH in 2010 under the NAPCC. It outlines strategies for mitigating GHG emissions and building resilience in infrastructure assets and communities.

2022

LT LEDS

India launched its long-term low-emission strategy for development in COP 28. This strategy, in line with the commitments under the Paris Agreement, focused on, among other strategies, long-term sustainable urbanism by integrating climate action, mitigation strategies and climate risk adaptation within planning processes.

Mission LiFE

The government of India introduced Mission Life in COP26 to encourage and mainstream environmentally responsible behaviours in everyday life. Intending to conserve natural resources, the mission focused on channelling the efforts of individuals and communities into a global mass movement of living in harmony with nature. The mission had seven main focus areas - Saving energy, Saving water, Stopping single-use plastics, Sustainable food systems, Reducing waste, healthy lifestyles, and Reducing e-waste.

1.4 ClimateSmart Cities Assessment Framework (CSCAF)

In February 2019, the Ministry of Housing and Urban Affairs (MoHUA) launched the ClimateSmart Cities Assessment Framework (CSCAF) under the Smart Cities Mission (SCM). This pioneering city-level framework, encompassing climate-relevant parameters, including those outlined in the National Clean Air Programme, aims to promote climate-resilient and low-carbon development across urban India, aligning with the Sustainable Development Goals (SDGs) and India's Nationally Determined Contributions (NDCs) towards mitigating global climate change. CSCAF as a city-level framework encompasses five climate-relevant thematic areas and 28 progressive indicators offering a comprehensive monitoring and evaluation tool for cities to annually assess their performance.

Comprising 28 progressive indicators across five thematic areas (see figure 1), the ClimateSmart Cities Assessment Framework (CSCAF) offers a comprehensive monitoring framework for evaluating the progress made in alignment with the National Mission for Sustainable Habitat (NMSH) guidelines. CSCAF functions as a tool for cities to annually assess their performance and provides an incremental roadmap for adopting and implementing relevant climate actions. The outcomes of CSCAF are utilized to monitor progress and inform NMSH. Additionally, the framework facilitates the dissemination of context-specific best practices implemented by Indian cities and assesses the necessary skills and resources for scaling up these practices through its Secretariat at the Climate Centre for Cities (C-Cube) at the National Institute of Urban Affairs (NIUA).

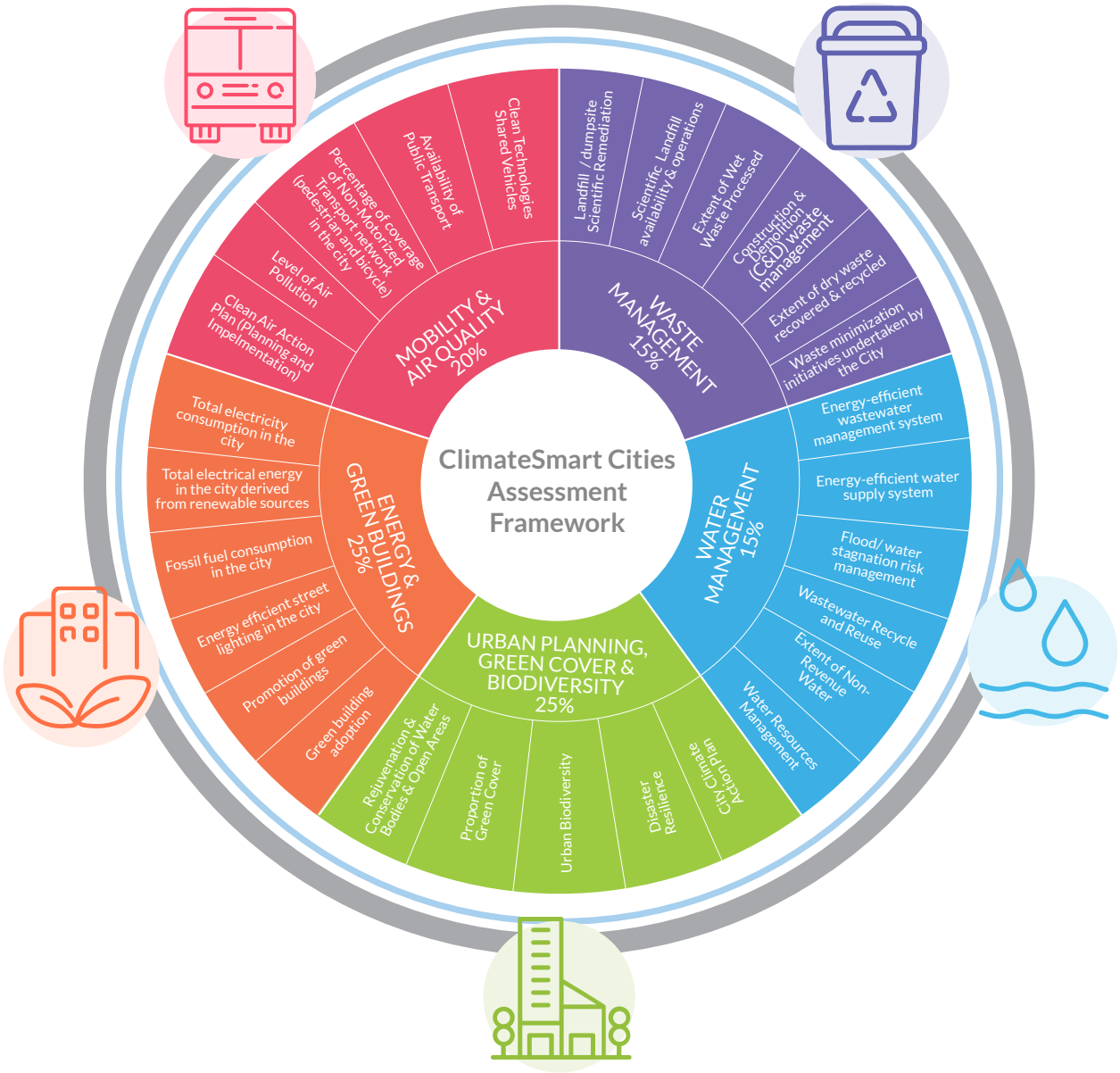
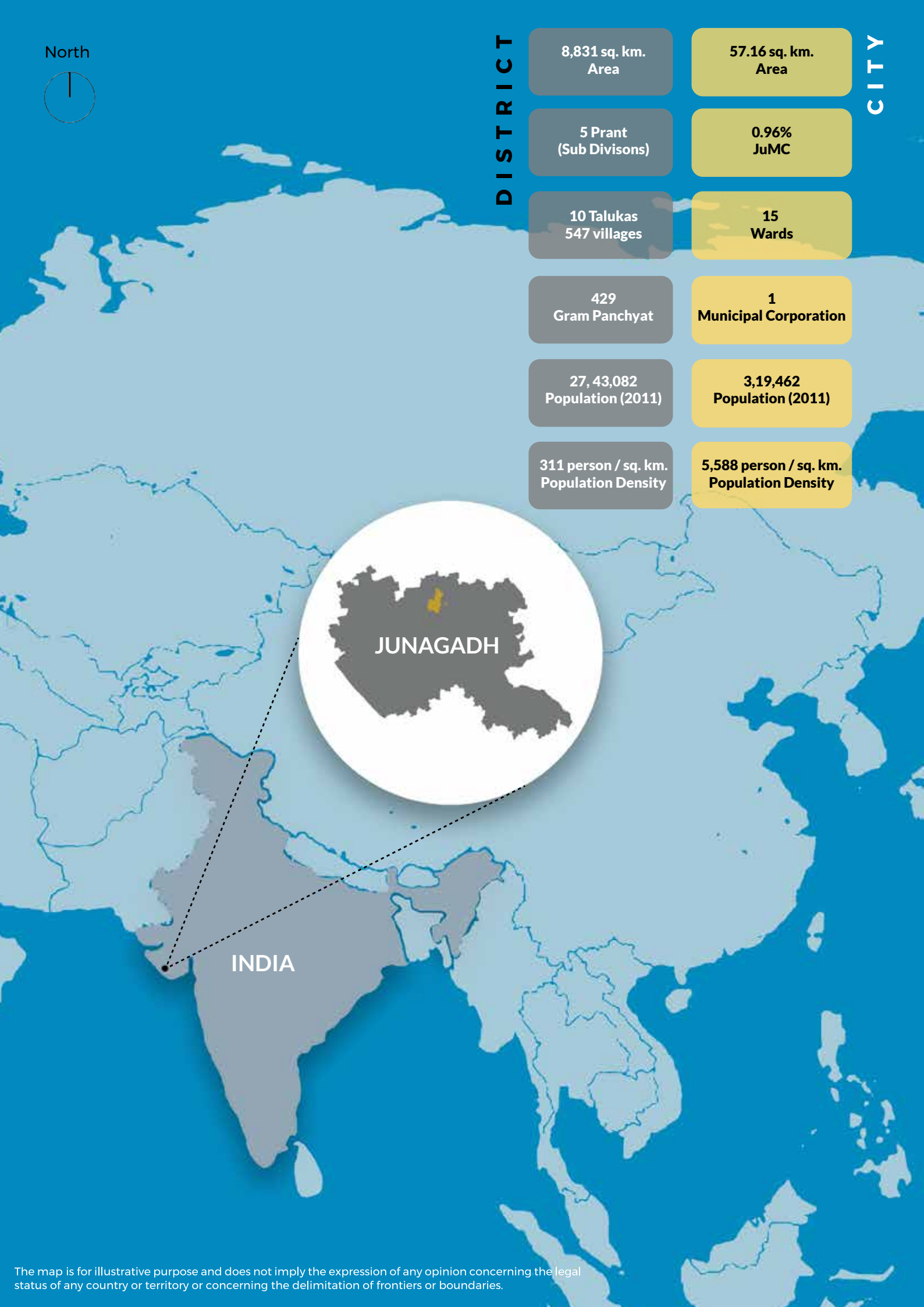


Figure 3: ClimateSmart Cities Assessment Framework

02 Profile

Regional Context
City Profile
Climate Change Impact



The map is for illustrative purpose and does not imply the expression of any opinion concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

2.1 Regional Context

Junagadh district, located in the western part of Gujarat, India, holds historical and geographical significance. It spans approximately 8,278 square kilometers and is situated between the Girnar hills and the Arabian Sea. Administratively, the district is divided into 10 talukas and comprises a diverse population, primarily engaged in agriculture, industry, and trade. The Junagadh Urban Development Authority (JUDA) encompasses parts of Junagadh and Vanthali talukas within a 390.25 sq. km area, including two urban centers: Junagadh in the east and Vanthali in the west. Historically, Junagadh has been a melting pot of cultures and empires, with a significant influence from the Maurya Empire, Kshatrapas, and Chudasama Rajputs. It became a princely state during British rule and joined India in 1948. The city experienced substantial growth post-1947, particularly in education, religious tourism, and various festivals like Shivratri and Parikrama. Urban growth has been notable towards Vanthali road due to infrastructure development, and the establishment of an agricultural university on the southwestern side of the city. The area around the Junagadh-Dhoraji highway has developed into an industrial estate, while the region towards Upleta remains predominantly agricultural.

Junagadh, located adjacent to the Gir National Park, stands as a crucial wildlife sanctuary renowned for harboring the Asiatic lion and a diverse array of species, thereby enhancing the region's biodiversity. The fertile soils surrounding Junagadh support a variety of crops such as groundnut, cotton, and various fruits and vegetables. The agricultural landscape is nourished by rivers like the Hiran, Shetrunji, and Raval, ensuring essential water resources. The area boasts nearly 2000 species of flora, including a significant presence of 400 tree species dominated by teak. Major crops cultivated in the district include wheat, oilseeds (with over 65% of the area dedicated to oilseed crops like groundnut and cotton), mangoes, bananas, onions, and brinjal.

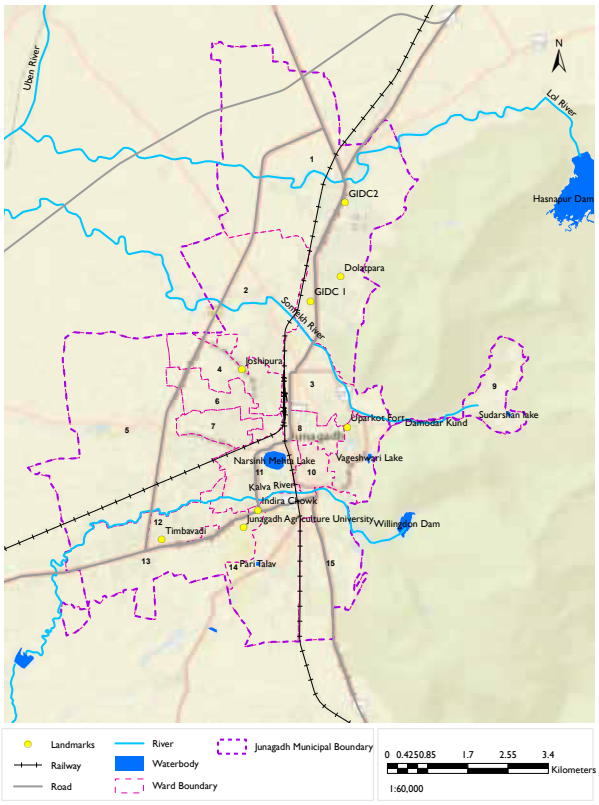
Notably, the National Research Centre for Groundnut (NRCG) is based in Junagadh, pivotal for groundnut crop research.

Junagadh is rich in minerals, prominently limestone and marl, with minor deposits of Blackstone, silt, and morram contributing to its mineral wealth. The district falls within agro-climatic zones VI (South Saurashtra) and VII (North Saurashtra), characterized by a predominantly hot climate with variations from hot to moderately hot throughout the year, except during winter. The coastal belt experiences a humid climate, with temperatures ranging from a minimum of 10°C in January to a maximum of 42°C in May. Industrial activity in Junagadh includes over 38 medium and large-scale industries concentrated mainly in Junagadh and Manavadar talukas. These industries span sectors such as edible oils and refinery plants. Additionally, numerous small-scale industries thrive in food products, chemicals, electrical equipment, textiles, and plastics, predominantly situated in Junagadh, Keshod, Manavadar, and Mangrol talukas.

In essence, Junagadh's exceptional biodiversity, coupled with its rich agricultural production, industrial development, and cultural heritage, underscores its significance as a unique and vital region within Gujarat. It offers substantial value to residents, researchers, conservationists, and tourists alike, contributing profoundly to the region's socio-economic fabric.

2.2 City Profile

Junagadh city is geographically positioned between latitudes 20.47°N to 21.45°N and longitudes 70.15°E to 70.55°E, located 340 km from the state capital, Gandhinagar. The city, governed by a Municipal Corporation, is one of the most well-connected in the district, with the Kalwa River flowing through its center. Proximity to the sea and the Girnar mountain ridge contribute to the city's deep-medium black coastal alluvium soil. According to the 2011 Census, Junagadh's population stands at 319,462, accounting for 1.24% of Gujarat's total urban population.



Map 1: Junagadh City Map

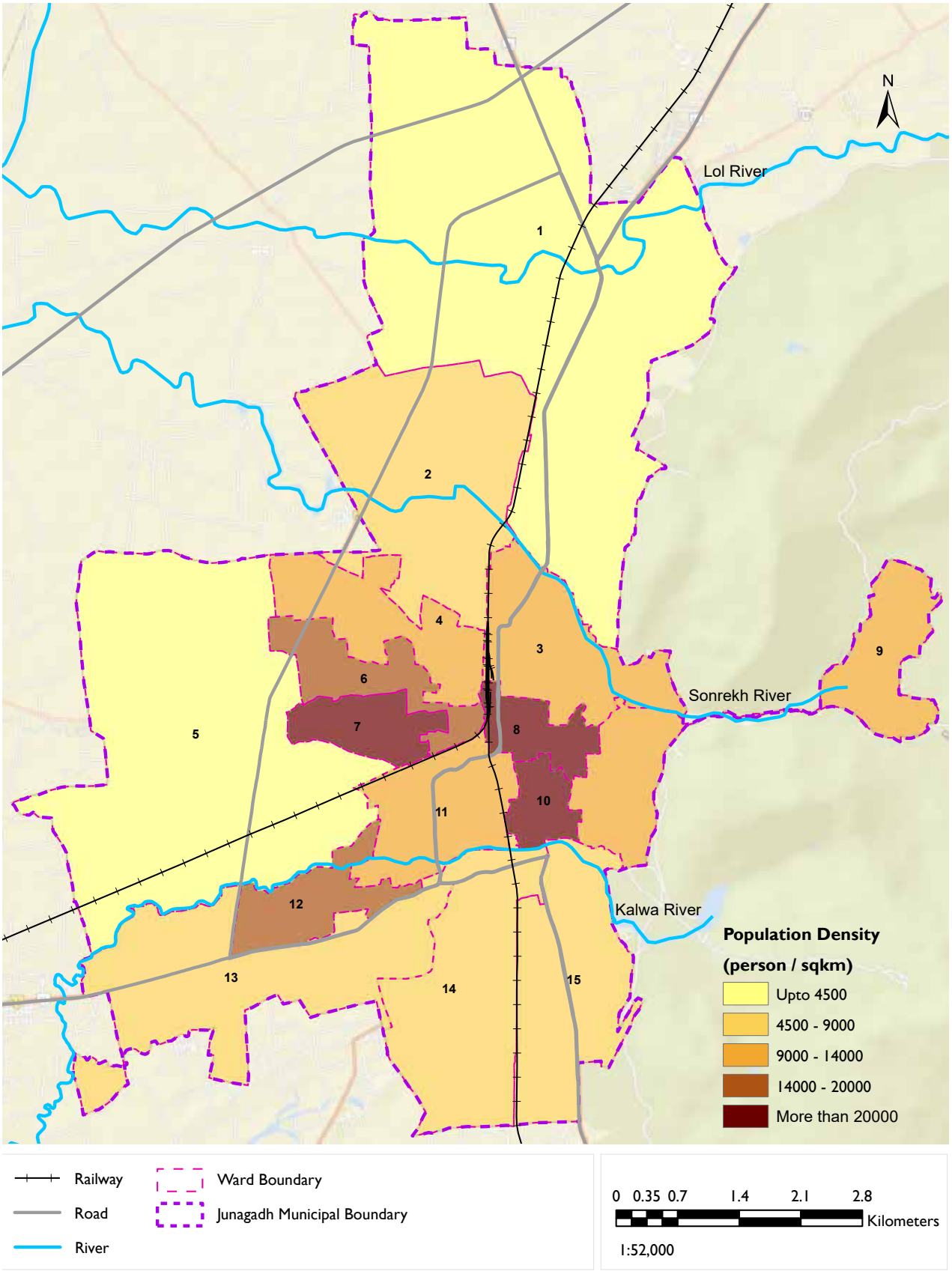
2.2.1 Connectivity

Junagadh city, part of Junagadh taluka in Junagadh district, is geographically bordered by Rajkot District to the north, Bhesan Taluka to the east, Mendarda and Visavadar Talukas to the south and southeast, and Vanthali Taluka to the west. The city is well-connected by rail, with a centrally located railway station that features five platforms and services both Broad-Gauge and Meter-Gauge lines. The nearest airport is in Rajkot, approximately 105 km from Junagadh.

Map 2: Regional Connectivity

2.2.2 Urban Profile

Junagadh city is divided into 15 administrative wards and 20 zones for efficient water supply management. The Gujarat Industrial Development Corporation (GIDC) zones are predominantly located in Ward 01, encompassing both sides of the Junagadh Highway road, thus serving as the city's primary industrial hub. The Bhawnath area, renowned for its significant tourist attractions, is situated in Ward 09. Furthermore, Wards 03, 04, 06, 07, 08, 10, and 11 are characterized by high-density populations and extensive built-up areas compared to other wards. The city is also home to numerous heritage structures, primarily located in the historic old city within Wards 03 and 08, highlighting its rich cultural



Map 3: Population Density map of Junagadh

2.2.3 Demography

Junagadh city, with an estimated population of approximately 452,000 in 2024, has shown significant growth since the 2011 census, which recorded a population of 319,462. The city has a balanced gender ratio with 955 females per 1000 males and a child sex ratio of 868 females per 1000 males. Junagadh boasts a high literacy rate of 88.00%, with male literacy at 92.46% and female literacy at 83.38%. The workforce comprises 103,257 individuals, with the majority being main workers (92.68%). The city also has a substantial number of houses, totaling 68,111. Overall, Junagadh is a vibrant and growing city with a well-educated population and a robust workforce.

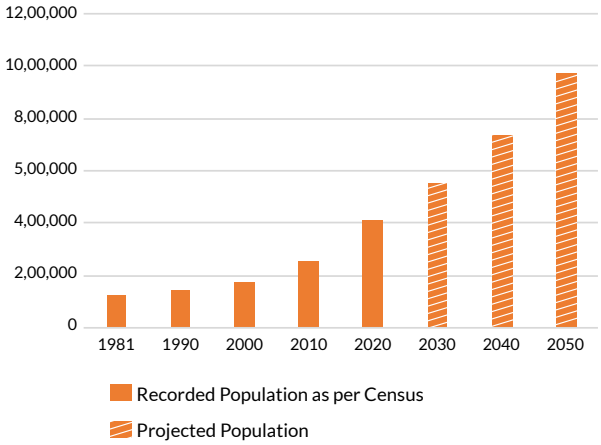


Figure 5: Projected Population Growth in Junagadh

2.2.4 Economy and Tourism

Junagadh city has over 20 cultural and architectural heritage assets, attracting significant tourist attention. Key tourist sites include Uparkot Fort, Mohabbat-E-Maqbara, Girnar Hills and Ropeway, Bhavnath Temple, Darbar Hall Museum, and Sakkarbaugh Zoo. Each year, hundreds of thousands of tourists visit Junagadh to experience its diverse offerings, which range from scenic beaches and spectacular hills to ancient heritage sites, wildlife sanctuaries, and religious places. As depicted in Figure 3, tourist footfall significantly increases during the winter months, nearly doubling compared to the summer months.

Junagadh serves as a vital trade center within the district, with agricultural produce being the primary economic driver. The household industries and informal sector also play crucial roles in employment and income generation. The city features two notable industrial clusters focused on groundnut and plastic production. Additionally, the tourism sector generates significant economic activities. Over 21,000 MSMEs are registered under the Udyam portal. According to the 2011 Census, the workforce participation rate in Junagadh was 32.32%, comprising 95,697 main workers and 7,560 marginal workers, totalling 1,03,257 workers. The workforce is categorized into cultivators (7.0%), agricultural laborers (8%), household industry workers (2.03%), and other workers

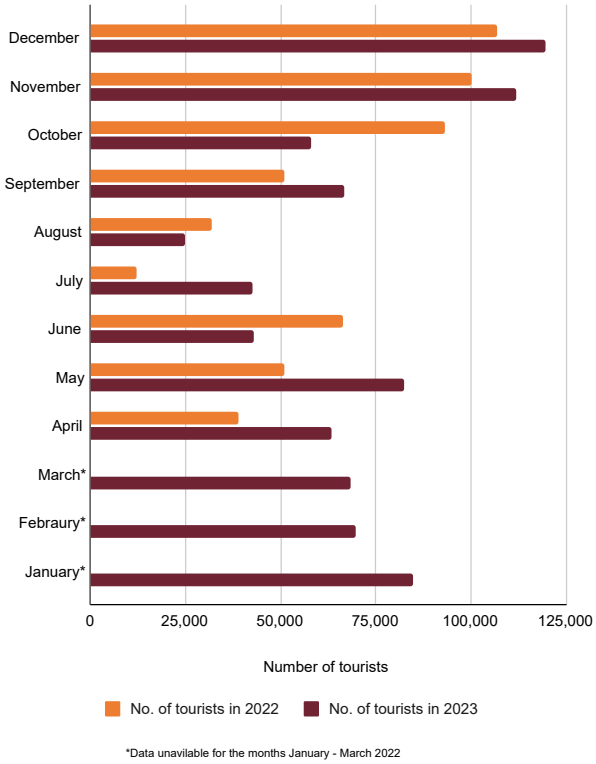


Figure 4: Girnar Ropeway Traffic in Junagadh (2022-2023)

Source: Pravasan Vibhag, District Collectorate Office

2.2.5 Climate

Junagadh experiences a tropical wet and dry climate, bordering on a hot semi-arid climate, with two primary seasons: a dry season from October to May and a wet season from June to September. The proximity of the Arabian Sea and the Gulf of Cambay significantly influences the local climate. The city generally experiences hot to moderately hot and dry conditions, consistent with the broader tropical climate of the state.

The district typically receives an average annual rainfall of 700-1050 mm. Summer temperatures can reach a maximum of 46.0 degrees Celsius, while winter temperatures can drop to a minimum of 4 degrees Celsius (Figure 6). The highest recorded annual rainfall was 2,800 mm in 1983.

In 2022, Junagadh received a total annual rainfall of 1318.9 mm over 53 rainy days, with the monsoon contributing 1267.5 mm over 52 days, starting from June 12th and lasting until October 10th. Additionally, the post-monsoon period saw 51.2 mm of rainfall. In 2021, the city received 1367.8 mm of annual rainfall over 47 rainy days, with 1227.5 mm during the monsoon season spread over 38 days, beginning on June 19th and extending until October 13th. Pre- and post-monsoon rains in 2021 amounted to 62.7 mm over 4 days and 77.6 mm over 5 days, respectively. This detailed rainfall pattern underscores the variability and distinct seasonal distribution of precipitation in Junagadh as shown in Figure 7.

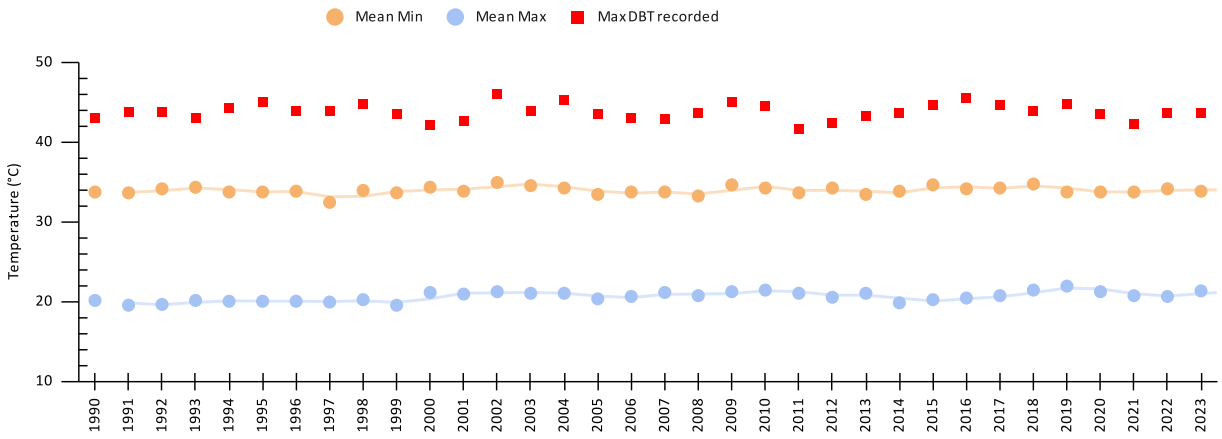


Figure 6: Temperature change in Junagadh (1990-2023)

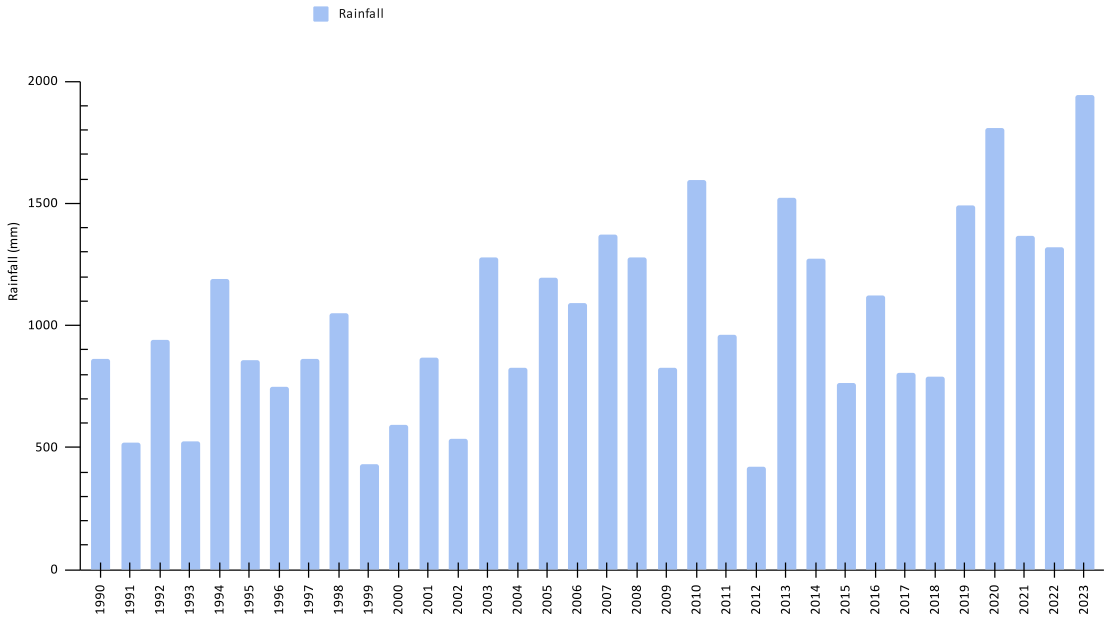


Figure 7: Rainfall pattern in Junagadh (1990-2023)

03 Methodology

Project Approach
Methodology for GHG inventory
Methodology for HVRA

3.1 Project Approach

This climate action plan looks at Junagadh as a climate victim, likely to be one of the worst impacted regions globally due to climate change. Aligning with the National Mission for Sustainable Habitat under the National Action Plan for Change and the CliamteSmart Cities Assessment Framework developed by the National Institute of Urban Affairs, this City Climate Action Plan looks at minimizing Junagadh's contribution to climate change by reducing its emissions and building resilience against the predicted impacts of climate change. The overall structure of the plan follows the four main stages as highlighted below:

Baseline Analysis	Based on the CSCAF framework, the baseline developed provides a comprehensive picture of disaster vulnerability and Green House Gas Emissions in Junagadh
Future Projections	Future projections of both GHG Emissions and Climate Patterns to understand how Junagadh will be impacted by global weather patterns and climate change while also mapping Junagadh's projected contributions
Problem Identification and Vision Setting	Discern areas where climate action is needed in Junagadh and establish a Vision and climate targets for the city
Implementation Road Map	Developing structural and non-structural measures to meet the climate targets set by the city, including recommendation timelines, financial and responsibility mapping and MEL frameworks

Through multiple rounds of stakeholder consultations, the plan incorporates the recommendations, feedback and on-ground knowledge of the residents, NGOs and government officials working in Junagadh. This Climate Action Plan has been developed for the Municipal area of 57.16 SqKm; however, the thrust areas and recommendations of this plan can be scaled up and expanded should the municipal area of Junagadh expand to include outgrowth areas.

Hazards
Vulnerability
Risk Assessment
GHG Emissions

August 2023

Data Collection & Literature Review

Extensive data, crucial for analysis and projections in the Action Plan development, was gathered from various departments and categorised into Hazards, Vulnerability, Risk Assessment, and Greenhouse Gas Emissions Inventory, utilising tabular and spatial formats to assess parameters and identify physical hotspots.

Sept. 2023

1st Stakeholder Consultation

Primary objective was to validate identified challenges and issues through interactive exposures, based on data collection and literature review.

Nov. 2023

Field Survey & Data Analysis

Field visits to natural resources, followed by data analysis that involved translated collected data into city implications for climate change, overlaying timelines and hotspots on spatial maps and conducting rigorous calculations to comprehend climate change effects in different city areas within the Hazards, Vulnerability, and Risks Assessment (HVRA)

Feb. 2024

Second Stakeholder Consultation

Goal was to collaboratively define the plan's vision, and pinpoint key focus areas with all relevant public, private and not-for-profit agencies. Recommendations were captured on maps, table, digital forms and through focused group discussions. It helped in creating a robust inventory of contextually relevant and locally integrated solutions

April 2024

Development of Recommendations

As per the estimated targets, recommendations were formulated in the shape of policies, projects and institutional frameworks

May 2024

Final Report Development

The last round of stakeholder consultations aimed to secure approval from city officials for the proposed actions outlined in the plan

Target Setting

On the basis of the 2nd stakeholder consultation, target setting was done with the support of esteemed dignitaries and officials

April 2024

Review and Feedback

The conclusive report has been presented to the city and GCoM for review and their feedback.

Final Submission to city

July 2024

3.2 Methodology for GHG inventory

A GreenHouse Gas (GHG) inventory seeks to accurately quantify and track the amount of greenhouse gases emitted (source) and removed (sink) by cities. The inventory provides a comprehensive picture of the sources of emissions, including the type and quantity of greenhouse gases emitted. This allows cities to establish baselines and identify and prioritise mitigation actions for reducing emissions in line with various national and international targets. Additionally, a uniform system of establishing GHG inventories enables centralised reporting by cities allowing for scrutinisation of actions, comparisons of efficiencies and ensuring the achievement of national/sub-national targets.

Emissions generated by various activities in cities are broadly divided into three categories based on where the emissions occur. These are as follows:

Scope 01	GHG emissions from sources located within the city boundary
Scope 02	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 03	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary

This Climate Action Plan, only Scope 1 and Scope 2 emissions of activities occurring within the 57.16 sqkm municipal boundaries of Junagadh are considered. The inventory developed will account for emissions of the seven gases currently required for most national GHG inventory reporting under the Kyoto Protocol: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), and nitrogen trifluoride (NF3). The development of the baseline will consider various activities categorised under Stationary Energy, Transportation and Waste as per below:

Emission Sources Considered for Junagadh Climate Action Plan

Stationary Energy	Residential buildings	Scope 01	Scope 02
	Commercial buildings	Scope 01	Scope 02
	Institutional buildings	Scope 01	Scope 02
	Manufacturing industries and construction	Scope 01	Scope 02
	Energy industries	Scope 01	Scope 02
	Agriculture, forestry, and fishing activities	Scope 01	Scope 02
	Non-specified sources (Municipal services, charging stations)	Scope 01	Scope 02
	Fugitive emissions from mining, processing, storage, and transportation of coal	Scope 01	Scope 02
	Fugitive emissions from oil and natural gas systems	Scope 01	Scope 02
Transportation	On-road transportation – Petrol, Diesel, CNG, LPG & PNG	Scope 01	Scope 02
	Railways	Scope 01	Scope 02
	Water-borne transportation	Scope 01	Scope 02
	Aviation	Scope 01	Scope 02
	Off-road transportation	Scope 01	Scope 02
Waste	Solid Waste Disposal	Scope 01	Scope 02
	Biological treatment of waste	Scope 01	Scope 02
	Incineration & open burning	Scope 01	Scope 02
	Waste water treatment & discharge	Scope 01	Scope 02

3.3 Methodology for Climate Risk Assessment

Climate risk and vulnerability assessments (CRVAs) are critical to a city's climate risk management strategy and form the basis for developing adaptation actions and climate action plans. Climate risk assessments identify the likelihood of future climate hazards and their potential impacts on cities and their communities, contributing to overall climate risk. The assessment for this Climate Action Plan focuses on the impacts of short-term risks posed by extreme weather events like heatwaves or cloud bursts and the long-term slow-impact effects of climate change. The climate risk analysis has been conducted in the following four stages:

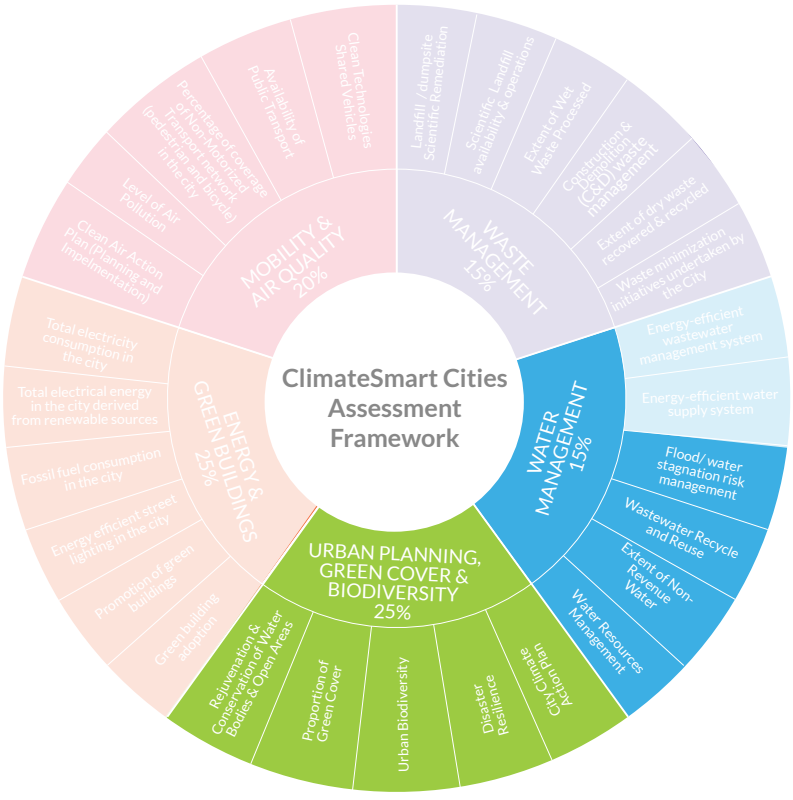
Emissions generated by various activities in cities are broadly divided into three categories based on where the emissions occur. These are as follows:

Hazard assessment — Hazard assessment identifies the probability, intensity and timescale of critical current and future climate hazards in a city and where these hazards are prevalent / are likely to manifest (2050 and beyond where possible)

Impact assessment — Impact assessment looks at the potential impacts of those climate hazard events on people, assets, services, and the natural environment

Risk assessment — Risk assessment determines the critical risks based on the interplay of hazards and impacts

The CSCAF framework has been used as a baseline for this analysis; two themes and nine indicators from the framework focus on understanding the past climate and disaster risks that the city has faced. The hazards identified have been spatialised, and multi-criteria decision analysis using the Analytical Hierarchy process was used to understand current and future risks. This understanding, in combination with climate modelling, temperature and rainfall projections, has been used to develop a comprehensive profile of future climate risks for the city.



04 Baseline

Baseline Analysis
Summary GHG Inventory
Summary HVRA

Baseline Analysis

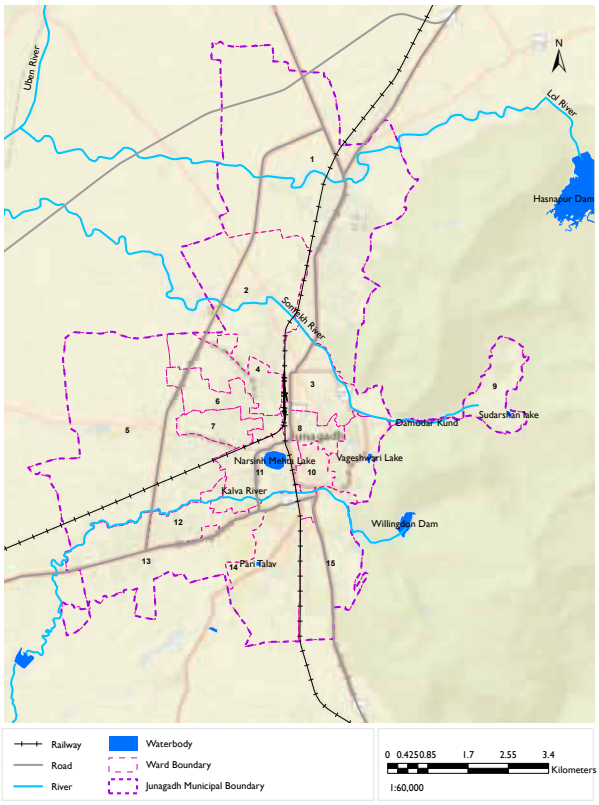
THEME 01: Urban Planning, Green Cover & Biodiversity

Rejuvenation And Conservation Of Water Bodies

Proportion of Green Cover

Urban Biodiversity

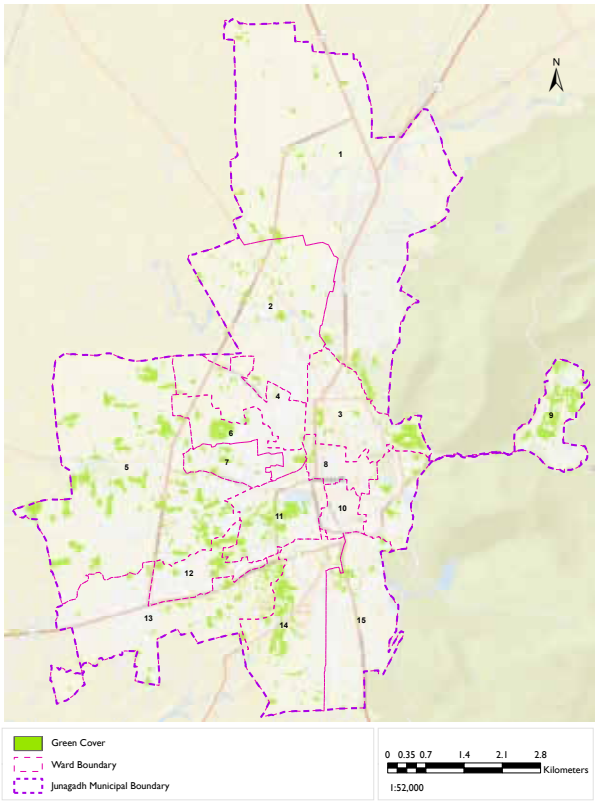
Disaster Resilience



Map 4: Waterbodies within Junagadh City

4.1.1 : Rejuvenation & Conservation Of Water Bodies

In Junagadh, there are a total of 8 water bodies, comprising 4 lakes and 3 rivers. The 4 lakes are Narsinh Mehta Lake, Vageshwari Lake, Pari Talav, and Sudarshan Lake. These lakes vary in their origin, with some being natural and others artificial. The 3 primary rivers flowing through the region are the Kalwa River (RL: 5.38km), Sonrekh River (RL: 5.84km), and Lol River (RL: 7.57), each contributing significantly to the local watershed. Within the municipal boundaries of Junagadh, there are 4 reservoirs, including the Willingdon Dam, the water storage facility at Uparkot Fort, and storage facilities located in Padariya and Dharagadh. The water bodies have been facing environmental degradation including reduction in depth due to sediment accumulation, improper disposal of solid waste, nutrient loading from agricultural runoff.

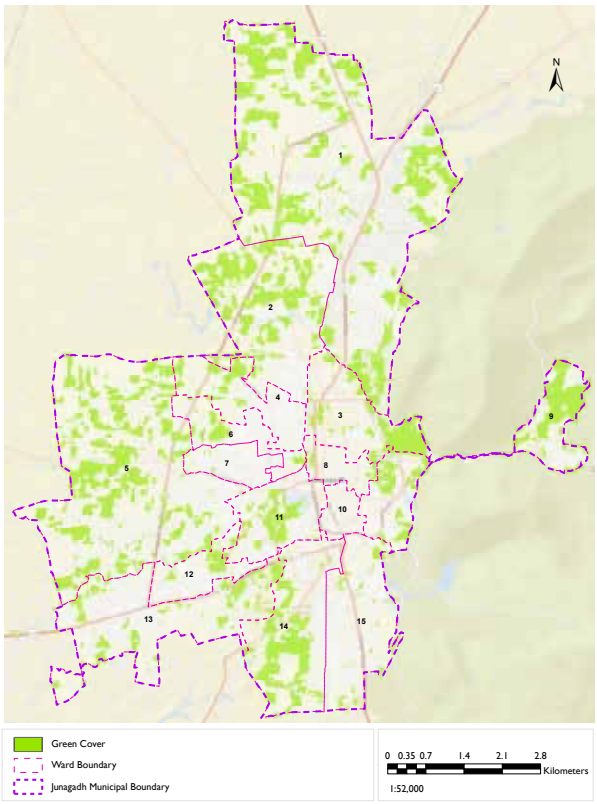


Map 5: Status of Green Cover (2001)

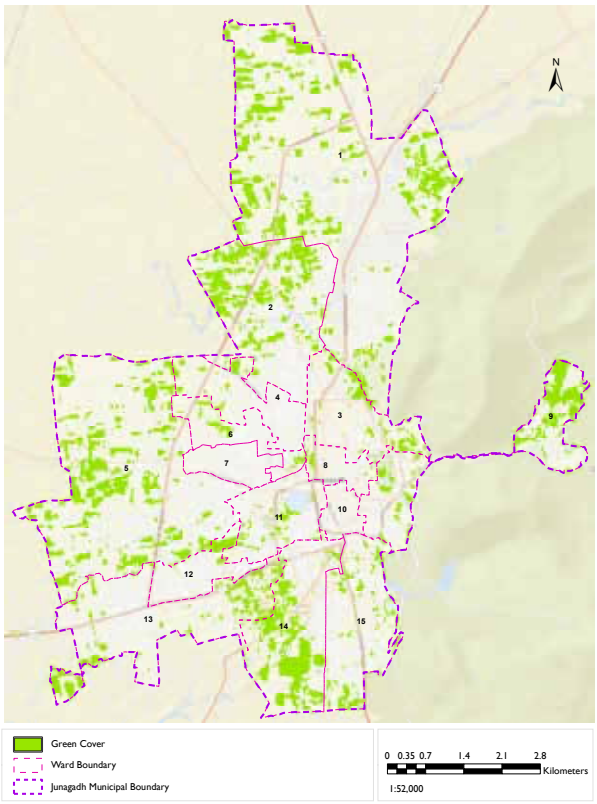
4.1.2 : Proportion of Green Cover

Junagadh city has experienced significant fluctuations in its green cover over the past two decades. In 2001, the green cover area constituted a mere 6.52% of the total city area, reflecting limited vegetation and green spaces. A decade later, in 2011, concerted efforts likely led to a substantial increase in green cover, reaching 22.25% of the city's total area. However, this positive trend did not persist, and by 2021, the green cover had sharply declined to 8.74 sqkm, representing only 15.1% of the total city area. This marked reduction underscores the urgent need for sustainable urban planning and conservation measures to restore and preserve green spaces in Junagadh. Moreover, the 15% green cover area is unevenly distributed among the wards. Specifically, seven out of the fifteen wards have less than 8% green cover. Among these seven wards, five (ward numbers 6, 7, 8, 10, and 12) are particularly alarming because they not only lack sufficient green spaces but also have a population density exceeding 15,000 persons per square kilometer. This high population density combined with minimal green cover poses significant environmental and health

concerns. Furthermore, it is crucial to highlight that wards 7 and 10 has less than 0.5% green cover, which needs immediate attention.



Map 6: Status of Green Cover (2011)



Map 7: Status of Green Cover (2021)

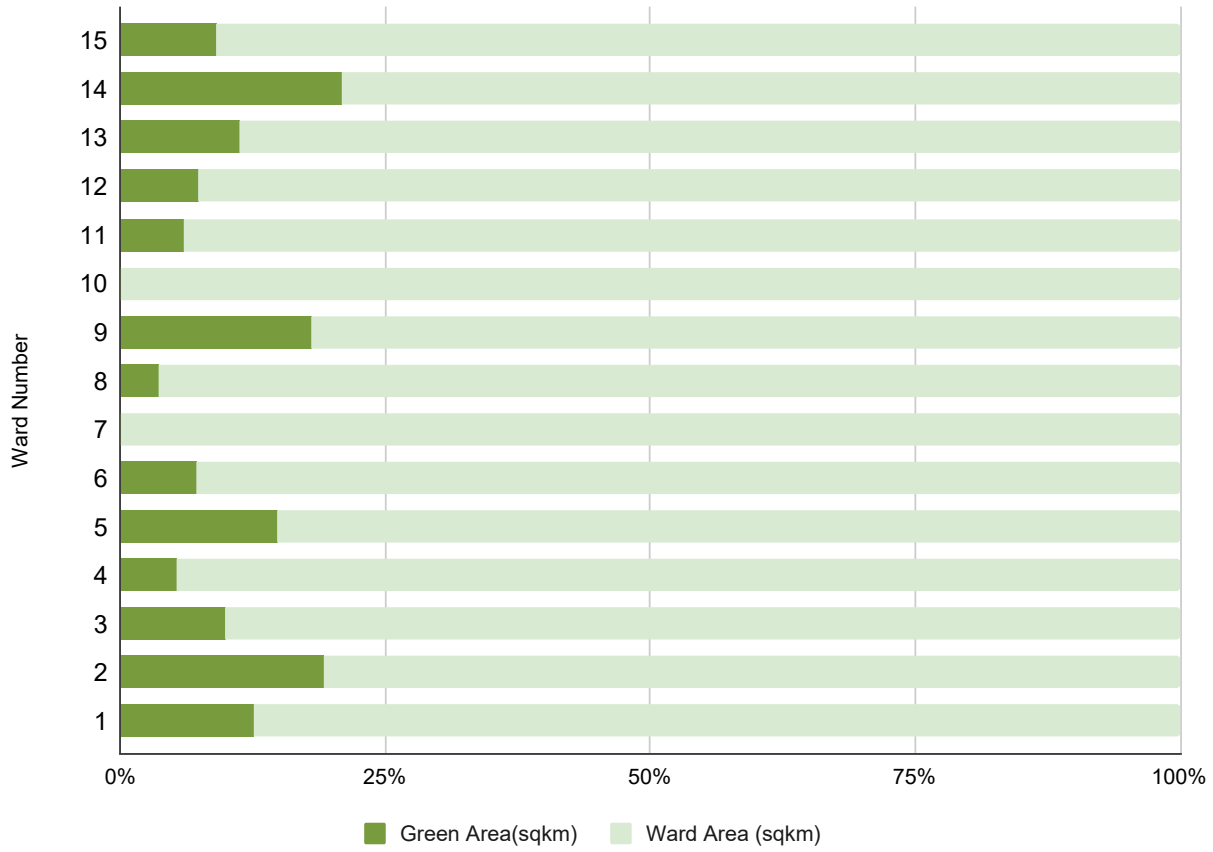


Figure 8: Status of Ward wise green cover

4.1.3 : Urban Biodiversity

Heritage Trees	Common Name	Height	Girth
Adansonia digitata L.	Monkey Bred Tree	10-20m	18 ft 5 in
Ficus religiosa L.	Peepal	10-16 m	26 ft
Switenia macrophylla G.king	Mahogany	25 m	18 ft
Ficus bengalensis L.	Banyan Tree	12-18m	50 ft
Manilkara hexandra (Roxb.	Rayan	10-15 m	18 ft.
Azadirachta indica A.	Margosa Tree	10-15 m	13.8 ft
Mimusops elengi L	Bullet wood Tree	3-10 m	9 ft 3 in
Prosopis cineraria L.	Lebbeck	5-10 m	9 ft 3 in
Limonia acidissima L.	Wood Apple	8-10 m	8 ft
Tamarindus indica L	Tamarind	10-15 m	10 ft 10 in
Terminalia arjuna (Roxb.)	Arjun	15-25 m	8 ft
Putranjiva roxburghii L	Child life Tree	5-20 m	12 ft 7 in
Ficus tsiela (Roxb.)	Pipar	18 m	12 ft 7 in
Hyphaene indica Gaertn.	Branches PAM	8-10 m	8 ft
Borassus flabellifer	Palm Tree	10-16 m	8 ft

Figure 9: List of heritage trees in Junagadh

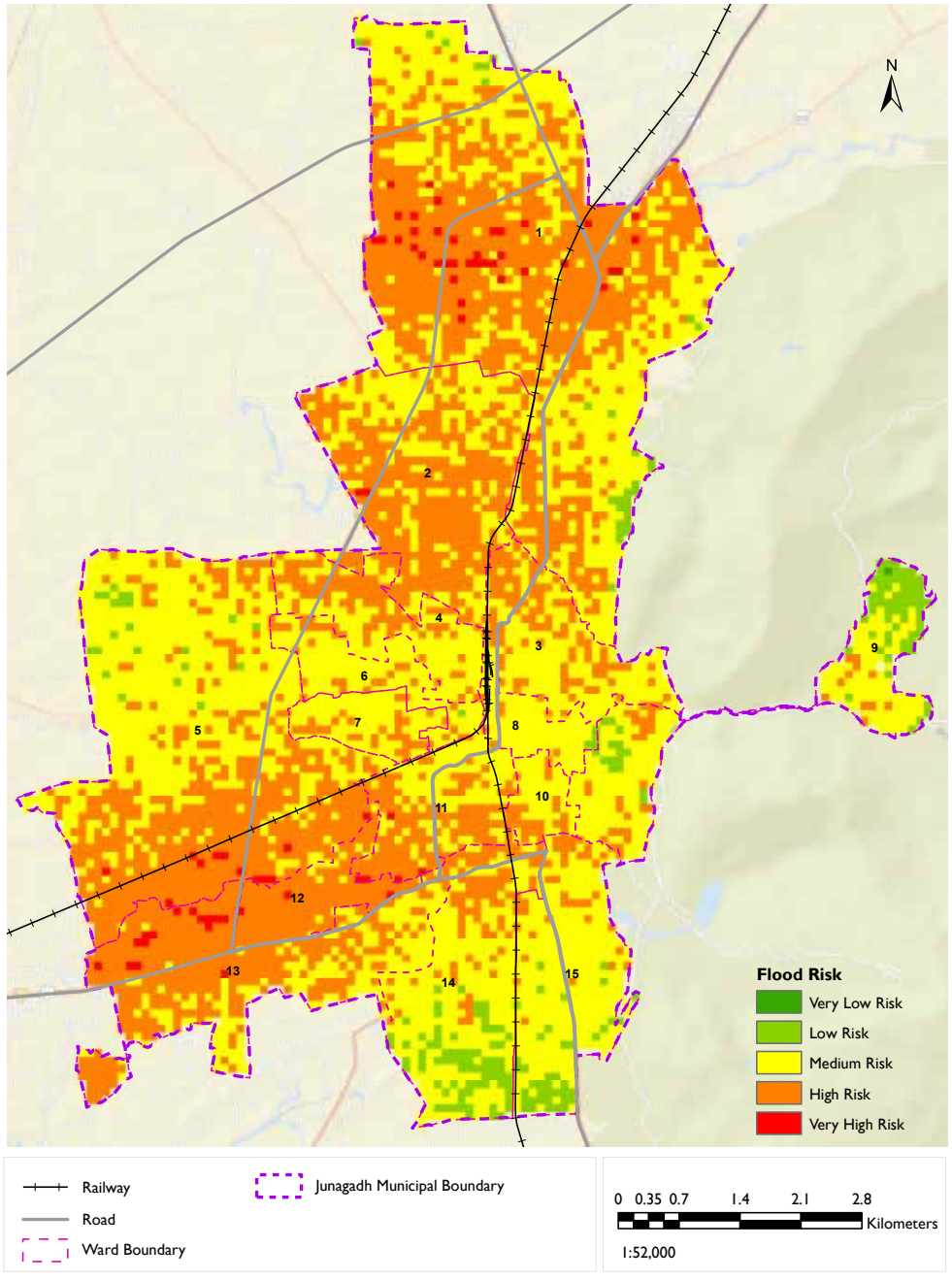
Legend

- High water holding capacity
- Moderate to high water holding capacity
- Moderate water holding capacity

Biodiversity Management Committee (BMC) was formed at the city level in 2022. People's Biodiversity Index (PBR) has not been developed by Junagadh Municipal Corporation yet. 60 native tree species were recorded in the city with Saraca Asoca (Green Ashoka Pendulum) having the highest species richness. Junagadh city also has 15 heritage tree species as shown in Figure 9. As per the report 'Status of Tree Cover in urban Areas of Gujarat', Junagadh city has a tree and forest cover per habitant equivalent to 8.5 m^2 leading to a total number of 23.4 tree per 100 persons. According to the report "Status of Tree Cover in Urban Areas of Gujarat," Junagadh city has a tree and forest cover of 8.5 square meters per inhabitant, resulting in a total of 23.4 trees per 100 people. To meet the minimum standard of 10 square meters of tree cover per inhabitant, 90,000 additional trees are required, the lowest ratio among the eight cities studied in Gujarat. The city still hosts a significant number of trees planted by the Nawab of Junagadh, including over 100-year-old Mahogany (Swietenia macrophylla G. King) and Bullet wood trees (Mimusops elengi). There are 149 trees with a girth exceeding 9 feet 8 inches, and 546 trees with a girth between 8 feet 2 inches and 9 feet 8 inches. However, the number of trees in the lower girth classes is relatively low. Encroachment in the forest area has been observed which has led to multiple incidences of human-wildlife conflicts since 2016 within the city boundary. Furthermore, three bird species (S. calvus, G. bengalensis, G. indicus) are classified as critically endangered (CR), two bird species (N. percnopterus, A. nipalensis) are classified as endangered (EN), and three bird species (A. ferina, C. clanga, S. aurantia) are classified as vulnerable (VU).

4.1.4 : Disaster Resilience

Junagadh city, located in a warm and humid climatic zone, experiences a significant temperature range of 10°C to 42°C. The city is situated in Seismic Zone III. The soil composition is deep- medium black coastal alluvium soil. The wind velocity in Junagadh averages 20.8 km/hr. The city experiences 55 rainy days annually, with an average rainfall of 881mm. According to the City Disaster Management Plan, approximately 40% of the houses in Junagadh are vulnerable to damage. The city's sloping topography exacerbates the risk of flooding in low-lying areas during heavy rains or storms, as there is no storm water drainage network to manage excess water. Historical data highlight significant disasters, including severe flooding from heavy rains recorded in July 2008 and 2023, extreme heat in May 2010, and cold in January 2008.



Map 8: Flood risk assessment

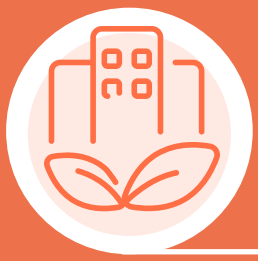
Baseline Analysis

THEME 02: Energy & Green Buildings

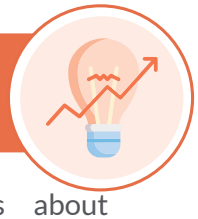
Electricity Consumption

Energy Derived from Renewable Sources

Fossil Fuel Consumption



4.2.1 : Electricity Consumption



Junagadh city annually consumes about 289,133 MWh of energy, translating to roughly 659 kWh per capita. The residential sector, LT (Low Tension) industries, and HT (High Tension) industries are the major consumers, accounting for 44%, 33%, and 14% of the total consumption, respectively (Figure 10). LT industries primarily comprise commercial and institutional establishments within the city. The average household consumes 1,265 kWh annually, indicating a greater reliance on fans for cooling rather than air conditioners.

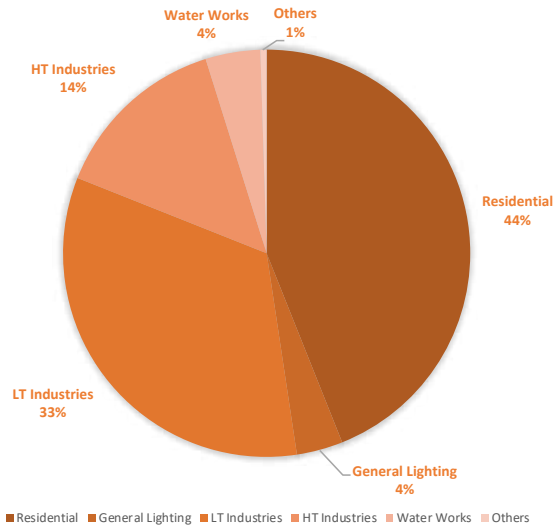


Figure 10: Electricity consumption city in year 2021-22

Source: PGVCL

Projecting future trends (Figure 11), residential electricity consumption is expected to double by 2050. The most significant growth is anticipated in the HT industry, with a projected rise of 141% in consumption compared to 2022. The overall electricity consumption is expected to increase by 94% by the inventory year.

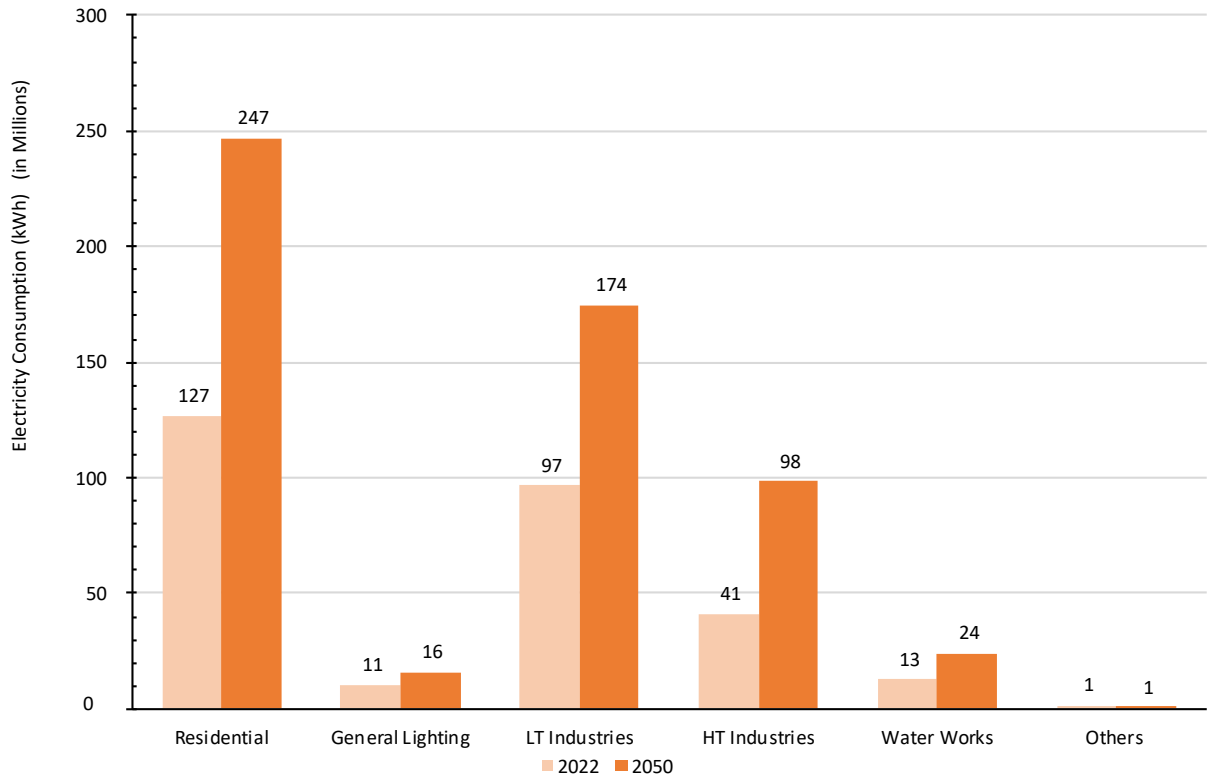


Figure 11: Projected electricity consumption of Junagadh city in the 2050

4.2.2 : Energy Derived from Renewable Sources

In Junagadh, 19% of the total electricity demand is met by renewable energy sources, with a total installed capacity of 37.8 MW. As shown in Figure 12, 42% of General Lighting Purpose(GLP) uses renewable energy, followed by high-tension industries (32%) and residential areas (31%). While LT industries are the second-largest consumers of electricity in Junagadh, only 7% of their energy comes from renewable sources. This highlights the need for increased solar panel installations within this sector.

Junagadh city has a potential of generating 1,605 kWh/kWp in a year from SPV panels. The monthly average of solar energy generation is within the range of 75-170 kWh/kWp as shown in Figure 13.

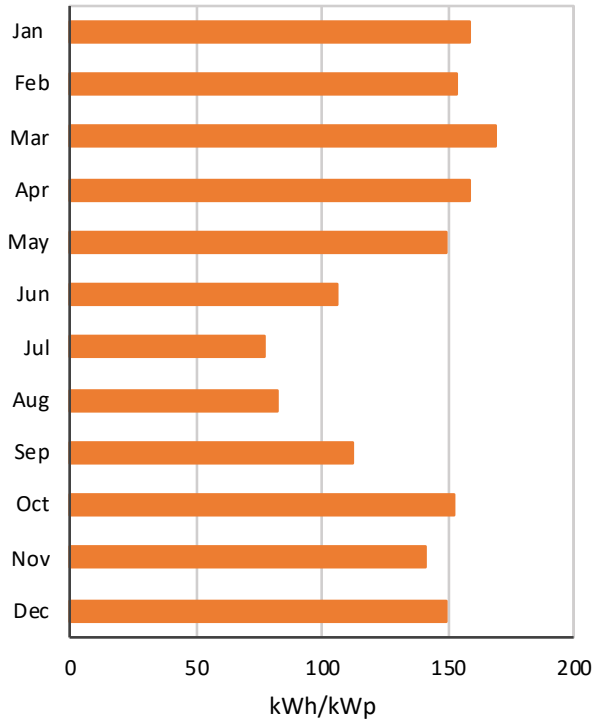


Figure 12: Monthly averages of solar photovoltaic power output of 1kWp panel in Junagadh

Source: Global Solar Atlas (Retrieved in June 2024)

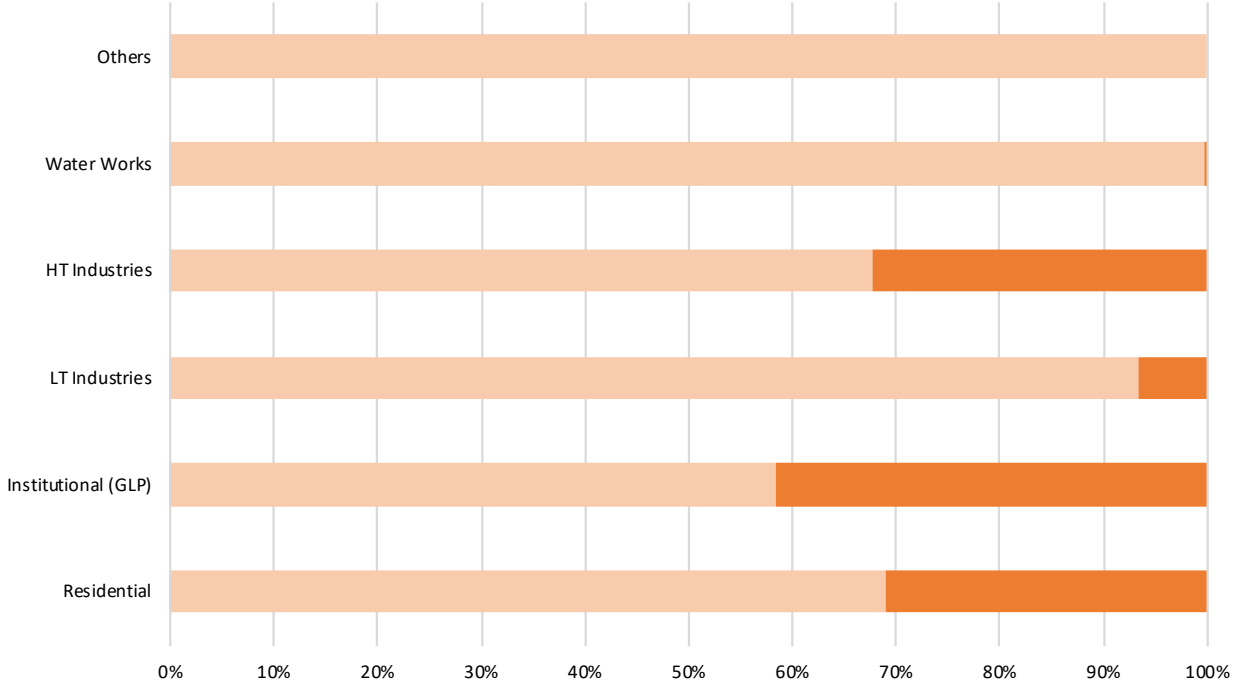
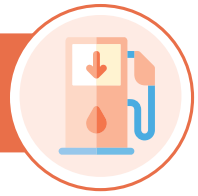


Figure 13: Percentage share of installed renewable energy load in different sectors

Source: PGVCL

4.2.3 : Fossil Fuel Consumption



In 2021-22, the distribution of greenhouse gas (GHG) emissions in Junagadh city from different fossil fuels was as follows: diesel was the largest contributor, accounting for 33% of the total emissions. Petrol contributed 28% of the emissions, compressed natural gas (CNG) contributed 7%, while liquefied petroleum gas (LPG) was responsible for 32% of the emissions (Figure 14).

By 2050, GHG emissions from CNG in Junagadh city are projected to increase ninefold compared to the base year. Emissions from petrol are expected to rise by 2.7 times, and those from diesel are anticipated to grow by 1.6 times as shown in Figure 15. This substantial escalation in fuel consumption and corresponding emissions highlights the urgent need for investment in zero tailpipe emission vehicles. Transitioning to electric and hydrogen-powered vehicles will be crucial to mitigate the environmental impact and address the rising levels of GHG emissions.

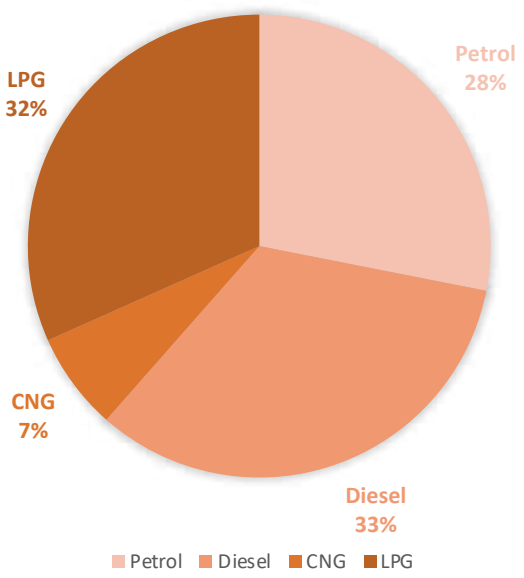


Figure 14: Share of GHG emissions from various fossil fuels consumed in 2021-22

Source: IOCL, BPCL, HPCL, Torrent Gas

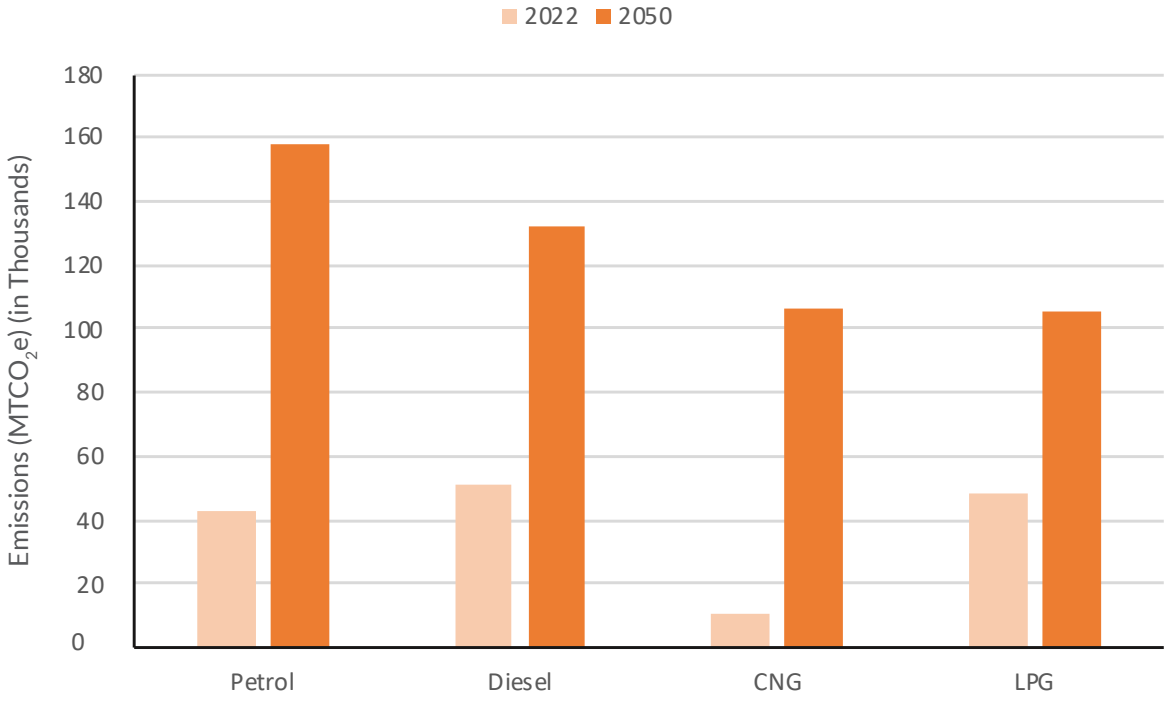


Figure 15: Share of GHG emissions from various fossil fuels consumed in 2021-22

Baseline Analysis

THEME 03: Mobility & Air Quality

Clean Technologies Vehicles

Availability of Public Transport

Coverage Of Non-Motorised Transportion

Air Pollution and Clean Air Action Plan

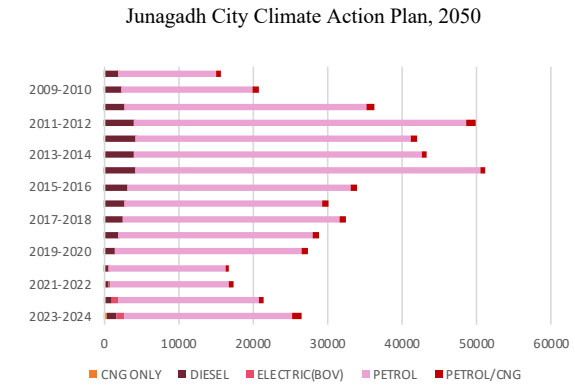


Figure 16: Registration of vehicles by fuel type

Source: RTO, Junagadh

Figure 17: GSRTC bus depot in Joshipura

Map 9: Traffic hotspots

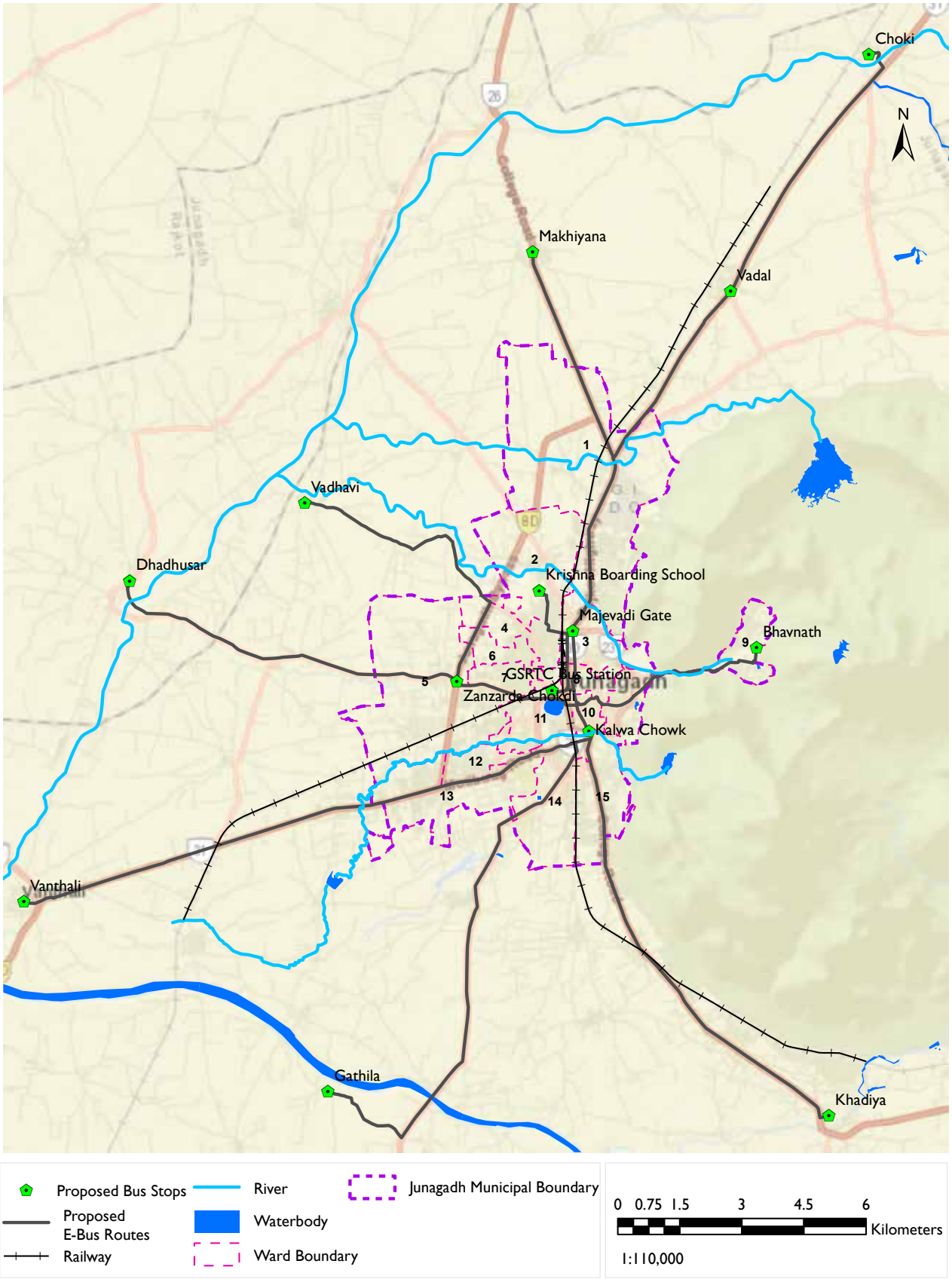
4.3.1 : Clean Technologies Vehicles

Junagadh's vehicular landscape demonstrates a diverse fuel usage pattern, reflecting both conventional and alternative energy sources. According to the recent vehicle class-wise fuel data, motor cycles and scooters dominate the city's transport sector with a significant number of vehicles running on petrol. The district dataset reveals the presence of 20,105 petrol-operated two-wheelers, highlighting petrol's prevalence as the primary fuel type. The data also indicates an emerging trend towards electric vehicles, with 839 electric bikes registered. The growing number of petrol/ethanol and petrol/hybrid vehicles, though currently low at 260 and 0 respectively, signals a potential shift towards more sustainable fuel options.

4.3.2 : Availability of Public Transport

Currently, Junagadh city lacks an intra-city public bus transportation system. The primary mode of shared public transport within the city comprises diesel-based auto-rickshaws, which charge fares ranging between INR 10-20. These auto-rickshaws operate on four main routes, with two routes terminating at Azad Chowk and the other two at Bhavnath. In terms of regional connectivity, the Gujarat State Road Transport Corporation (GSRTC) operates 1,060 buses starting from Rajkot, of which only 6 are electric, with the remainder being diesel-based.

In alignment with the Gujarat State Electric Vehicle Policy 2021, Junagadh city plans to enhance its public transportation infrastructure by procuring 50 electric buses. As part of this initiative, 25 electric buses have already been sanctioned.



Map 10: Identified EV bus routes by JuMC

Source: JuMC

Figure 18: Lack of NMT infrastructure near College Road in Gandhi Gram

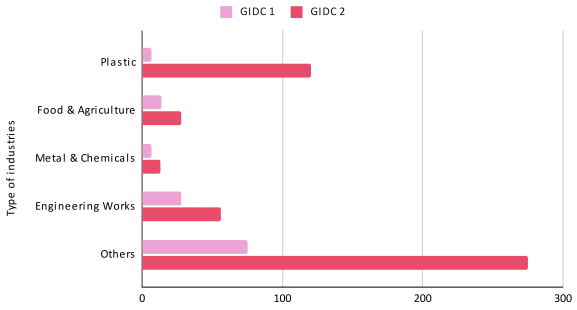
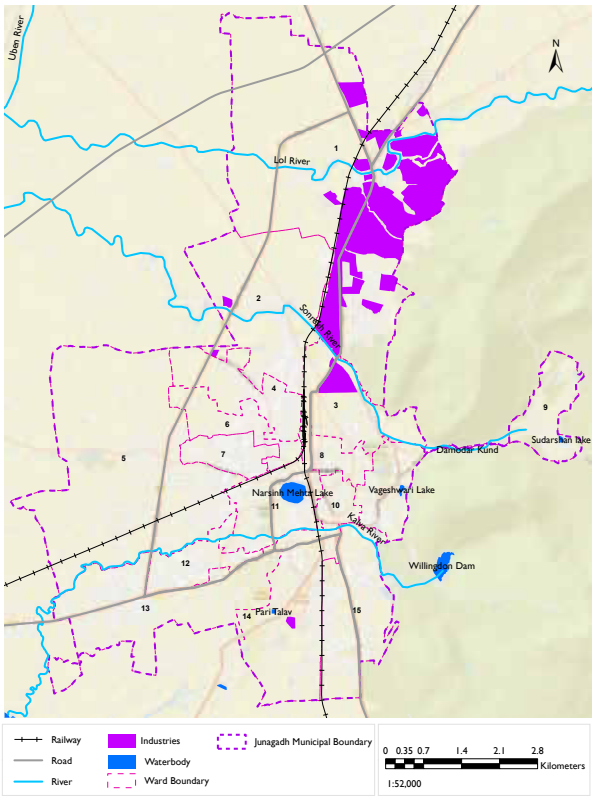


Figure 19: Type of industries in GIDC 1 & 2
Source: GIDC Regional Office, Junagadh



Map 11: Industrial zone in Junagadh
Source: JUDA DP 2031

4.3.3 : Coverage Of Non-Motorised Transportion

Junagadh currently lacks proper non-motorized transport (NMT) infrastructure, significantly impacting the mobility and safety of pedestrians and cyclists. The city has no designated cycle tracks, and the total length of footpaths accounts to only 17 kilometers, primarily concentrated near the Daulatpara area along NH 15 and along Damodar Kund. In comparison, the total road length in Junagadh is approximately 523 kilometers, highlighting the stark insufficiency of pedestrian infrastructure. Additionally, many areas along the roads have been encroached upon, further limiting the already scarce space for safe walking and cycling. The availability of NMT infrastructure also affects the ability to access public transport systems where they exist.

4.3.4 : Air Pollution and Clean Air Action Plan

Junagadh has recently established two air quality monitoring stations, one continuous and one ambient, to begin systematic monitoring of air quality data. While most measured parameters are within permissible limits, PM10 levels have exceeded the permissible limit of 60 $\mu g/m^3$, reaching over 100 $\mu g/m^3$ in March 2023. This alarming increase in particulate matter can be attributed to the high proportion of two-wheeler ownership and extensive industrial pollution within and near the city. Plastic and packaging being the highest contributors.

To effectively maintain air quality standards, Junagadh needs to conduct a source apportionment study to identify the specific sources and contributions of various pollutants. Based on the findings, the city must develop and implement a comprehensive Clean Air Action Plan.

Baseline Analysis

THEME 04: Water Management

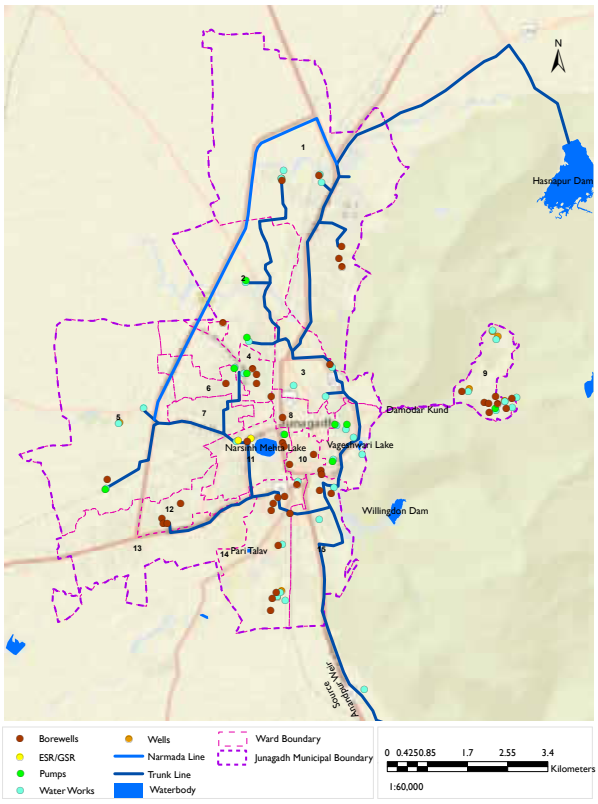
Water Resources Management

Water Recycle & Reuse

Extent of Non-Revenue Water (NRW)

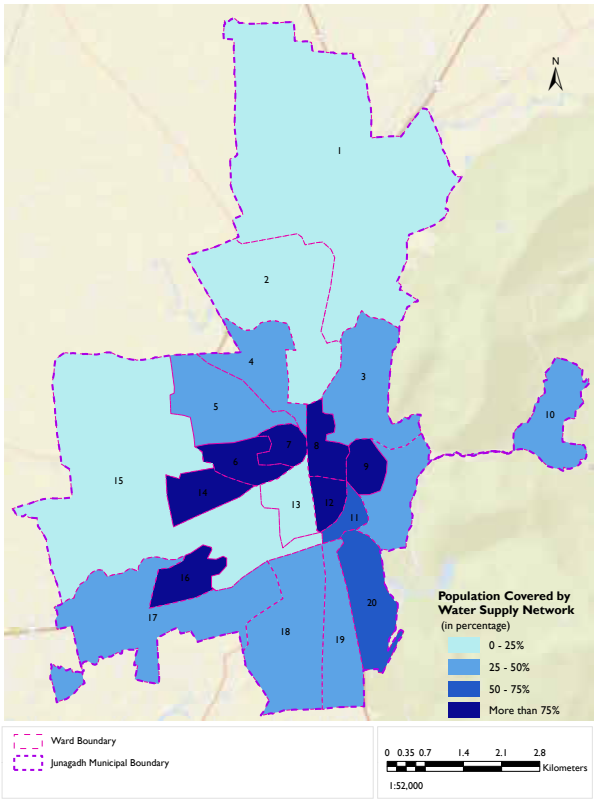
Flood And Water Stagnation Risk Management

4.4.1 : Water Resources Management



Map 12: Water Supply Infrastructure

Source: JuMC



Map 13: Population coverage of water supply network

Source: JuMC

Junagadh city is currently grappling with a significant water supply deficit. The total water supply available to the city stands at 25 million liters per day (MLD), whereas the demand is approximately 68.94 MLD, leading to a shortfall of 34.94 MLD. This disparity is reflected in the restricted water distribution duration, which is limited to just 45 minutes every alternate day, indicating severe water scarcity. The city's primary water sources are as follows:

S. No.	Water Sources	Capacity (mcft)	Water Supply (MLD)
1.	Hasnapur Dam,	287.25	11
2.	Willingdon Dam	25.22	1
3.	Anandpur Weir	77.1	10
4.	Open wells and bores	-	3

These sources cumulatively provide the reported 25 MLD, servicing a population of 1,84,000 households across a water supply network that covers 29 sq. km. which is ward no. 6, 7, 8, 9, 12, 14, and 16 as shown in Map 10.

The city operates two water treatment facilities. The Dharagadh filter plant in Mulawada has a capacity of 37 MLD and currently stores 15 MLD, with plans to expand storage by an additional 10 MLD. This plant supplies water for 1 hour daily to nearby villages and key city areas, including Dolatpara and Adityapur to Sabalpur. The Padariya filter plant, serving Uparkot and other regions, has a capacity of 20 MLD. Both plants conduct daily water quality tests.

Junagadh has proposed infrastructure improvements to bridge the supply-demand gap including the expansion of the water distribution network, construction of 13 Ground Storage Reservoirs (GSRs) and 8 Elevated Storage Reservoirs (ESRs). These reservoirs will increase the city's water storage capacity, ensuring reliable water availability.

4.4.2 : Water Recycle & Reuse

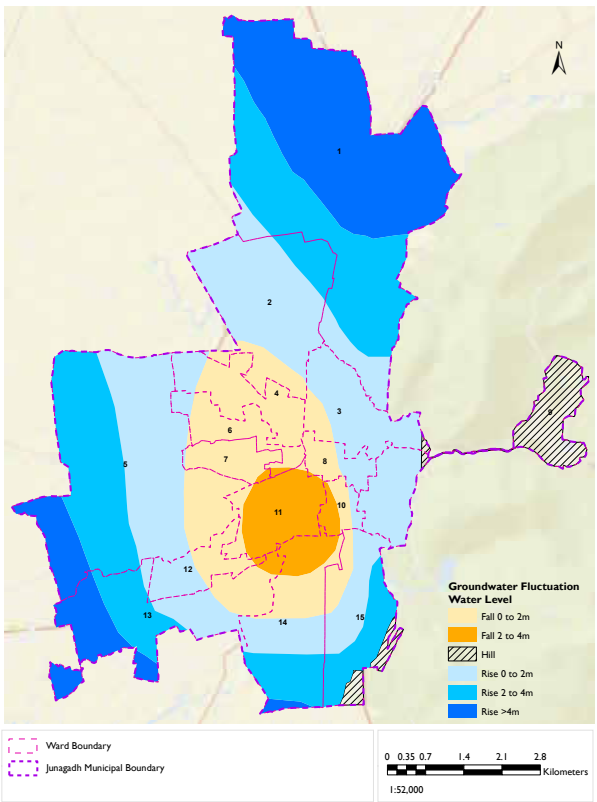
In the 2021-2022 period, 75,700 households were connected to the city's sewerage network. The city operates three sewage treatment plants (STPs) with capacities of 8.2 MLD at Bilkha Road, 11 MLD at Zanzarda Road, and 15.5 MLD at Wadla Road near the Sonrekh River. Additionally, two STPs are under construction: one at Narsinh Mehta Lake with a capacity of 2.5 MLD, and another at the Sonrekh River with a capacity of 29.5 MLD. Despite the scarcity of freshwater in Junagadh, the city does not actively reuse treated water; instead, the outflow from the STPs is discharged into nearby water bodies. Although there is a proposal to utilize some of the treated water for agricultural and industrial purposes, this plan has not yet been operationalized.

Map 14: Sewerage Trunk Line and STPs

Source: JuMC

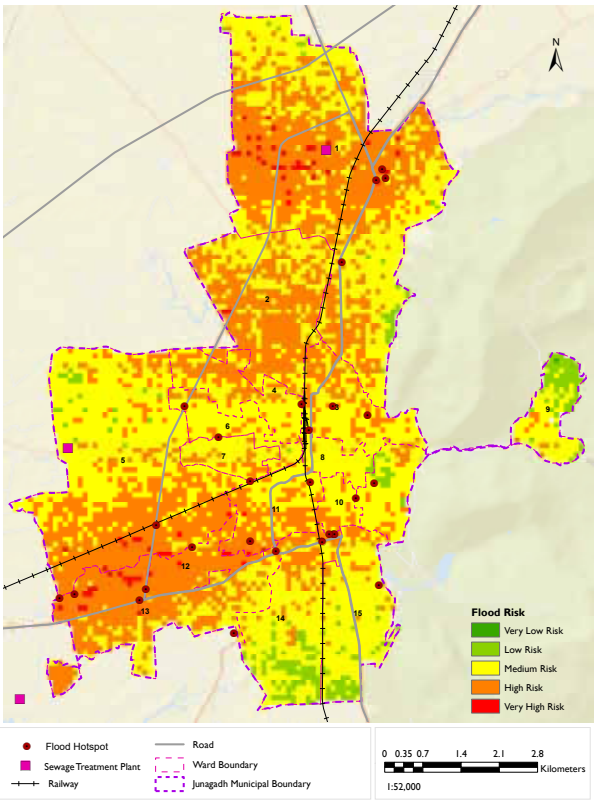
4.4.3 : Extent of Non-Revenue Water (NRW)

In the context of Junagadh city, particularly during the 2014-2015 period, the city experienced an NRW rate of 36%. Currently, the rate of NRW slightly surpasses the service level benchmark of 20%, primarily due to incomplete water metering infrastructure and the resultant extraction of groundwater without appropriate water tax payments. Incomplete water metering means that water consumption is not accurately measured for all consumers. This leads to a significant portion of the water supplied being unaccounted for, contributing to the high NRW rate. To address these challenges, Junagadh Vision Report 2035 aims to reduce NRW by implementing measures to mitigate transmission and distribution losses. This includes improving water metering infrastructure to ensure all water usage is accurately accounted for and taxed appropriately.



Map 15: Post Monsson Groundwater Status

4.4.4 : Flood and water stagnation risk management



Map 16: Location of STPs and flood hotspots over flood risk areas

Out of the total area of 57.82 square kilometers, different risk levels are allocated as follows: 1.72 square kilometers are designated as low risk, 29.6 square kilometers as medium risk, 23.85 square kilometers as high risk, and 0.54 square kilometers as very high risk. It's important to note that the storm-water drainage network currently offers no coverage, leaving the city highly vulnerable to potential flooding and water-related hazards. A significant 43% of the city's area falls under high to very high risk.

To address these risks, the city has implemented a functional Early Warning System (EWS) to help reduce the impact of such events. Acknowledging the pressing need, the city has prioritized the construction of a storm-water drainage network along the main roads as a short-term project. Additionally, as part of mid-term initiatives, JuMC has proposed rainwater harvesting from surface runoff, collecting water from government buildings other than the corporation, and establishment of an underground water recharge system.

In June 2024, the Junagadh Municipal Corporation (JuMC) became the first civic body in Asia to trade water credits from its Hasnapur water conservation project, which was recently registered under the Universal Water Registry (UWR) program. This milestone aligns with the UWR Rainwater Standard's objective of promoting water harvesting, recharge, and conservation efforts that are socially equitable, environmentally sustainable, and economically beneficial. The concept of water credits was introduced by the UNFCCC in 2014, with credits distributed through authorized agencies and redeemable by civic bodies, industries, and residential communities that effectively store rainwater. JuMC's achievement involves earning an impressive 9 million water credits for conserving 100 million liters of water in its Hasnapur water reservoir, which caters to 30% of the city's water needs. The Hasnapur Dam and reservoir, dating back to 1964, boasts a substantial storage capacity of up to 340 million cubic feet of water. This massive reservoir has been pivotal in enabling JuMC to become the first civic body in India to earn water credits, setting a significant precedent in sustainable water management practices.

Baseline Analysis

THEME 05: Waste Management

Waste Minimisation Initiatives

Extent of Dry Waste Recovered and Recycled

Construction & Demolition (C&D) Waste Management

Extent of Wet Waste Processed

Scientific Landfill Availability & Landfill/ Dumpsite Scientific Remediation

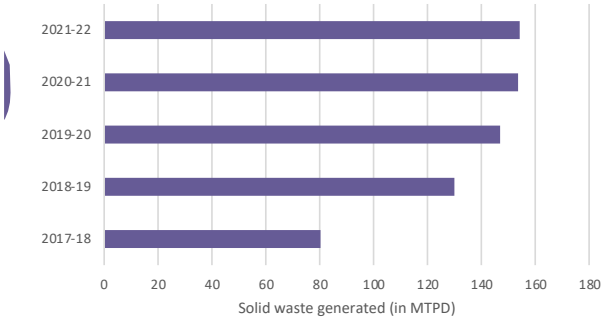


Figure 20: Total solid waste generated (2014-2022)

Source: Swachhatam Portal MIS

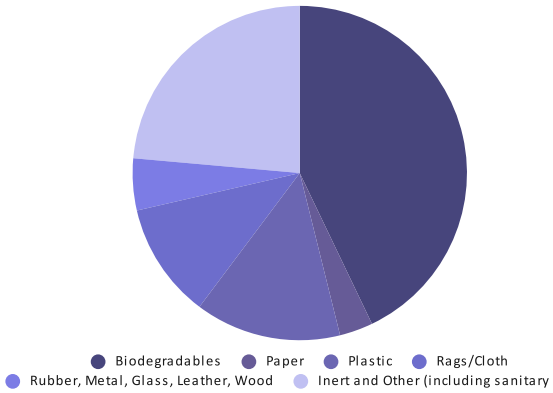


Figure 21: Classification of Solid Waste

Source: Vision Plan 2035, JMC

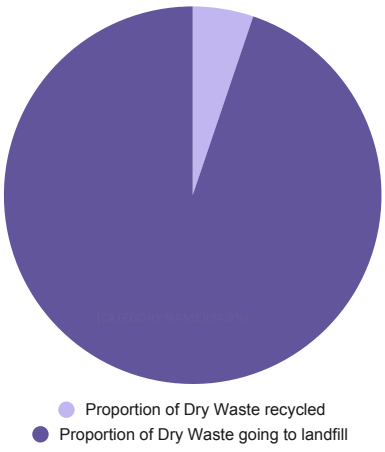


Figure 22: Proportion of dry waste processing

Source: JMC

4.5.1 : Waste Minimisation Initiatives

From 2017 to 2022, the solid waste generation in Junagadh city has increased significantly, rising from 80 MTPD to 154 MTPD. This increase is further observed during periods of high tourist activity, notably in February during Mahashivratri and in November for Kartik Purnima/Parikrama. The current disposal practices by local residents, commercial establishments, and industries involve dumping solid waste into nearby unlined drains and water bodies. Projections indicate a substantial rise in solid waste generation, from approximately 150 MTPD in 2020 to an alarming 363 MTPD by 2053. Junagadh is progressively enhancing its solid waste management infrastructure, particularly in areas with high foot traffic such as hawkers' zones and tourist visitors.

4.5.2 : Extent Of Dry Waste Recovered And Recycled

The extent of source segregation of municipal solid waste in Junagadh city stands at 13%. The current composition of waste includes 219 kg of biodegradables, 16.5 kg of paper, 72.1 kg of plastic, 57 kg of rags/cloth, 25.58 kg of rubber, metal, glass, leather, and wood, and 120.42 kg of inert and other materials. Waste collection methods are varied, with door-to-door collection via Tata Ace trucks accounting for 64% of the total, amounting to 83 metric tons (MT). Additional means of collection include container lifting/dumper placer (22.5 MT), hotel and kitchen waste collection using Tata 709 trucks (22.5 MT), and vegetable market waste collection with tractors and trailers (2.0 MT). Projections indicate a significant increase in wet waste, from 80 MTPD in 2020 to 182 MTPD by 2053. This highlights the need for increase in the efficiency of source segregation and expanding collection and processing infrastructure.

4.5.3 : Construction & Demolition (C&D) Waste Management

The current Construction and Demolition (C&D) waste generation stands at 2 TPD. To address this, two C&D waste management plants are under development within Junagadh. The first facility, located in Ivnagar, will have a capacity of 5 TPD providing immediate relief for local waste accumulation. The second, significantly larger plant, with a capacity of 30 TPD, is poised to handle a substantial increase in C&D waste.

Figure 23: Demolition waste at Sant Kabir Road

4.5.4 : Extent of Wet Waste Processed

In Junagadh city, 43% of the total waste generated is categorized as wet waste, amounting to 72 metric tons per day (MTPD). Currently, the city operates a 15 TPD Bio Composter System (BioCMS) and a 40 TPD auto segregation facility. Despite these facilities, only 15 MTPD of the wet waste is being processed, leaving a significant gap in waste management capacity. To address this shortfall, the city is in the tendering phase for additional processing facilities, which include a 25 TPD BioCMS and a 25 TPD compost plant. Upon completion of these projects, Junagadh will have a combined capacity of 65 TPD for wet waste processing.

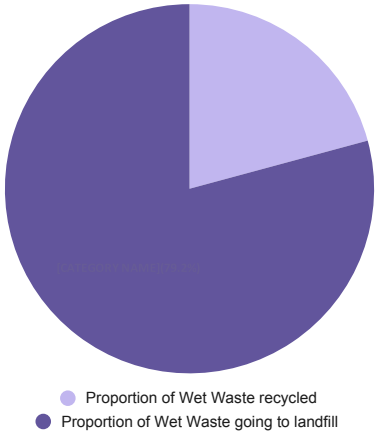
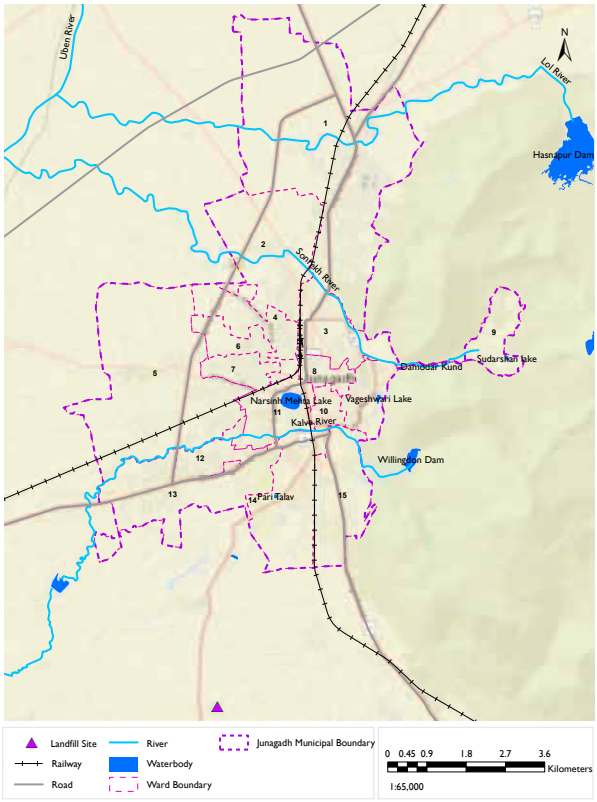


Figure 24: Proportion of wet waste processing

Source: JMC

4.5.5 : Availability of Scientific landfill and Landfill remediation

In Junagadh city, 57 MTPD of wet waste currently end up in the landfill, highlighting a significant challenge in waste management. Despite having remediated 4.93 lakh metric tons of legacy waste, the city lacks a scientific landfill. However, a pivotal development is underway with the construction of an integrated waste management facility and sanitary landfill at the existing dumpsite in Ivnagar.



Map 17: Landfill site

Figure 25: Auto-segregation facility at Ivnagar

4.6 Impact of Climate Change

Junagadh, located in Gujarat, experiences significant climatic variability and is particularly vulnerable to extreme temperature events. The region faces a high frequency of hot days and nights, with increasing trends observed in recent years. Junagadh, along with other districts in Saurashtra, has seen a notable rise in the number of extremely hot days, reflecting a broader trend of rising temperatures across Gujarat. The region is also prone to heatwaves, which are expected to become more frequent and intense due to climate change. Precipitation patterns in Junagadh show variability, with an increase in extreme rainfall events projected under future climate scenarios. This variability poses challenges for water management and agriculture, crucial sectors for the region's economy. The combined effects of rising temperatures and changing precipitation patterns underscore the need for adaptive strategies to mitigate climaterelated risks in Junagadh.

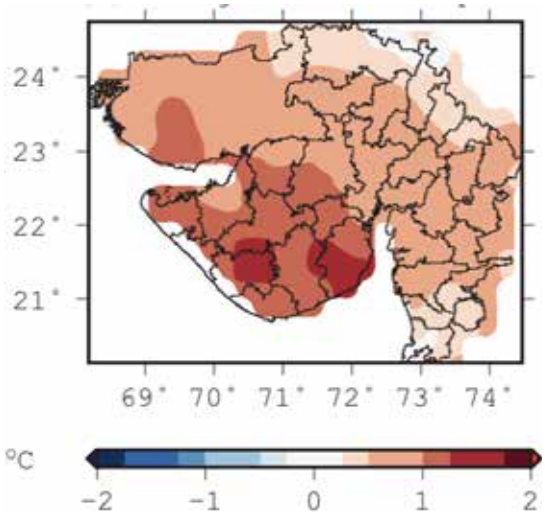


Figure 26: Mean Minimum Temperature Change

Source: Gujarat SAPCC

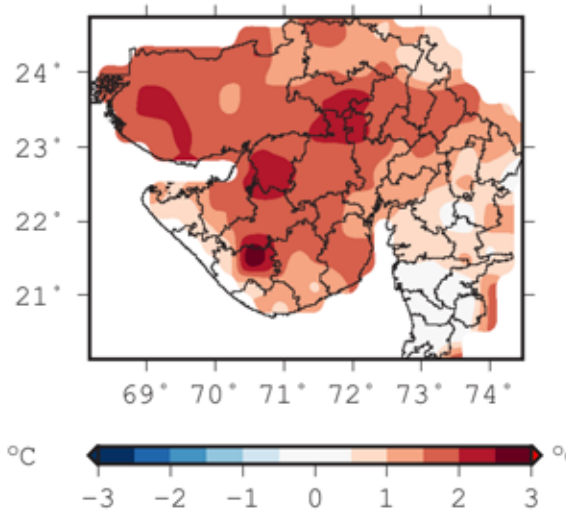


Figure 27: Mean Average Temperature Change

Source: Gujarat SAPCC

Understanding the impacts of climate change on local weather patterns will be critical to developing strategies for enhancing Junagadh's resilience against future risks. The Junagadh CAP employs multi-model climate high-resolution projections for the baseline period (1980-2015), which were validated against the observed climate variables from the local meteorological station in Junagadh. The temperature projections from the GFDL ESM4 model are found to be in good agreement with the observations; however, no single model investigated in the present study reasonably simulates precipitation, and therefore, a multi-model ensemble is used for precipitation projections.

Two climate scenarios under the Shared Socioeconomic Pathways, defined in the IPCC Sixth Assessment Report on Climate Change in 2021, are considered for this modeling. These scenarios SSP2-4.5 (Middle of the road) and SSP 5-8.5 (Fossil-Fueled Development) are defined as:

SSP 2-4.5	The "Middle of the road" or medium pathway extrapolates the past and current global development into the future. Income trends in different countries are diverging significantly. There is a certain cooperation between states, but it is barely expanded. Global population growth is moderate, leveling off in the second half of the century. Environmental systems are facing a certain degradation. This can be understood as an update to scenario RCP4.5.
SSP 5-8.5	Fossil-fueled Development. Global markets are increasingly integrated, leading to innovations and technological progress. The social and economic development, however, is based on an intensified exploitation of fossil fuel resources with a high percentage of coal and an energy-intensive lifestyle worldwide. The world economy is growing and local environmental problems such as air pollution are being tackled successfully. It can be understood as an update of the CMIP5 scenario RCP8.5, now combined with socioeconomic reasons.

As per the IPCC, the projected temperature changes under the SSP 2 -4.5 scenario is 2.0°C by 2060 and 2.7°C (with an estimated range between 2.1°C – 3.5°C) by 2100, while it is 2.4°C by 2060 and 4.4°C (with an estimated range between 3.3°C – 5.7°C) by 2100 in the SSP 5 - 8.5 scenario.

4.6.1 Temperature

Under the model ACCESS-ESM1-5, Junagadh is projected to witness an average decadal temperature increase of 6.5°C by 2100 under the SSP 5-8.5 scenario and 2.7°C under the SSP 2-4.5 scenario. By 2050, the temperature is expected to increase by 2.7°C and 1.9°C in the two models, respectively. The projected increase in temperature till 2100 is shown in the graphs below. Peak temperatures, however, are projected to go up by 5.2°C to 6.9°C during the summer months, while the winter maximums are expected to increase by around 7.5°C as per SSP 5-8.5 scenario.

The monthly breakdown of the projected temperature increase provides a much more telling picture of the effect on Junagadh. While the increase in temperature in the early summer months is relatively modest in both the models by 2050 and 2100, the increase across before summer and the winter months is significantly steeper.

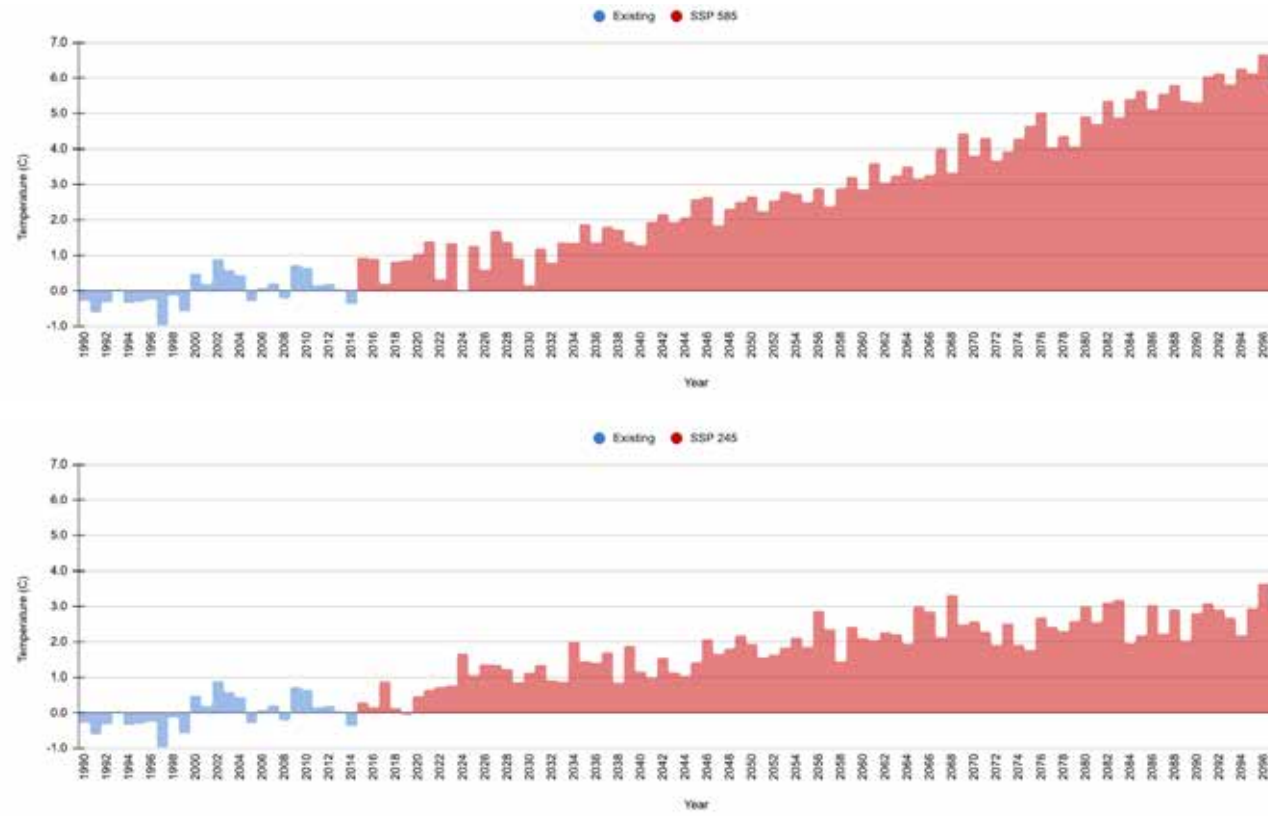


Figure 28: Yearly Projected Temperature Change

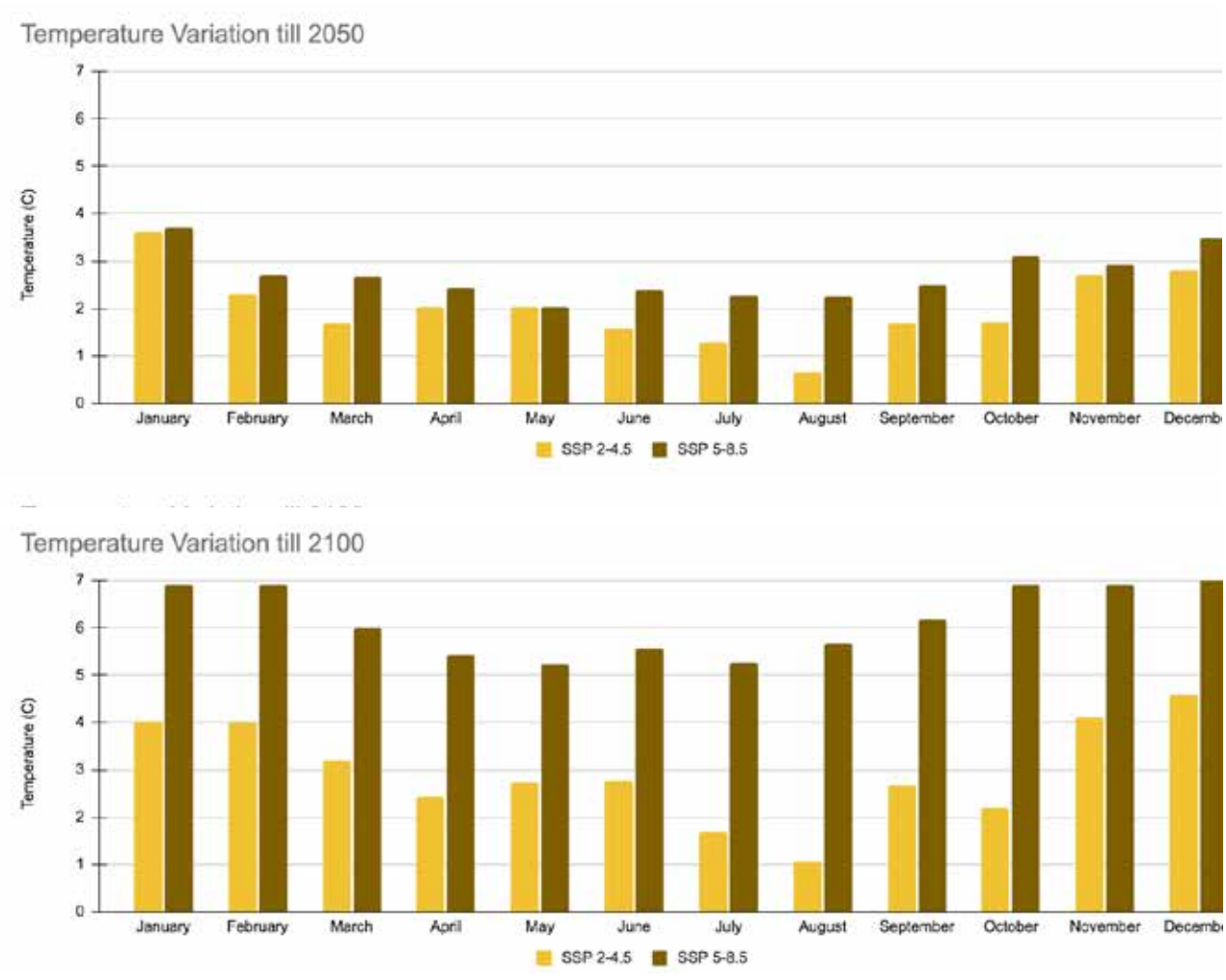


Figure 29: Monthly Projected Temperature Change

4.7 Summary of GHG Inventory

Based on the analysis in the previous sections, a baseline emission inventory has been developed for the year 2021-22. Junagadh's total emission for the inventory year is 4,22,512 MTCO2e. This translates to a per capita emission rate of 0.96 MTCO2e. Stationary energy accounts for more than 63% of the emissions, with Residential, LT Industries and HT industries consumption contributing the most to it. The other big component of city's emission inventory is transportation emissions, which account for almost 25% of the total and are composed of petrol, diesel and CNG vehicles. The emissions from waste contribute only 12% of the total emissions which includes emissions from solid waste disposal and waste water treatment & discharge. The GHG emissions for Junagadh are projected to increase by at least 2.6 times to 10,79,834 MTCO2e by the horizon year of the plan (2050). The contribution of Residential usage, LT Industries usage, consumption of CNG and usage from General Lighting Purpose is expected to increase. Overall, the contribution of transportation is expected to increase to 37%, while the contribution of the stationary energy and waste sectors is expected to come down to 52% and 11%, respectively. The graphs on the following page highlight these projections and changes.

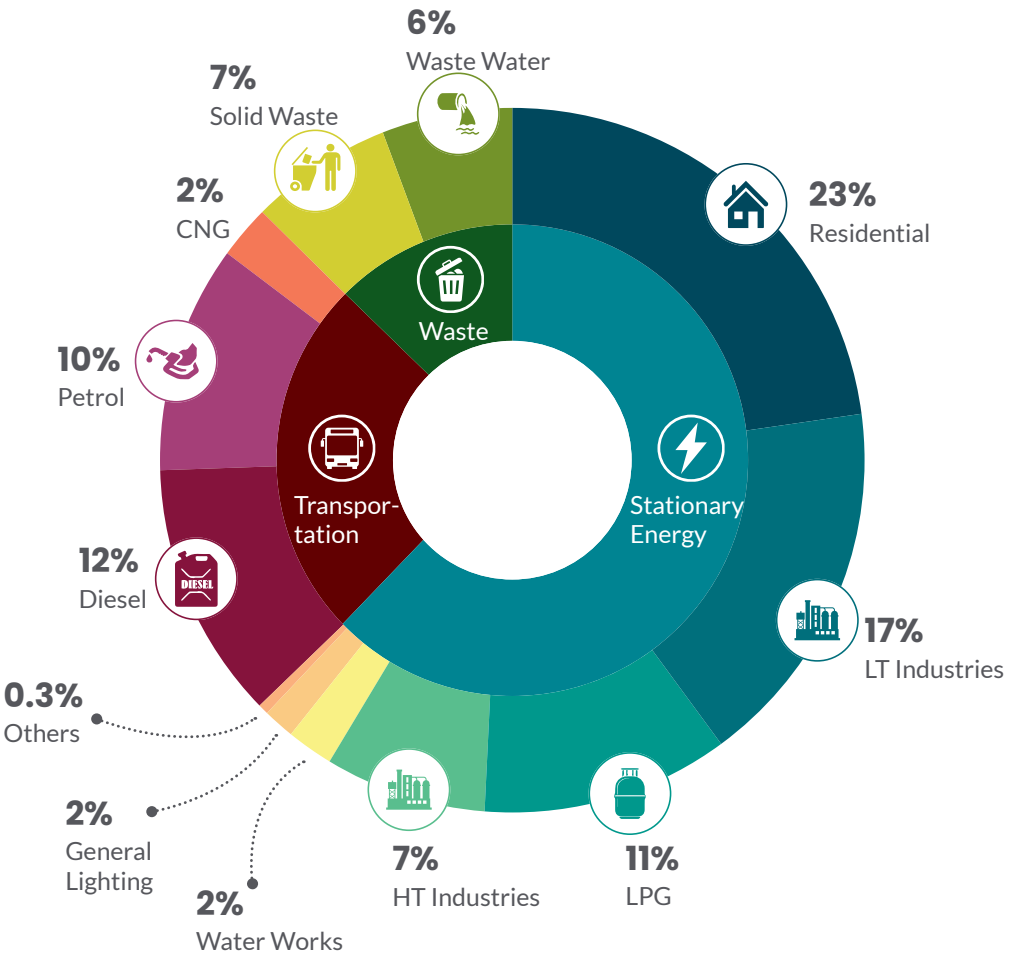


Figure 30: Baseline year GHG inventory for Junagadh 2021-22

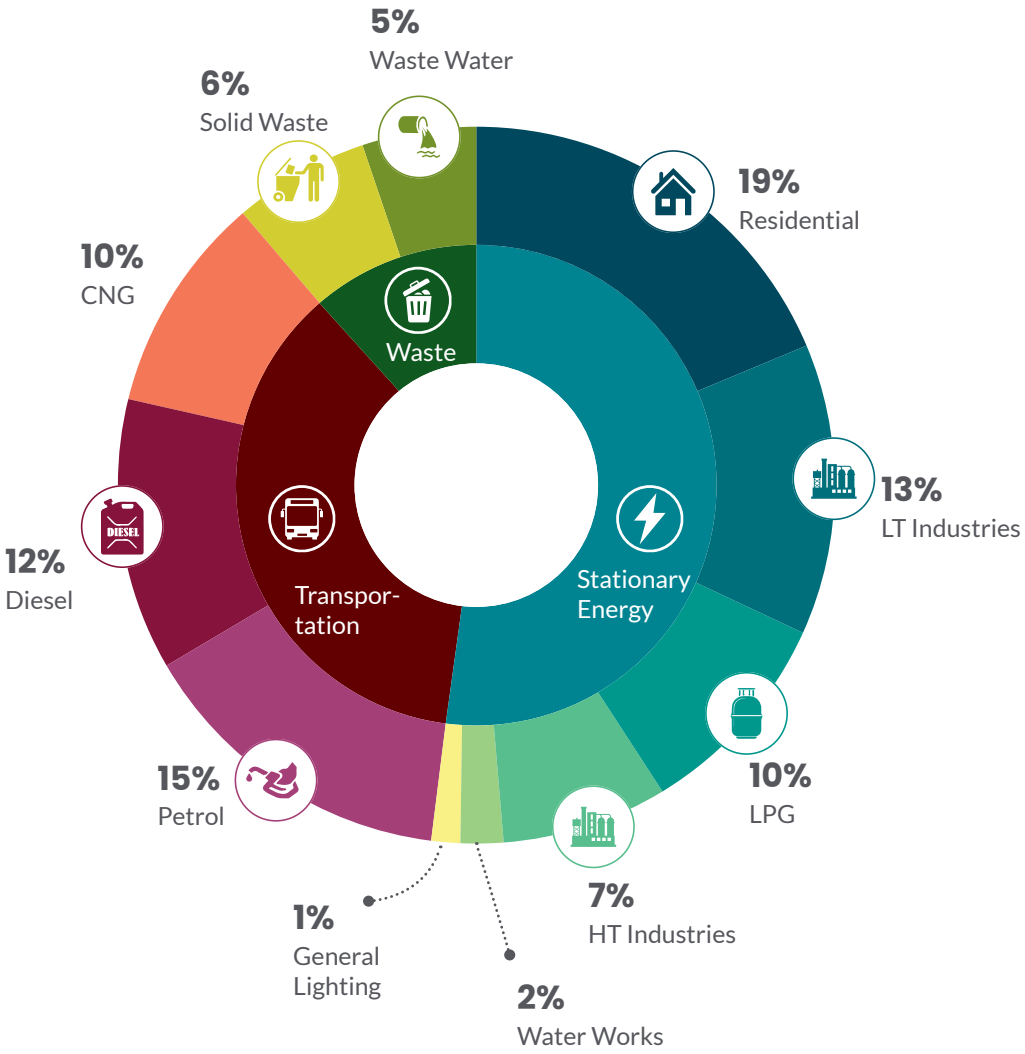
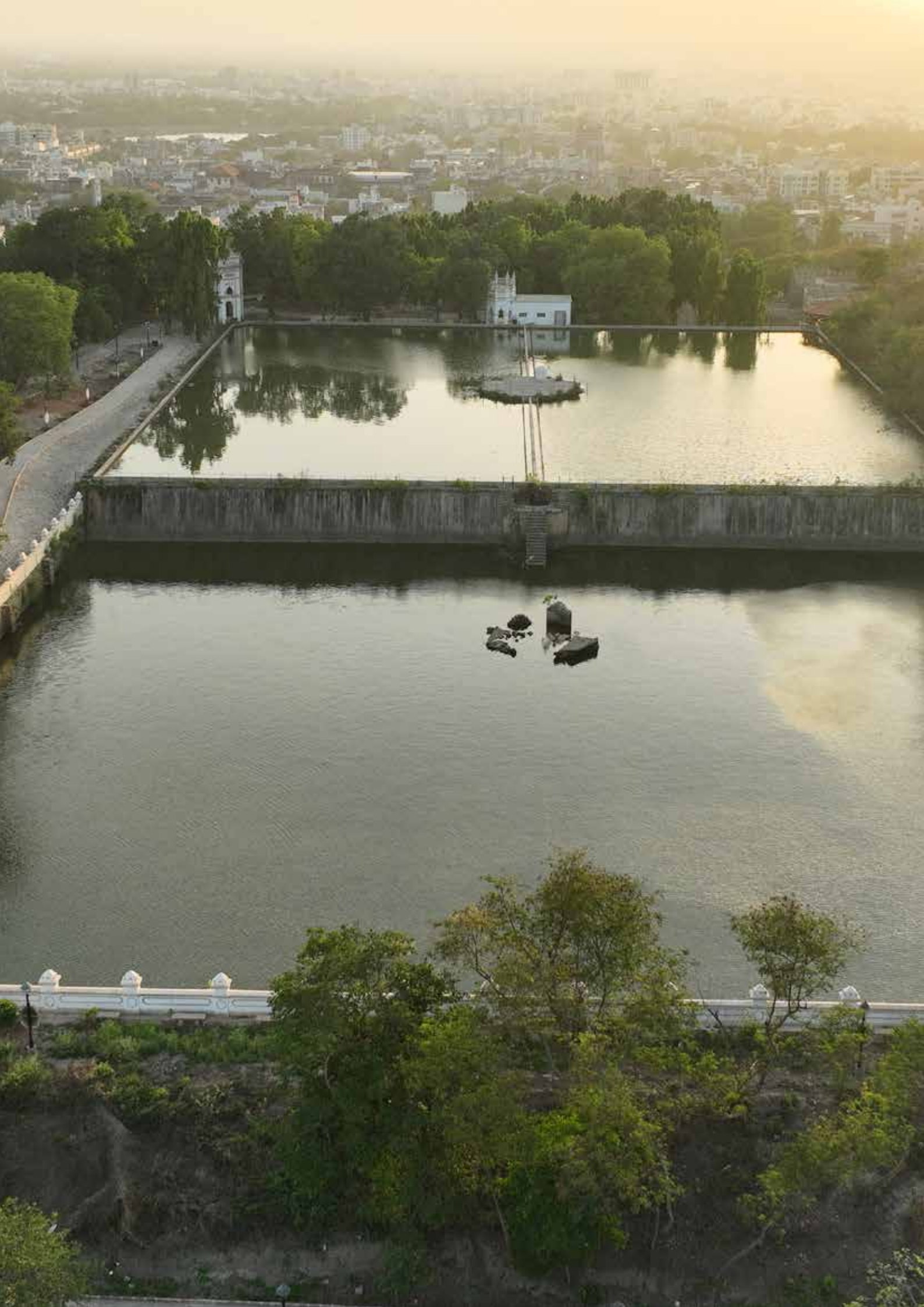


Figure 31: Horizon year GHG inventory for Junagadh 2050

05 Recommendations

Mitigation Scenarios
Costing of Mitigation Interventions
Recommendation and Strategies



5.1 Vision for the Junagadh CAP

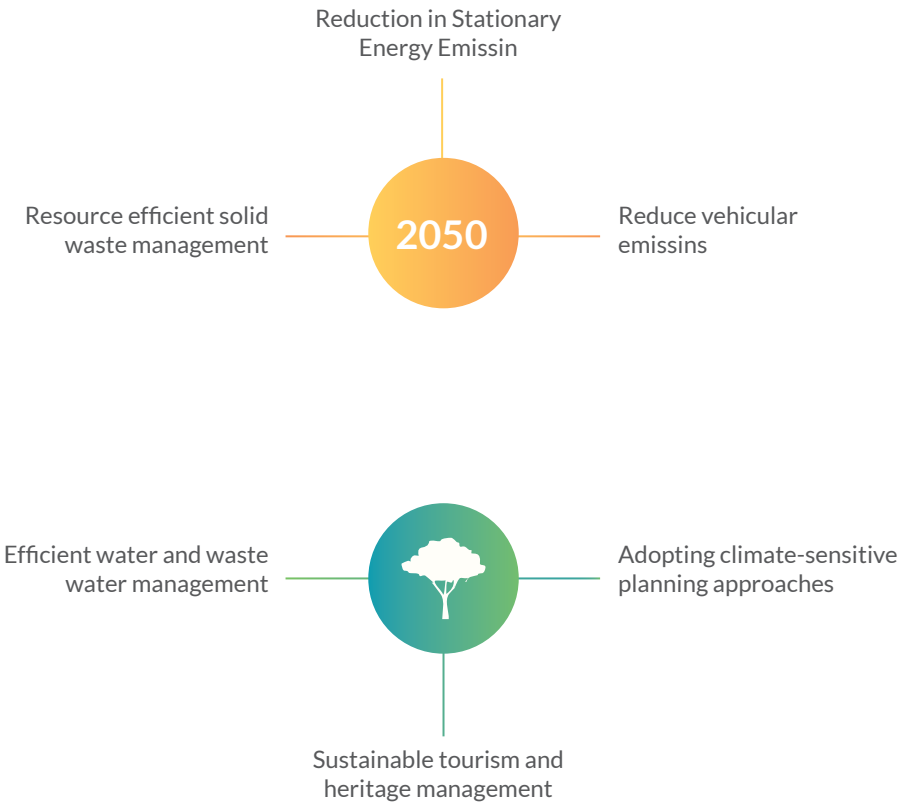
This climate action plan establishes a dual vision of achieving a climate resilient and net zero Junagadh by 2050. The dual visions address the two main elements of a climate action plan - Mitigation and Adaptation. This ambitious vision has been set in consultation with the public, the public representatives and the administration. This collective aspiration reflects Junagadh's determination to stand as a beacon of sustainability, setting an example for communities worldwide. This vision also underscores the region's commitment to cultivating environmental responsibility and resilience within its long-term growth strategy. By embracing this forward-looking vision, Junagadh seeks to preserve its natural splendour and build a balanced, sustainable future for generations to come.

Net Zero By 2050

Climate Resilient Junagadh

5.2 Thrust Areas

Six thrust areas have been identified through which the vision set out in this Climate Action Plan is proposed to be achieved The thrust areas are further divided into 20 objectives and 38 proposals. These proposals are a combination of mitigation and adaptation actions which are either policies, plans or projects.



5.3 Mitigation Actions

5.3.1 Overview of Actions

The 11 proposals addressing mitigation actions are divided into three main categories: Existing & Planned Actions, Ambitious Actions, and the Extended Scenario. Together, these interventions are projected to reduce emissions by 10,79,834 MTCO2e by 2050. Existing & Planned Actions are those already being undertaken by national, state, and local governments. Ambitious Actions include adopting energy efficiency in all buildings, installing rooftop solar panels, developing a multimodal public transport network, and transitioning to zero tailpipe emission vehicles. To ensure the successful implementation of these actions, IEC measures are necessary to promote resource-efficient individual behaviours aligned with Mission LiFE.

Implementing all strategies under the Ambitious Scenario can lead to 52% emission reductions from BAU Scenario. Therefore, Junagadh must identify additional strategies to address the remaining emissions. These actions include development of On-grid Renewable energy farms, Municipal Solid waste management, efficient treatment of used water and plantation of trees to increase the carbon sink of the city.

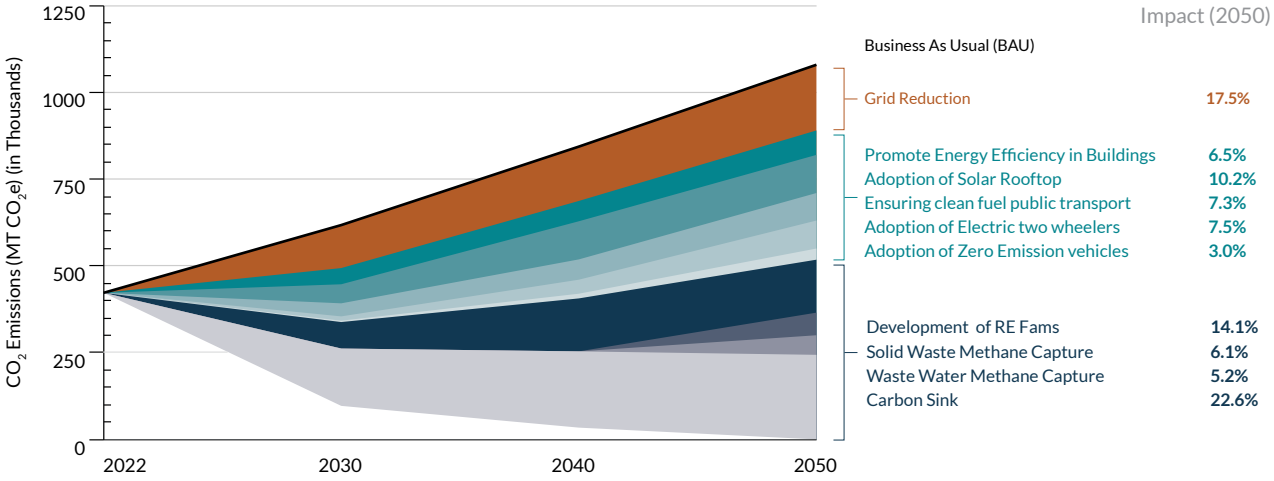
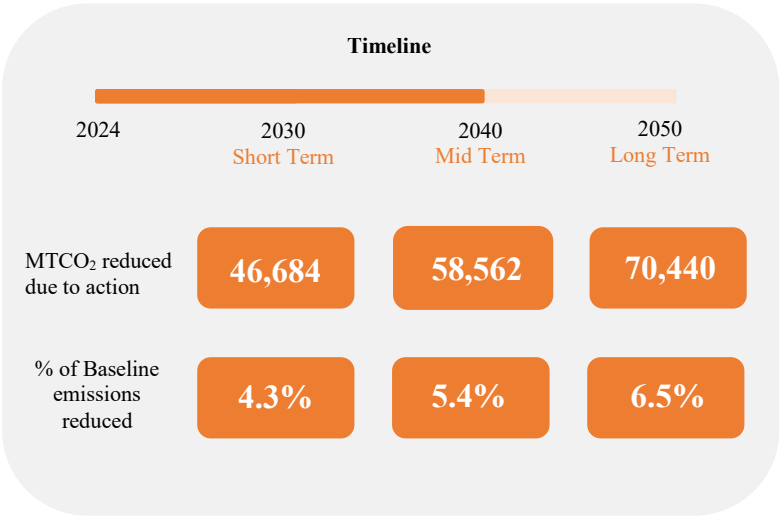


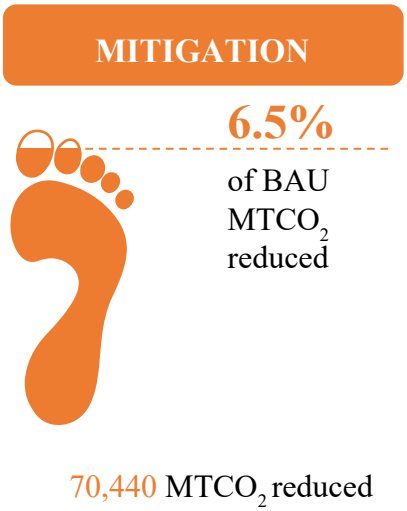
Figure 32: Summary of Mitigation measures

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A1: Promote energy efficiency in buildings

Despite Junagadh's significant strides in agricultural and industrial sectors, the city faces a critical challenge in energy efficiency, particularly in its buildings. Currently, there are no green building initiatives in place, and the city's households and dharamshalas predominantly depend on traditional fans. This reliance on less efficient cooling methods underscores the need for a shift towards more sustainable practices. Moreover, Junagadh's industrial sector, which includes over 600 small and large-scale industries, presents a substantial opportunity to adopt energy efficient equipments for their processing activities. By promoting energy-efficient building designs and integrating renewable energy sources, Junagadh can reduce its energy consumption, lower greenhouse gas emissions, and pave the way for a more sustainable and resilient urban environment.





Action: Advancing Green Building Practices

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A1: Promote energy efficiency in buildings

About

Junagadh currently lacks green building initiatives, revealing a significant deficiency in its sustainable development strategy. To address this, the city should implement comprehensive green building practices aimed at reducing stationary energy emissions. Specific measures should include the adoption of energy-efficient building designs, utilization of sustainable construction materials, and integration of advanced energy management systems. By enforcing stringent green building codes and standards, Junagadh can significantly enhance energy performance in both new and existing construction.

Recommendations

Description	Time frame	Proposal Detail
1. Implement local bylaws mandating compliance with ECBC/ENS/ ECSBC for all new buildings, aligned with state-level notifications	**Short Term**	**Proposal type:** *Policy* **Responsible agency:** *GEDA*
2. Establishment of a Green Building Cell and a High-Level Green Building Committee Key tasks of a High-Level Green Building Committee: ● Set-up targets for promotion of green and energy efficient buildings ● Ensure code compliance and enforcement at city level by providing guidance & support to the green building cell ● Explore synergies with similar programmes and identify opportunities for joint ventures, public private partnerships for green building promotion and adoption ● Provide update on city level progress, feedback and recommendations to State/ National Level Agencies Key tasks of a Green Building Cell: ● Develop strategies and products for green building promotion including green building guidelines for design, material and construction technologies ● Facilitate demonstration/pilot projects at the city level to showcase green building concepts ● Empanel green building vendors i.e. material suppliers & technology solution providers or alternately endorse green building vendors approved by government institutions ● Develop green building compliance procedure and measurement system and integrate in the online building approval system	**Short Term**	**Proposal type:** *Institutional Mechanism* **Responsible agency:** *GEDA*
3. For newly constructed, large-scale buildings (>30,000 sq.m.) classified as commercial, shopping, or institutional, implement mandatory compliance with either a 5-star energy rating or the SuperECBC standard	**Short Term**	**Proposal type:** *Policy* **Responsible agency:** *GEDA*
4. Enforce the implementation of passive cooling techniques in all new construction projects: ● Residential Buildings: Ensure adherence to either Eco Niwas Samhita or established Green Building standards ● Non-residential Buildings: Ensure conformity with the Energy Conservation Building Code (ECBC) or obtain a 5-star energy rating	**Medium Term**	**Proposal type:** *Policy* **Responsible agency:** *Building department, JuMC & GEDA*

Description	Time frame	Proposal Detail
5. Retrofit existing buildings with energy efficient design principles (including window shading, heat reflective paint etc.)	**Medium Term**	**Proposal type:** *Project* **Responsible agency:** *Building department, JuMC*

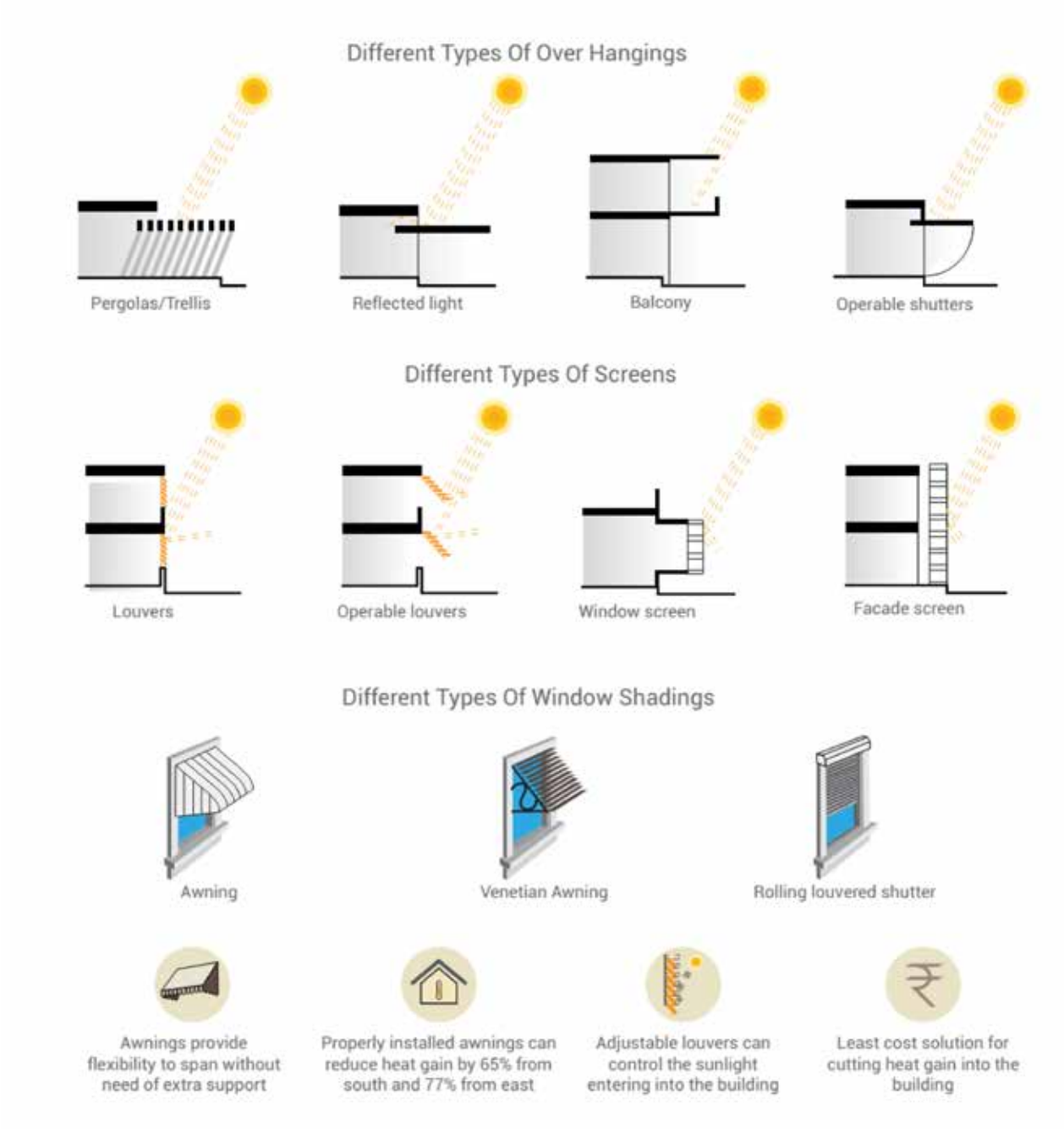


Figure 33: Cooling solutions for new construction

Source: House Owners' Guide to Alternate Roof Cooling Solutions by NDMA 2021

Action: Adopting Energy-Efficient Technologies

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A1: Promote energy efficiency in buildings

About

Junagadh must prioritize implementing energy-efficient systems, including high-efficiency air conditioners, LED lighting, BLDC fans, and BEE star-rated appliances, to effectively reduce stationary energy emissions and achieve significant energy savings while lowering greenhouse gas emissions.

Recommendations

Description	Time frame	Proposal Detail
Installation of smart meters in non-residential and residential buildings	**Short Term**	**Proposal type:** Project **Responsible agency:** PGVCL
Promote energy-efficient fixtures like LED lights, BLDC fans and BEE star rated appliances in existing buildings	**Short Term**	**Proposal type:** Project **Responsible agency:** PGVCL
Mandate energy-efficient appliances for all new construction projects (BEE star rated appliances)	**Medium Term**	**Proposal type:** Policy **Responsible agency:** PGVCL

Type	Wattage (kW)	Energy use per day (kWh)	Energy use per year (kWh)	Cost per unit (INR/ kWh)	Total Cost (INR)	Savings (INR)
Conventional Fans	0.075	1.125	411	6	2,464	
BLDC Fans	0.03	0.45	164	6	986	1,478

Figure 34: Energy consumption and savings: Conventional Fans vs BLDC Fans (Assumption: Ceiling fans run regularly for 15 hours per day for 365 days)

Action: Energy Efficiency in Industrial Sector

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A1: Promote energy efficiency in buildings

About

Junagadh must prioritize energy efficiency in industrial buildings to effectively reduce stationary energy emissions and achieve significant reductions in industrial emissions. This can be accomplished by implementing advanced energy management systems, optimizing production processes, and integrating energy-efficient technologies. Regular energy audits and retrofitting existing facilities with energy-saving equipment will further enhance efficiency.

Recommendations

Description	Time frame	Proposal Detail
1. For HT industrial consumers: ● Mandate periodic energy audits for energy intensive industries ● Mandate BEE star rated electric appliances and equipment used in industries ● Implementation of PAT System to reduce specific energy consumption in industries **Case Study:** PAT System implementation in Pune The Perform, Achieve, and Trade (PAT) scheme, implemented by the Bureau of Energy Efficiency (BEE) under the National Mission for Enhanced Energy Efficiency (NMEEE), is a flagship program aimed at improving energy efficiency in energy-intensive industries across India. Pune, a prominent industrial hub, stands to benefit significantly from the implementation of the PAT system. It sets specific energy consumption (SEC) reduction targets for designated consumers (DCs) in energy-intensive sectors. These targets are defined over a three-year cycle, and industries that exceed their targets can trade the excess energy savings as Energy Saving Certificates (ESCerts) with other industries that fall short of their targets.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** *PGVCL & GIDC*
2. For LT industrial consumers: ● Implement a telescoping pricing mechanism to promote the adoption of rooftop solar PV systems on buildings with connected load of above 5kW	**Medium Term**	**Proposal type:** Policy **Responsible agency:** PGVCL & GIDC

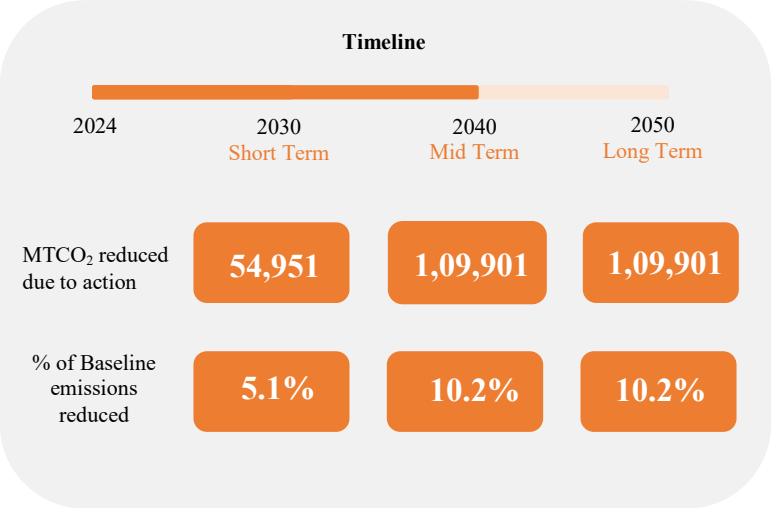
Objective A2: Increase the renewable share

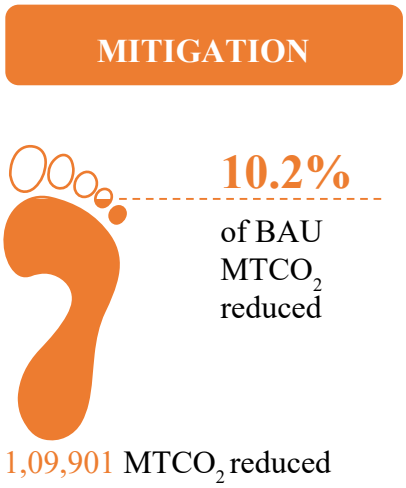
To increase the share of renewable energy in Junagadh, it is crucial to build on the city's relatively high adoption of solar rooftops. Currently, Junagadh offers a 20% rebate in property tax as an incentive for adopting solar rooftops, positioning it favourably compared to other renewable energy initiatives. However, the effectiveness of this incentive is hindered by a lack of awareness among residents. By enhancing public awareness campaigns about the available incentives and the benefits of solar energy, Junagadh can further accelerate the transition to renewable energy.

Action: Adoption of Solar Rooftop

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A2: Increase the renewable share





About

Junagadh should prioritize the adoption of solar rooftop systems to significantly reduce stationary energy emissions and increase the renewable energy share in the city's energy mix. By promoting the installation of solar photovoltaic panels on rooftops of residential, commercial, and industrial buildings, Junagadh can harness clean and sustainable energy directly from sunlight. Implementing supportive policies, providing financial incentives, and conducting public awareness campaigns will be crucial in accelerating solar rooftop adoption and achieving the city's renewable energy objectives.

Recommendations

Description	Time frame	Proposal Detail
1. All existing and newly constructed municipal buildings should be installed with solar rooftops	**Medium Term**	**Proposal type:** *Policy/Project* **Responsible agency:** JuMC
2. Optimisation of industrial energy consumption within GIDC through rooftop solar	**Medium Term**	**Proposal type:** *Planning/Project* **Responsible agency:** *GIDC*

Description	Time frame	Proposal Detail
3. Enhance community adoption of solar through: ● Promotion of existing incentives, such as a 20% rebate on property tax for installing solar rooftops ● Include promotional information on the reverse side of electricity bills to highlight the savings from solar rooftop installations ● Foster behavioural change through citizen engagement by launching a comprehensive awareness campaign to promote energy conservation practices and educate consumers on the benefits of passive and solar rooftop initiatives	**Short Term**	**Proposal type:** *IEC activities* **Responsible agency:** *Building department, JuMC &* PGVCL

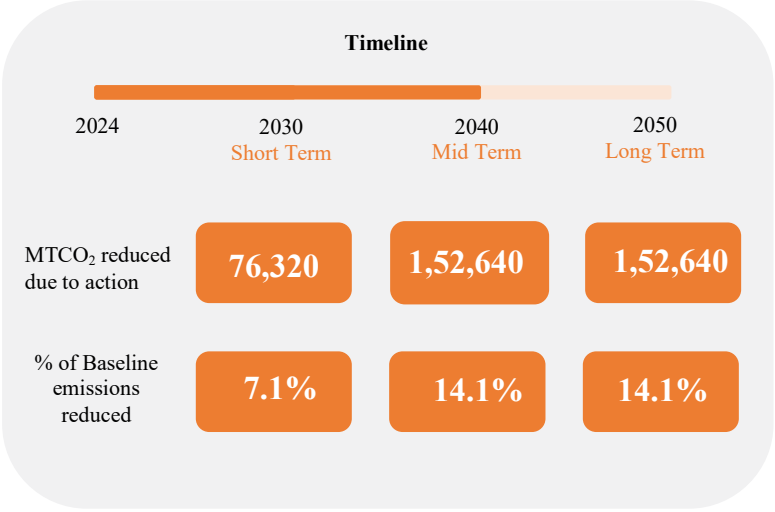
Objective A3: Increase the share of clean and sustainable energy in the overall energy mix

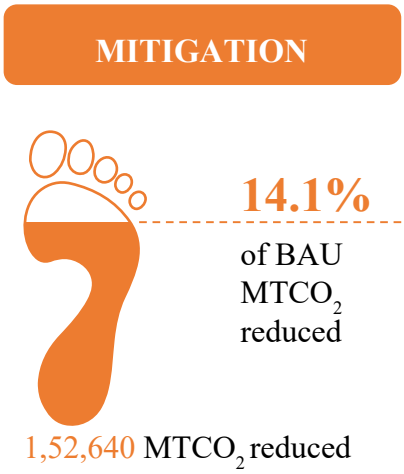
The city currently utilizes grid-supplied electricity, and this initiative focuses on two key areas: developing large-scale renewable energy farms and establishing a dedicated team to spearhead city-wide renewable energy efforts. By relying on local, renewable sources, the city reduces vulnerability to global fossil fuel price swings and disruptions, fostering independence. Additionally, construction and operation of these farms will create local jobs and long-term cost savings for residents and businesses through reduced reliance on expensive fossil fuels.

Action: Development of on-grid RE farms

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A3 : Increase the share of clean and sustainable energy in the overall energy mix



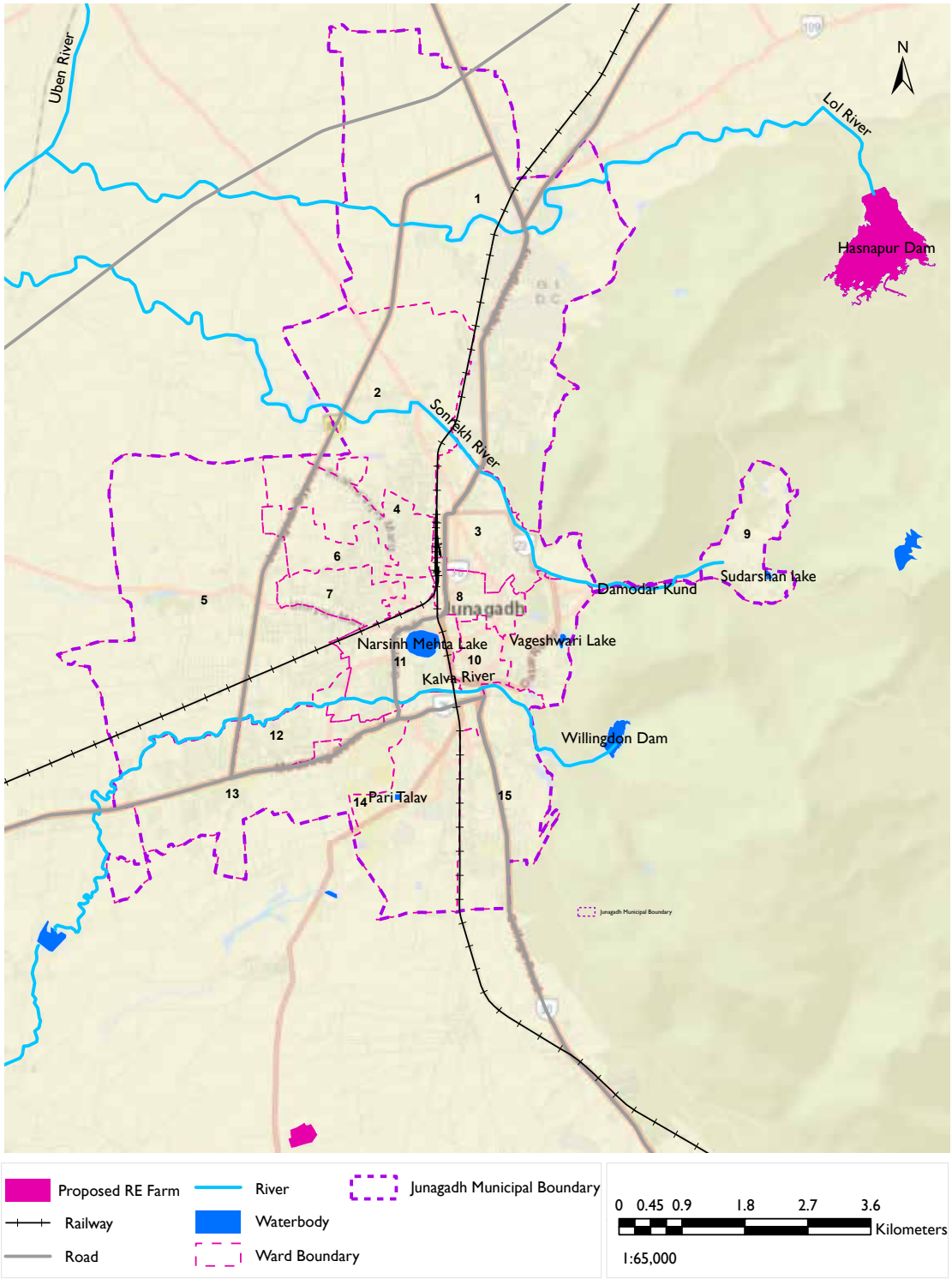


About

To increase the share of clean and sustainable energy in Junagadh's overall energy mix, the development of on-grid renewable energy farms is proposed, focusing on solar energy. Implementing these projects at strategic locations through a Public-Private Partnership (PPP) model will leverage private sector expertise and resources while ensuring government support.

Recommendations

Description	Time frame	Proposal Detail
1. Establishment of two 50MW renewable energy farms through Public-Private Partnership (PPP) model. Potential sites for these developments include a floating solar installation at Hasnapur Dam and a solar rooftop system at the Ivnagar dumpsite.	**Medium Term**	**Proposal type:** Project **Responsible agency:** PGVCL & JuMC



Map 18: Proposed RE farm locations

Objective A4: Reduction in Municipal Systems

Government and municipal buildings represent a crucial starting point for achieving carbon neutrality within Junagadh city. By retrofitting these buildings to enhance energy efficiency, the city can set a strategic example for its citizens, demonstrating a tangible shift towards zero-carbon building practices. The reduction in energy consumption and emissions from municipal buildings will contribute substantially to the overall reduction in the city's carbon footprint. Furthermore, the financial savings from reduced energy bills can be reinvested in additional sustainability initiatives.

Action: Retrofitting Municipal Systems for Enhanced Energy Efficiency

Thrust Area A: Reduction in Stationary Energy Emissions

Objective A4: Reduction in Municipal Systems

About

Junagadh is actively retrofitting its municipal systems to enhance energy efficiency and reduce stationary energy emissions, with a specific focus on optimizing municipal operations. A notable achievement includes reducing the city's street lighting bill by half, from INR 35,00,000 to INR 13,00,000, through measures such as upgrading to energy-efficient LED streetlights and implementing smart lighting controls. Continued efforts in retrofitting municipal buildings, upgrading HVAC systems, and integrating advanced energy management technologies will further contribute to reducing energy consumption and associated emissions.

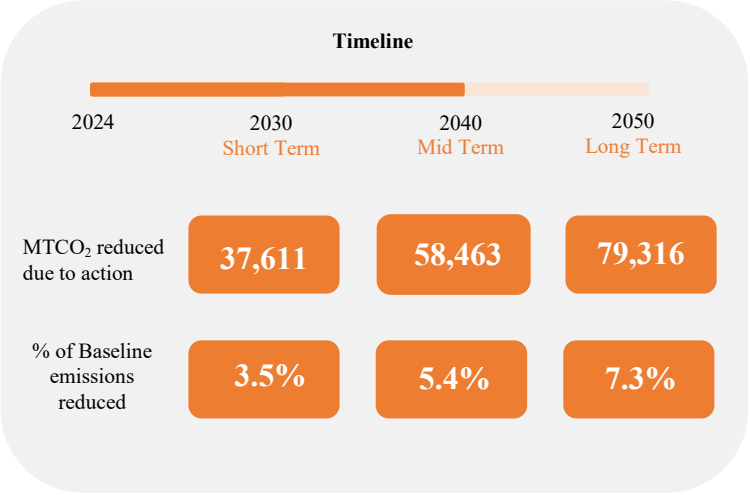
Recommendations

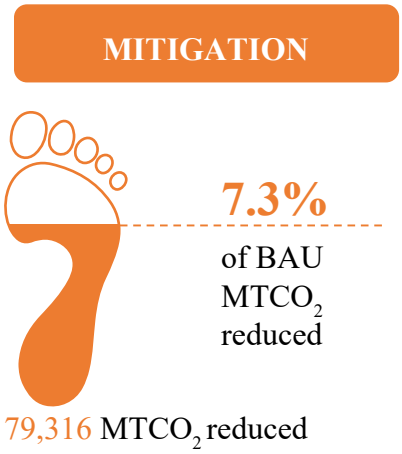
Description	Time frame	Proposal Detail
1. Implement energy-efficient systems for water supply and treatment by: ● Conducting periodic energy audits ● Undertaking cost-effective retrofits ● Integrating SCADA systems ● Utilizing high-efficiency motors	**Medium Term**	**Proposal type:** Project **Responsible agency:** JuMC
2. Transition to solar powered street lights from LED street lights in order to further reduce expenditure	**Short Term**	Proposal type: Policy **Responsible agency:** Electrical department, JuMC

Thrust Area B: Reduce vehicular emissions

Objective B1: Ensuring clean fuel public transport

Implementing clean fuel public transport in Junagadh necessitates a comprehensive strategy focused on reducing vehicular emissions and fostering sustainable transportation modes. A critical component of this strategy is transitioning the bus fleet to electric vehicles (EVs). Additionally, the establishment of Low Emission Zones (LEZs) will limit the circulation of high-emission vehicles, thereby significantly reducing air pollution. To further support these initiatives, targeted surveys within neighbourhoods to identify last-mile connectivity issues are proposed to be conducted.





Action: Transition Bus Fleet to EV

Thrust Area B: Reduce vehicular emissions

Objective B1: Ensuring clean fuel public transport

About

Transitioning the bus fleet to electric vehicles (EVs) is a pivotal strategy for reducing vehicular emissions and ensuring clean fuel public transport in Junagadh. The city has already made significant progress by initiating the process of procuring 25 intracity. Additionally, GSRTC has introduced 6 intercity electric buses, setting a strong foundation for a sustainable public transport system. This transition aims to replace traditional diesel-powered buses, which are major contributors to urban air pollution, with zero-emission electric buses.

Recommendations

Description	Time frame	Proposal Detail
1. For intracity buses: ● Procurement of EV buses ● Invest in developing fast charging infrastructure	**Short Term**	**Proposal type:** Project **Responsible agency:** Transport department, JuMC
2. For intercity buses: ● Begin converting the fleet of 1,030 buses, which currently use 225,000 liters of diesel monthly, to electric vehicles (EVs) ● Invest in developing fast charging infrastructure	**Medium Term**	**Proposal type:** Project **Responsible agency:** GSRTC

Action: Advancing Non-Motorised Transport and Low Emission Zones

Thrust Area B: Reduce vehicular emissions

Objective B1: Ensuring clean fuel public transport

About

Advancing Non-Motorised Transport (NMT) infrastructure and establishing Low Emission Zones (LEZs) are essential strategies in Junagadh to reduce vehicular emissions and promote clean fuel public transport. Currently, Junagadh has 17 km of NMT infrastructure out of 523 km of total roads, underscoring the need for expansion. Implementing LEZs will further restrict high-emission vehicles, effectively mitigating air pollution.

Recommendations

Description	Time frame	Proposal Detail
1. Design and construct dedicated cycle tracks and pedestrian paths along major roads and key areas, prioritizing connectivity to residential areas, commercial centers, and public transport hubs.	**Medium Term**	**Proposal type:** Project **Responsible agency:** Road department, JuMC
2. Implement measures to create a pedestrian-friendly environment. This includes installing adequate lighting, installing surveillance cameras integrated with a command and control center, and prioritizing accessibility features like ramps and crosswalks. This will not only ensure safety but also improve public perception and comfort.	**Medium Term**	**Proposal type:** Project **Responsible agency:** Road department, JuMC
3. Implement and enforce regulations to prevent encroachments on footpaths and cycling lanes, ensuring safe and unobstructed passage for pedestrians and cyclists.	**Medium Term**	**Proposal type:** Planning **Responsible agency:** Road department, JuMC
4. Launch educational campaigns to raise public awareness about the numerous benefits of NMT, including improved health, reduced pollution, and enhanced community well-being. This will encourage a shift towards active travel choices and support the long-term success of the NMT initiative.	**Short Term**	**Proposal type:** IEC activities **Responsible agency:** Road department, JuMC
5. Redesign specific zones according to scientific research into Low Emission Zones (LEZs), such as Bhavnath	**Medium Term**	**Proposal type:** Project **Responsible agency:** Road department, JuMC & GPCB
6. Introduction of Public Bicycle Sharing (PBS) System across the tourist circuits and providing walkable infrastructure	**Short Term**	**Proposal type:** Project **Responsible agency:** Road department, JuMC

Action: Strengthening existing IPT services and vehicles

Thrust Area B: Reduce vehicular emissions

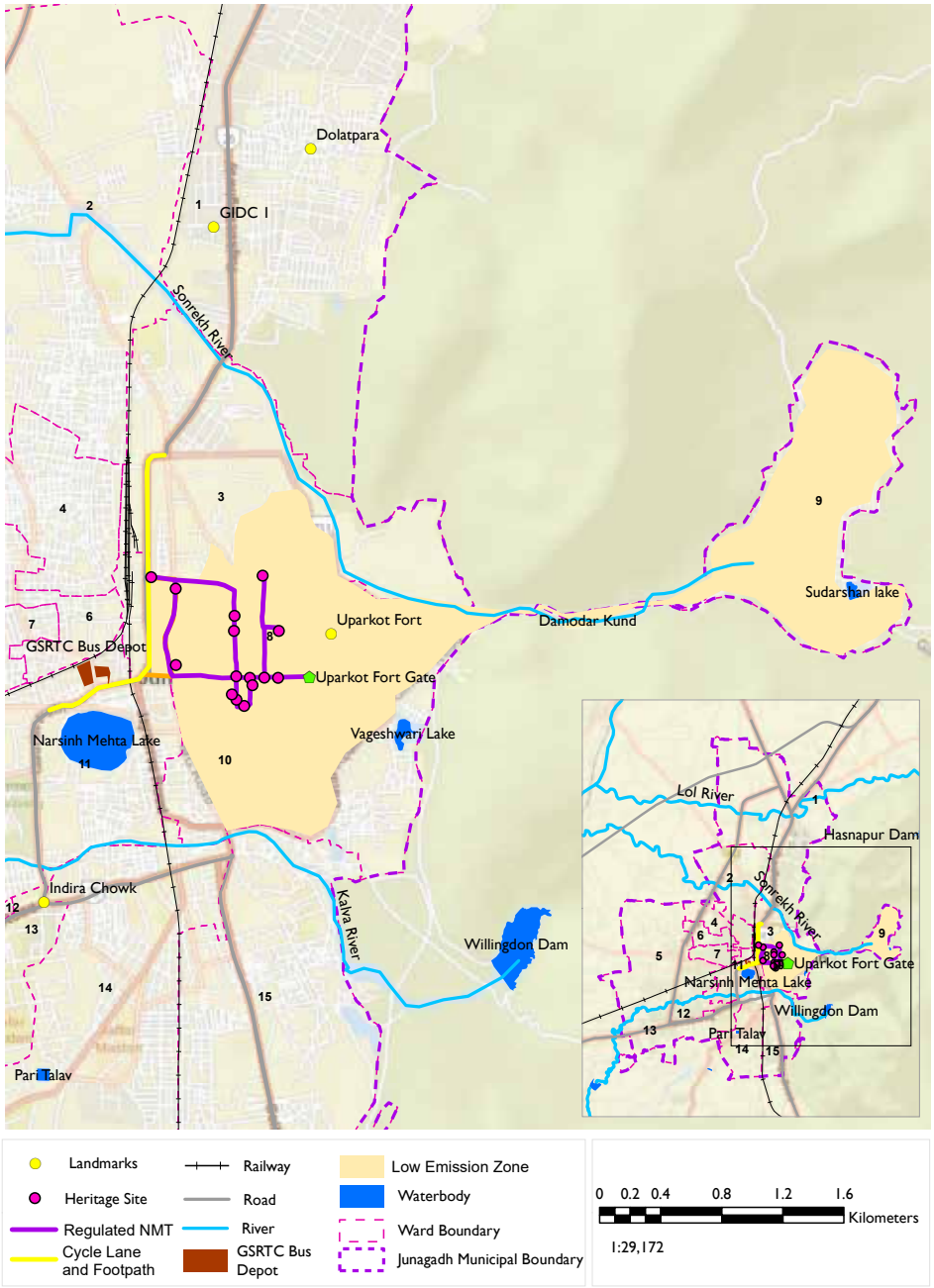
Objective B1: Ensuring clean fuel public transport

About

Junagadh city's intermediate public transport (IPT) services are currently limited and predominantly reliant on diesel-fueled vehicles, contributing to substantial urban air pollution. To address this, it is imperative to strengthen existing IPT services by integrating cleaner fuel alternatives and enhancing overall service quality. Moreover, enhancing IPT services with increased coverage, reliability, and accessibility will encourage a shift away from private vehicle use, further reducing traffic congestion and emissions.

Recommendations

Description	Time frame	Proposal Detail
1. Conduct a targeted survey within neighbourhoods to assess last-mile connectivity challenges (preferred modes, existing options, accessibility issues). This data will guide solutions for improved walking, cycling, and e-mobility options.	**Short Term**	**Proposal type:** Planning **Responsible agency:** Road department, JuMC
2. Given the narrow roads in Junagadh city, limiting movement of private vehicles and introduction of public transportation can be implemented to reduce congestion	**Short Term**	**Proposal type:** Project **Responsible agency:** Traffic Police
3. Streamline licensing procedures for electric/CNG e-rickshaws and three-wheelers by reducing paperwork, utilizing online platforms, and clarifying eligibility criteria. This will facilitate clean last-mile transportation and support livelihoods.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** RTO
4. For 3 wheeler vehicles ● Develop and implement a comprehensive program to incentivize and support the conversion of diesel vehicles registered within the RTO to electric vehicles (EVs) offering additional incentives like scrappage value adjustments ● Implement special tariffs at charging stations for commercial operators who use three-wheeler EVs for their businesses. ● Partner with fleet operators to integrate three-wheeler EVs into public transport and goods delivery services. ● Enforce regulations that support the adoption of three-wheeler EVs, such as preferential access in low emission zones	**Short Term**	**Proposal type:** Project **Responsible agency:** JuMC & RTO



Map 19: Proposed NMT Network and Low Emission Zones Map

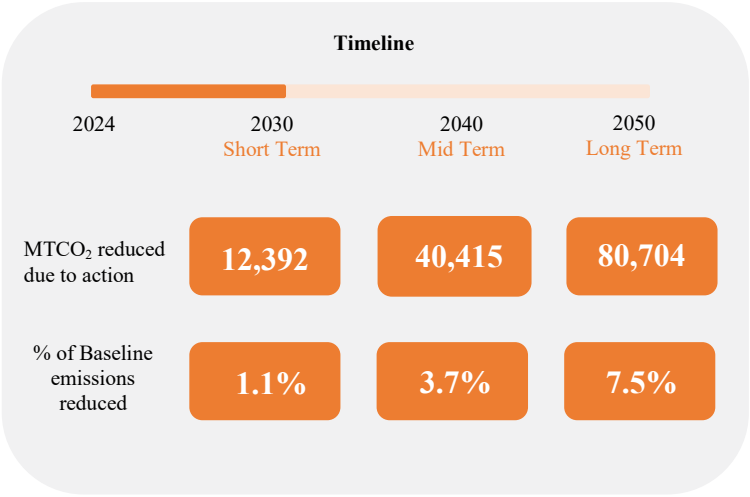
Objective B2: Transition to zero tailpipe emissions vehicle

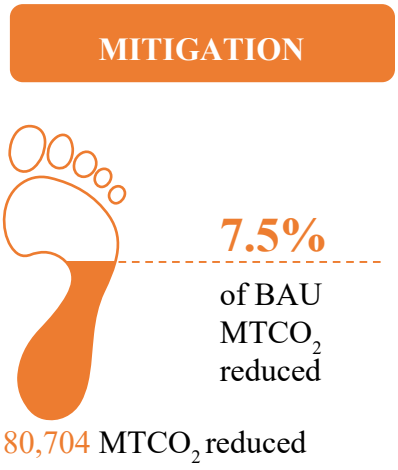
The adoption of electric vehicles (EVs) across two, three, and four-wheeler categories is essential for Junagadh to achieve significant reductions in vehicular emissions and transition to zero tailpipe emission vehicles. Presently, the city's uptake of CNG-based three-wheelers is constrained by prevalent misconceptions regarding their performance on slopes, which deters potential buyers. To overcome these barriers, a robust transition strategy to EVs must be implemented, encompassing public awareness campaigns to dispel myths about CNG and EV efficiency and performance. This transition is pivotal in reducing vehicular emissions, as EVs produce no tailpipe emissions, directly contributing to improved air quality and public health. Policy interventions, such as subsidies for EV purchases, incentives for scrapping old diesel vehicles, and the development of extensive EV charging infrastructure, are crucial to support this shift. Additionally, fostering partnerships with manufacturers and fleet operators can facilitate the integration of EVs into the public and private transport sectors, ensuring a comprehensive approach to sustainable urban mobility in Junagadh.

Action: Adoption of Electric Two Wheelers

Thrust Area B: Reduce vehicular emissions

Objective B2: Transition to zero tailpipe emissions vehicle





About

Junagadh city experiences high usage of two-wheeler vehicles, predominantly powered by diesel and petrol, contributing significantly to vehicular emissions. To address this environmental concern, the city should implement measures to encourage the transition of these users to electric vehicles (EVs). This can be achieved through the provision of subsidies and incentives aimed at making electric two-wheelers more financially accessible. By promoting the adoption of EVs, Junagadh can significantly reduce vehicular emissions, moving towards the objective of transitioning to zero tailpipe emissions vehicles.

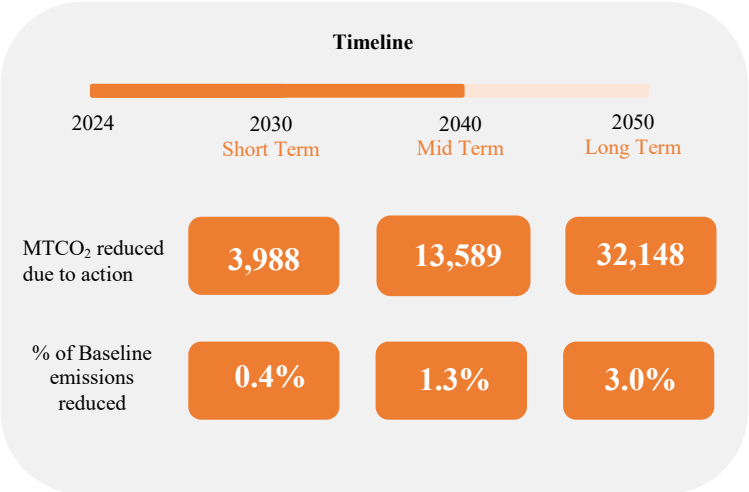
Recommendations

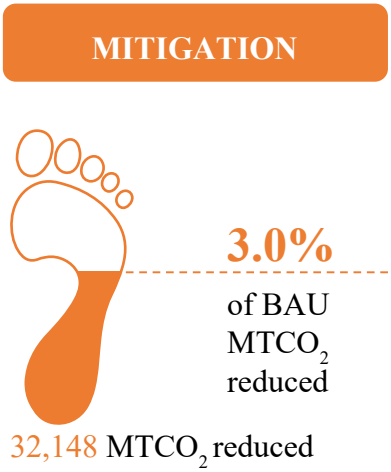
Description	Time frame	Proposal Detail
1. For 2 wheeler vehicles ● Designate and provide free parking spaces specifically for two-wheeler EVs in key areas such as commercial centers, residential complexes, and public facilities ● Implement discounted rates for charging two-wheeler EVs at public charging stations ● Collaborate with EV manufacturers and rental companies to offer affordable rental solutions for two-wheeler EVs, making them more accessible	**Short Term**	**Proposal type:** Planning **Responsible agency:** JuMC

Action: Adoption of zero emission vehicles

Thrust Area B: Reduce vehicular emissions

Objective B2: Transition to zero tailpipe emissions vehicle





About

By 2050, Junagadh is projected to have 39,031 4 wheeler vehicles on road. Navigating this growth necessitates a strategic shift towards sustainable transportation solutions like EVs and Hydrogen Fuel Cell Vehicles (FCEVs). Junagadh's current EV adoption rate is concerningly low. While financial benefits exist, these might not be sufficient to incentivize large-scale adoption at the necessary pace. The existing Gujarat EV policy, which offers subsidies of up to ?1,50,000 for 20,000 four-wheeler EVs over a four-year period, is unable to attract citizens to adopt EVs due to the limited availability of fast-charging stations across the city.

Recommendations

Description	Time frame	Proposal Detail
1. For 4 wheeler vehicles ● Introduce time-limited incentive schemes (such as free parking until 2030) to boost initial uptake and create momentum for broader adoption ● Implement a program to replace city administrative vehicles with electric vehicles (EVs) to reduce the carbon footprint of municipal operations	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Transport department, JuMC

Action: Establishing EV Charging Infrastructure

Thrust Area B: Reduce vehicular emissions

Objective B2: Transition to zero tailpipe emissions vehicle

About

Currently, Junagadh lacks EV charging stations, which impedes widespread adoption of electric mobility. Increasing the number of charging points across strategic locations such as residential areas, commercial hubs, and public spaces will encourage more drivers to switch to electric vehicles. This infrastructure expansion must include fast-charging stations to minimize downtime and enhance convenience for EV users.

Recommendations

Description	Time frame	Proposal Detail
1. Partner with charging infrastructure companies to expand the network of charging stations and ensure reliable access for EV users on PPP Model	**Medium Term**	**Proposal type:** Project **Responsible agency:** RTO
2. Increase the number of public charging stations in strategic locations such as shopping malls, office complexes, and residential areas. Ensure that charging stations are equipped with multiple charging points to accommodate a larger number of users.	**Medium Term**	**Proposal type:** Project **Responsible agency:** RTO
3. Ensure compliance with MoHUA MBBL-2016 guidelines by establishing at least one public charging station within every 3km x 3km grid.	**Medium Term**	**Proposal type:** Project **Responsible agency:** JuMC

Objective B3: Efficient traffic management

Junagadh city faces significant traffic management challenges, primarily due to non-functional traffic light signals and a railway track running parallel to a highly congested street. The absence of operational traffic lights exacerbates congestion and poses safety risks, especially at intersections near the railway track. This situation contributes to increased vehicular emissions, worsening air quality and impacting public health. Implementing parking solutions and stringent traffic regulations can address these issues effectively. Establishing designated parking areas will reduce the incidence of haphazard parking, thereby improving traffic flow. Simultaneously, rigorous enforcement of traffic rules and the introduction of automated traffic signal systems will enhance overall traffic management. By optimizing traffic flow and reducing idle time at congested intersections, these measures will not only improve vehicular movement but also significantly reduce emissions, aligning with the broader objective of promoting efficient and sustainable urban transport in Junagadh.

Action: Parking Solutions and stringent traffic regulation

Thrust Area B: Reduce vehicular emissions

Objective B3: Efficient traffic management

About

Junagadh city, characterized by its narrow lanes and high 2 wheeler vehicular density, faces significant challenges in managing traffic and reducing vehicular emissions. To address these issues, implementing advanced parking solutions alongside stringent traffic regulations is crucial. By optimizing parking facilities and enforcing strict traffic rules, the city can alleviate congestion. This dual approach aims to enhance traffic flow and efficiency, contributing to cleaner air and a more organized urban environment.

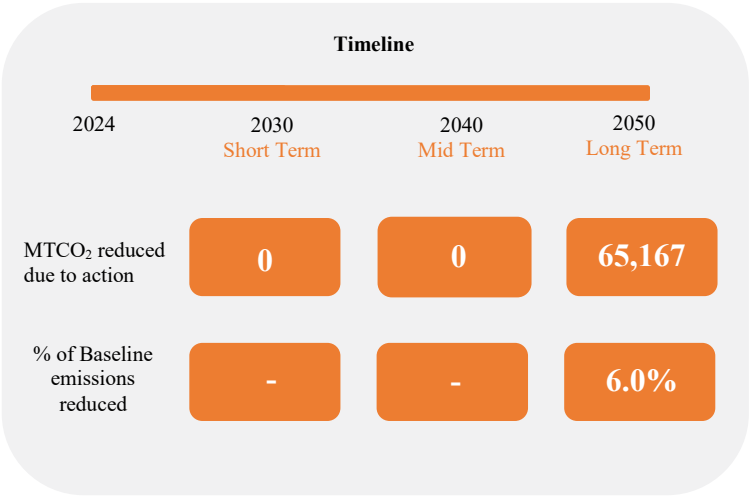
Recommendations

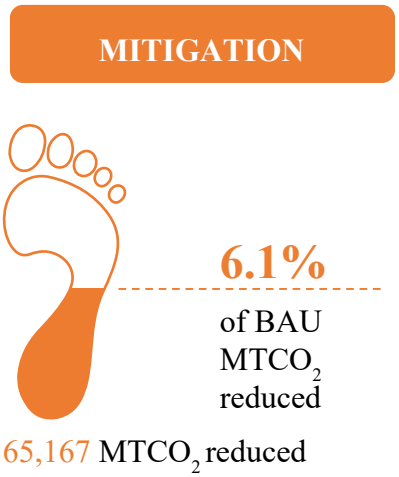
Description	Time frame	Proposal Detail
1. Conduct a comprehensive survey to identify suitable locations for shaded parking, focusing on high-traffic and high-demand areas.	**Short Term**	**Proposal type:** Planning **Responsible agency:** Traffic Police & JuMC
2. Introduce dynamic pricing models that adjust fees based on demand, time of day, and duration of parking to optimize space utilization such as implement higher parking fees in high-demand areas, such as commercial areas, to reduce congestion and encourage the use of public transport	**Short Term**	**Proposal type:** Policy **Responsible agency:** Traffic Police & JuMC
3. Restrict vehicular movement strictly between 6:00 AM to10:00 PM IST, while ensuring e-rickshaw services are available during the remaining hours of the day in demarcated high demand areas as per the comprehensive study.	**Medium Term**	**Proposal type:** Planning **Responsible agency:** Traffic Police & JuMC

Thrust Area C: Resource efficient solid waste management

Objective C1: Efficient Waste Management

In Junagadh city, dry waste accounts for approximately 57% of the total waste generated, highlighting a significant challenge in the current waste management system, which is compounded by limited solid waste collection coverage. To address this, implementing Waste Segregation at Source (WSS) is crucial. By encouraging residents and businesses to separate dry and wet waste at the point of generation, the efficiency of waste processing can be markedly improved. Additionally, a robust Construction and Demolition (C&D) Waste Management strategy is essential to handle the substantial debris generated from ongoing urban development. Ensuring 100% waste collection coverage remains a key objective, necessitating the expansion and optimization of the existing waste collection infrastructure. By achieving comprehensive waste collection and promoting systematic segregation and management of all waste types, Junagadh can significantly enhance its waste management efficiency.

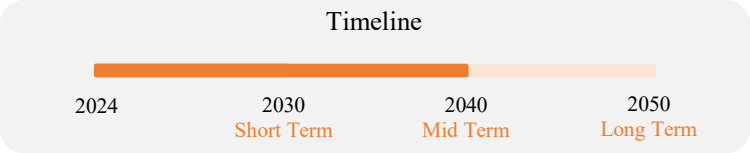




Action: Waste Segregation at Source (WSS)

Thrust Area C: Resource efficient solid waste management

Objective C1: Efficient Waste Management



MITIGATION

About

As highlighted in indicator 5.2 (Extent of Dry Waste Recovered And Recycled) of the waste management thematic area, Junagadh should aim to expand its extent of source segregation from 13% to 100%. Achieving comprehensive WSS necessitates sustained sensitization and active participation from individuals and institutions generating waste, fostering a collaborative approach to waste management that enhances overall efficiency and sustainability.

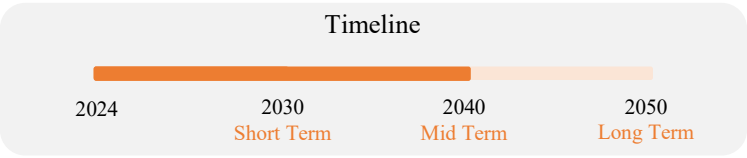
Recommendations

Description	Time frame	Proposal Detail
1. Expand MRFs and recycling centres to substantially decrease the volume of waste directed to landfills Case Study: *Zero Waste initiative in San Francisco, USA* San Francisco implemented a comprehensive recycling and composting program with an extensive network of MRFs and recycling centres thereby achieving an 80% diversion rate from landfills.	**Short Term**	**Proposal type:** Project **Responsible agency:** Solid Waste department, JuMC
2. Offer discounts on utility bills for residents and tax rebates for businesses that actively participate in recycling programs Case Study: *Green Exchange Program in Curitiba, Brazil* Residents exchange recyclable waste for bus tokens, food, or school supplies which significantly increased recycling rates and waste diversion from landfills	**Short Term**	**Proposal type:** Policy **Responsible agency:** Solid Waste department, JuMC
3. As per Policy Guidelines Promoting Behaviour Change for Strengthening Waste Segregation at Source by Niti Aayog (2021), BIS codes can be applied for adoption of different recycled materials to promote their acceptability **Case Study:** *BIS Codes for recycled aggregates in Ahmedabad, Gujarat* The Ahmedabad Urban Development Authority (AUDA) and the Ahmedabad Municipal Corporation (AMC) have established guidelines to ensure compliance with BIS 383:2016, promoting the use of recycled coarse and fine aggregates in construction. These projects reported a 30% reduction in the use of natural aggregates and an average cost saving of 20-25% compared to using virgin raw materials.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Solid Waste department, JuMC

Action: Construction and Demolition (C&D) Waste Management

Thrust Area C: Resource efficient solid waste management

Objective C2: Efficient Waste Management



MITIGATION

About

Junagadh is experiencing rapid urbanization and infrastructure development, leading to a significant increase in construction and demolition (C&D) waste. Currently, a significant portion of C&D waste is dumped in open spaces, along roadsides, and in water bodies. Future actions require enforcement of stringent regulations to prevent illegal dumping and promote recycling and reuse.

Recommendations

Description	Time frame	Proposal Detail
1. Promote the reuse of C&D waste in non-structural applications such as concrete, paving blocks, and road pavements	**Short Term**	**Proposal type:** Policy **Responsible agency:** Solid Waste department, JuMC
2. High-efficiency crushers and screeners designed to process C&D waste into reusable aggregates can be utilised. They produce high-quality recycled aggregates that can be used in new construction projects	**Short Term**	**Proposal type:** Project **Responsible agency:** Road and Buildings Department, Government of Gujarat

Action: Ensure 100% waste collection

Thrust Area C: Resource ef ficient solid waste management

Objective C1: Efficient Waste Management

MITIGATION

About

Junagadh produces 154 metric tons per day (MTPD) of municipal solid waste, with limited coverage across the city. Achieving 100% waste collection in Junagadh requires a comprehensive and integrated approach involving infrastructure development, community engagement, policy

enforcement, and technological innovations. Currently, the waste generated in the Gujarat Industrial Development Corporation (GIDC) area is not collected, and GIDC lacks its own waste management facility. Therefore, the municipal corporation could expand its services to GIDC, charging a collection fee that would contribute to its revenue.

Recommendations

Description	Time frame	Proposal Detail
1. Initiate solid waste collection in industrial areas/non-served areas	**Short Term**	**Proposal type:** Planning **Responsible agency:** Solid Waste department, JuMC
2. Implement smart waste management systems by deploying waste bins equipped with sensors to monitor fill levels and optimize collection routes for waste transport vehicles	**Short Term**	**Proposal type:** Project **Responsible agency:** Solid Waste department, JuMC
3. Invest in GPS-enabled vehicles for efficient route planning and tracking, ensuring timely waste collection across Junagadh	**Short Term**	**Proposal type:** Project **Responsible agency:** Solid Waste department, JuMC
4. Partner with Community-Based Organizations (CBOs) for waste collection in slum areas and informal settlements **Case Study:** *CBOs for Waste Collection in Pune, Maharashtra* The Pune Municipal Corporation (PMC) partnered with SWaCH (Solid Waste Collection and Handling), a cooperative of waste pickers, to ensure inclusive and efficient waste management services. SWaCH provided door-to-door waste collection and segregation services, particularly in underserved areas	**Short Term**	**Proposal type:** Planning/ Project **Responsible agency:** Solid Waste department, JuMC

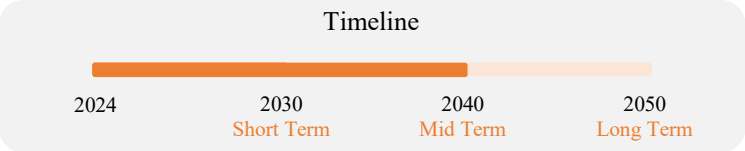
Objective C2: Promoting circular economy

Junagadh, experiencing significant growth and development, is poised to face an increase in construction and demolition (C&D) waste. Implementing effective recycling practices for this waste can establish a robust system of circularity, reducing environmental impact and promoting sustainable urban development. Furthermore, with a population of over 1,000 cows, Junagadh holds substantial potential for biogas production from cow dung. This not only provides an efficient waste management solution but also serves as a renewable energy source, contributing to the city's energy needs. By harnessing both C&D waste recycling and biogas production, Junagadh can pave the way towards a more sustainable and resource-efficient future.

Action: Utilization of Recycled Produce

Thrust Area C: Resource efficient solid waste management

Objective C2: Promoting circular economy



MITIGATION

About

The Construction and Demolition (C&D) waste rules, 2016 issued by the Ministry of Environment, Forests and Climate Change, Government of India, under the Environment (Protection) Act, 1986, defines the procedure for ULBs to undertake construction and demolition waste management. This includes process to be followed for collection, segregation, storage, transportation, processing and disposal of waste generated within their jurisdiction. The ULBs shall follow 14 directions and strategies and oblige the duties as stated in rules 4,12, 15 and other relevant rules of SWM Rules, 2016.

Recommendations

Description	Time frame	Proposal Detail
1. Mandate the inclusion of recycled C&D materials (10- 20%) in municipal and government contracts, subject to rigorous quality control standards and specifications	**Short Term**	**Proposal type:** Policy **Responsible agency:** Road and Buildings department, Government of Gujarat
2. Biogas production from cow dung through anaerobic digestion Case Study: *Deonar Abattoir Biogas Plant in Mumbai, Maharashtra* Cow dung, slaughterhouse waste, and other organic waste is used to generate renewable energy Capacity: 1.2 MW (megawatts) of electricity per day	**Short Term**	**Proposal type:** Project **Responsible agency:** Solid Waste department, JuMC
3. Promote Industrial Symbiosis to foster connections between industries where the waste of one becomes the raw material for another, reducing overall waste and resource consumption **Case Study:** *Eco-Industrial Park (EIP) in Kalundborg, Denmark* Novo Nordisk, a pharmaceutical company, supplies biological sludge to local farmers for use as fertilizer. Saving: 586,000 tonnes of CO^2 and 62,000 tonnes of residual materials recycled in EIP	**Medium Term**	**Proposal type:** Project **Responsible agency:** Solid Waste department, JuMC

5.4 Adaptation Actions

5.4.1 Overview of Actions

Adaptation measures are essential to equip Junagadh with the tools and strategies needed to confront the consequences of climate change effectively. As underscored in the previous sections, Junagadh faces significant climate risks in water management, sustainable tourism and flood resilience. Climate change exacerbates these challenges, necessitating proactive measures to enhance resilience and fortify the community against the evolving impacts of a changing climate. In light of these considerations, adaptation becomes a response to current challenges and a critical investment in building a sustainable and climate-resilient future for Junagadh.

This Climate Action Plan identifies three thrust areas to address Junagadh's climate adaptation needs. These are related to Effective Water and Wastewater Management, Sustainable tourism and heritage management and Adopting climate-sensitive planning approaches. 12 objectives and 21 actions have been proposed to help Junagadh adapt to its climate change-related challenges. These actions are a combination of policy, plans and projects devised to help build the resilience of the existing settlements and ensure that future developments have climate resilience built in.

Thrust Area D: Efficient water and waste water management

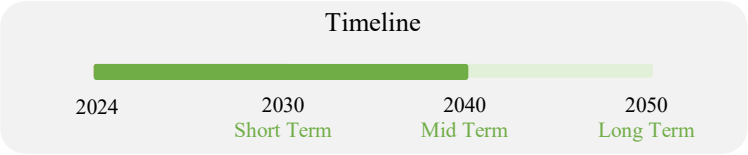
Objective D1: Enhancing Municipal supply

Junagadh city currently faces significant challenges in water supply coverage, with only a limited number of households receiving 24x7 water access. This inadequacy has led to a heavy reliance on borewell extraction to meet daily water needs, exacerbating the depletion of groundwater resources. The over-extraction of groundwater poses risks such as declining water tables, reduced water quality, and increased pumping costs. To address these issues, it is crucial to implement comprehensive water management strategies. These could include enhancing the city's water infrastructure, promoting rainwater harvesting, and encouraging the adoption of water-efficient practices among residents. Additionally, investment in modernizing the water distribution network to ensure equitable and continuous water supply can significantly alleviate the pressure on groundwater resources, promoting sustainable water use and securing the city's water future.

Action: 24x7 Water Supply System

Thrust Area D: Efficient water and waste water management

Objective D1: Enhancing Municipal supply



ADAPTATION

About

The Vision Strategy for Junagadh City 2035 outlines the goal of implementing a 24x7 water supply. This can be achieved by improving the water supply system through optimizing operational functions for accurate measurement and extending pipeline infrastructure. 24x7 water supply ensures infrastructure longevity, maintains consistent water pressure, and reduces the reliance on groundwater extraction.

Recommendations

Description	Time frame	Proposal Detail
1. Ensure efficient operational functions such as billing & collection and meter rectification to ensure accurate metering and detecting leaks or unauthorized use	**Short Term**	**Proposal type:** Planning/ Project **Responsible agency:** Water Works, JuMC
2. In accordance with the guidelines outlined in the MoHUA Manual on Water Supply and Treatment Systems (2023), it is advised to undertake retrofitting of pipelines. This process may entail the replacement of certain pipes and the installation of parallel pipelines in specific cases.	**Medium Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
3. Introduce 100% metering system with a differential volumetric tariff structure. This approach can be aimed to promote water conservation by charging higher rates for higher consumption levels and incentivizing responsible water usage. **Case Study:** *Water By-laws and Tariffs in Cape Town, South Africa* Cape Town's water by-laws implement a volumetric tariff structure consisting of tiered pricing with escalating rates as consumption increases. It includes a basic allowance for essential needs, increase in the rate per unit of water as consumer moves into higher tier of consumption, seasonal variation in water pricing and rebates for conservation measures.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC

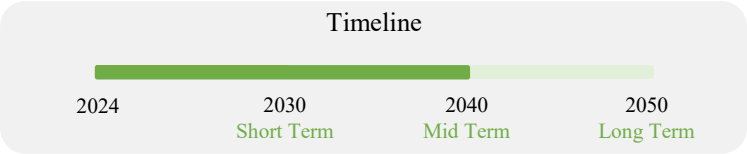
Objective D2: Reduction of Non-Revenue Water (NRW)

Non-Revenue Water (NRW), which includes losses due to leakages, unauthorized connections, and inaccurate metering, is a significant issue in Junagadh, with the NRW rate surpassing the service level benchmark. To address this, effective water management practices are necessary to reduce water losses in the distribution system. This includes promptly detecting and repairing leaks and implementing universal metering for accurate monitoring and control of water flow. Additionally, regulating borewell water extraction and promoting fair water distribution are crucial for improving overall service reliability and sustainability. These measures will help Junagadh enhance its water management infrastructure, ensuring more efficient and equitable water use.

Action: Reduce extensive extraction of water

Thrust Area D: Efficient water and waste water management

Objective D2: Reduction of Non-Revenue Water (NRW)



ADAPTATION

About

Non-Revenue Water (NRW) represents water that is lost or unaccounted for within the distribution system, including leakages, unauthorized connections, and inaccurate metering. Given Junagadh city's NRW rate exceeds the service level benchmark of 20%, the subsequent proposals aim to regulate borewell water extraction and promote equitable water distribution.

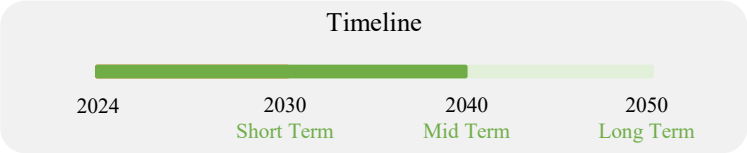
Recommendations

Description	Time frame	Proposal Detail
1. Conduct a comprehensive survey of the city to identify all existing borewells and collate data on ownership, depth and usage of each borewell	**Short Term**	**Proposal type:** Planning **Responsible agency:** Water Works, JuMC
2. Install water meters on all borewells to accurately measure water extraction and implement a centralised monitoring system to track water usage from each borewell	**Short Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
3. Establish regulations limiting the volume of water that can be extracted from borewells based on assessments and enforce strict penalties for non-compliance with extraction limits	**Short Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC
4. Enact regulations prohibiting the drilling of new borewells and the extraction of groundwater in areas where water supply is accessible	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC
5. Implement a phased approach to gradually decommission existing borewells in depleted areas, providing alternative water supply solutions (such as rainwater harvesting) to affected users	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC

Action: Reduce water loss

Thrust Area D: Efficient water and waste water management

Objective D2: Reduction of Non-Revenue Water (NRW)



ADAPTATION

About

Efficient water management is critical for reducing Non-Revenue Water (NRW) by minimizing water loss within the distribution system. This involves implementing a multifaceted approach to identify and address leaks promptly. Furthermore, implementing universal metering provides precise monitoring and control of water flow, facilitating overall service reliability.

Recommendations

Description	Time frame	Proposal Detail
1. Conduct a thorough assessment of the water distribution network and prioritize the replacement of old and leaking pipes. This will involve upgrading the entire pipeline system with durable materials to reduce leakage.	**Medium Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
2. Implementing pressure management techniques to minimize the stress on the pipeline system, thereby reducing the frequency of leaks and bursts **Case Study:** *Pressure Management Program in Lisbon, Portugal* Lisbon faced high levels of NRW due to leaks and bursts within their distribution network. To address this, they implemented a comprehensive pressure management program. They installed Pressure Reducing Valves (PRVs) in each of their 40 DMAs (District Metered Areas) to regulate and optimize pressure levels. Additionally, they utilized pressure management software to dynamically monitor and adjust pressure settings in real-time based on demand. As a result, NRW was reduced from 23% to 12% with significant reduction in pipe bursts and leaks.	**Medium Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
3. Utilize advanced leak detection technologies like acoustic sensors, satellite imagery and smart water meters to pinpoint specific areas for repair	**Medium Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
4. Launch campaigns to educate the public on the importance of reporting leaks and using water efficiently	**Short Term**	**Proposal type:** IEC activity **Responsible agency:** Water Works, JuMC

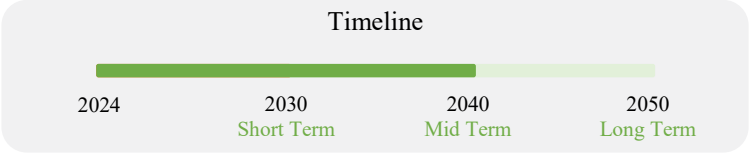
Objective D3: Reducing dependency on borewells

Reducing dependency on borewells in Junagadh necessitates promoting rainwater harvesting, implementing water conservation practices, and diversifying water sources. These efforts aim to mitigate groundwater depletion and ensure sustainable water management for the city's long-term water security.

Action: Rainwater Harvesting at Household level

Thrust Area D: Efficient water and waste water management

Objective D3: Reducing dependency on borewells



ADAPTATION

About

Implementing rainwater harvesting at the household level is essential for reducing the high dependency on borewells on the core parts of Junagadh. By capturing and utilizing rainwater for non-portable uses, households can significantly decrease their reliance on groundwater resources. To achieve this, planning-level measures and strict enforcement of existing building by-laws mandating rainwater harvesting systems should be undertaken by the city.

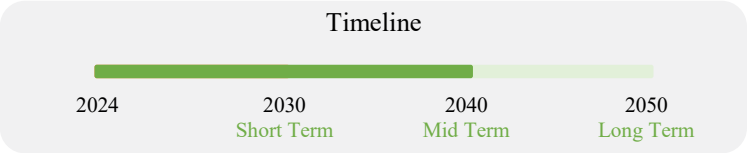
Recommendations

Description	Time frame	Proposal Detail
1. Junagadh city should enforce the Model Building Bye-Laws 2016 by TCPO, MoHUA that all buildings having a plot size of 100 sq.m. or more, while submitting the building plans for sanction, shall mandatorily include the complete proposal of rainwater harvesting.	**Short Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC
2. A rain water harvesting plan needs to be designed where the recharge bores (minimum one per 5000 sqm of built-up area) shall be provided. The rain water harvested should be stored in a tank for reuse in household through a provision of separate water tank and pipeline to avoid mixing with potable municipal water supply. The excess rain water harvested be linked to the tube well bore in the premise through a pipeline after filtration in the installed filters.	**Medium Term**	**Proposal type:** Plan **Responsible agency:** Water Works, JuMC
3. Effective techniques such as roof catchment systems, rain barrels and underground storage tanks can be promoted.	**Short Term**	**Proposal type:** IEC **Responsible agency:** Water Works, JuMC

Action: Rainwater Harvesting at Community level

Thrust Area D: Efficient water and waste water management

Objective D3: Reducing dependency on borewells



ADAPTATION

Recommendations

Description	Time frame	Proposal Detail
1. Junagadh city should enforce the Model Building Bye-Laws 2016 by TCPO, MoHUA, for all new construction proposals, regardless of plot size. This includes the compulsory implementation of rainwater harvesting structures and the requirement to avoid concrete paving and use of permeable materials for all open parking spaces.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC
2. The existing topography of Junagadh city may be leveraged to create multiple small catchments.	**Medium Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
3. The city can consider enforcement of the International Building Code (IBC) which recommends a minimum of 10 feet between building foundations and ponding water or infiltration areas. **Case Study:** *Seattle Building Code, 2018* As per Section 1804, Seattle has implemented strict regulations based on IBC standards to ensure a minimum distance of 10 feet between building foundations and such areas to mitigate risks related to water infiltration and flooding.	**Short Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC
4. City shall include inspection of rainwater harvesting structures before issuing Completion Certificates or NOCs for service connections to the property and design its own incentive and penalty systems to promote rain water harvesting.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Water Works, JuMC

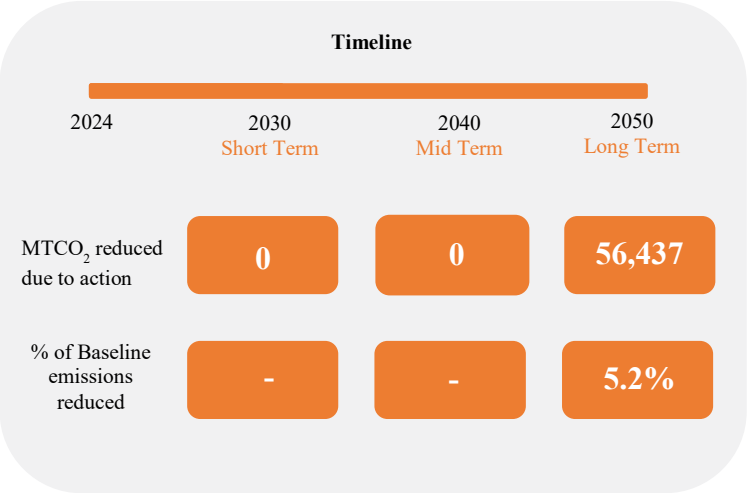
Objective D4: Reduction in non-domestic water consumption

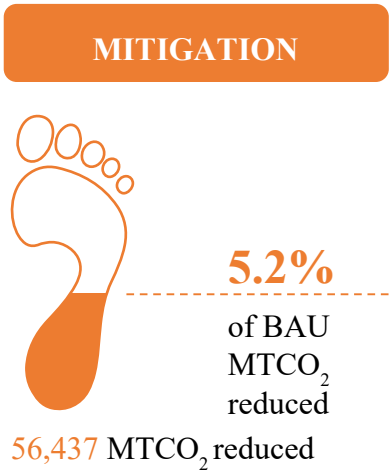
Reducing non-domestic water consumption in Junagadh involves promoting water-efficient technologies in industries and agriculture, implementing strict water use regulations, and encouraging the reuse of treated wastewater. These measures aim to conserve water resources, enhance sustainability, and reduce the city's overall water footprint.

Action: Reuse of treated waste water

Thrust Area D: Efficient water and waste water management

Objective D4: Reduction in non-domestic water consumption





About

Efficient water and wastewater management, through the reuse of treated wastewater, is a key strategy for reducing non-domestic water consumption. Currently, Junagadh practices this by repurposing treated wastewater from the Zanzarda Sewage Treatment Plant (STP) for irrigation purposes. Expanding this approach to include industrial processes and toilet flushing can further reduce the demand for freshwater resources.

Recommendations

Description	Time frame	Proposal Detail
1. Treated wastewater can be utilized in horticulture for irrigation purposes and landscaping across the city	**Short Term**	**Proposal type:** Project **Responsible agency:** Water Works & Garden department, JuMC
2. Industries within GIDC 1 & 2 can use treated wastewater for non-potable purposes like washing equipment, vehicles, and facilities, reducing demand on freshwater sources.	**Short Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC & GIDC

Description	Time frame	Proposal Detail
3. Implementing a dual piped system in group housing to ensure the reuse of treated wastewater for non-potable uses like gardening and flushing	**Medium Term**	**Proposal type:** Plan **Responsible agency:** Water Works & Sanitation department, JuMC
4. Junagadh Agriculture University (JAU) can utilizes treated wastewater for irrigation in agricultural research fields and demonstration plots	**Short Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC & Junagadh Agriculture University (JAU)

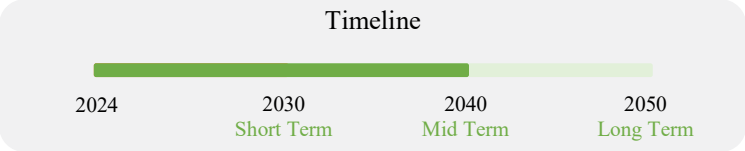
Objective D5: Reduction in water wastage at household level

Reducing water wastage at the household level in Junagadh involves promoting water-saving fixtures like low-flow faucets and toilets, educating residents on efficient water use practices, and implementing leak detection and repair programs. These initiatives aim to conserve water resources, lower utility costs, and foster a culture of sustainability among residents.

Action: Shift to efficient fixtures to reduce wastage

Thrust Area D: Efficient water and waste water management

Objective D5: Reduction in water wastage at household level



ADAPTATION

Recommendations

Description	Time frame	Proposal Detail
1. Transition towards water efficient fixtures and fittings such as: ● **Water-saving Faucet Aerators:** are designed with the purpose of dispensing water at a defined flow rate of 2 to 8 litres/minute Saving: Upto 80% ● **Tank Banks:** are simple bags placed inside the flush tank to displace an amount of water equal to the water in the tank bath for every flush Saving: Upto 30% ● **Flow Restrictors:** limit the amount of water that is let out of an existing shower and are also recommended for taps where aerators are not feasible Saving: Upto 60% ● **Water-free Urinal Pots:** An average urinal wastes 80 to 100 liters of water daily. This can be prevented by using smart water-free urinal pots that perform efficiently without any water Saving: Upto 80% ● **High-efficiency Washing Machines:** use less water load, use less energy and reduce electricity bills Saving: Upto 50%	**Medium Term**	**Proposal type:** IEC **Responsible agency:** Water Works, JuMC
2. Transition towards dual water efficient toilets that uses two buttons for flushing to use as per requirement i.e. partial and full flush Saving: Upto 75% **Case Study:** *Beddington Zero Energy Development (BedZED) in Sutton, United Kingdom* A typical toilet uses up to 9 litres per flush and accounts for 33% of an average household's annual water consumption. BedZED's 3-5 litre dual-flush toilets save an estimated 55,500 litres of water per household per year compared to the 7.5 litre maximum permitted under the 1999 UK Water Byelaws.	**Medium Term**	**Proposal type:** IEC **Responsible agency:** Water Works & Sanitation department, JuMC

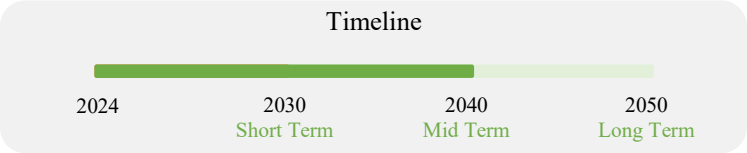
Objective D6: Improving the quality and pollution abatement

Improving the quality and pollution abatement in Kalva River, Lol River, and Sonrekh River in Junagadh involves implementing stringent waste management practices, promoting eco-friendly agricultural techniques, and establishing water treatment facilities. These efforts aim to restore water quality, safeguard aquatic ecosystems, and enhance the overall environmental health of the rivers for the community's benefit.

Action: Maintenance of existing waterbodies

Thrust Area D: Efficient water and waste water management

Objective D6: Improving the quality and pollution abatement



ADAPTATION

Recommendations

Description	Time frame	Proposal Detail
1. Narrow stretches of Kalva, Sonrekh and Lol river should undergo extensive cleaning to remove accumulated waste and debris and enhance the rivers' health	**Short Term**	**Proposal type:** Project **Responsible agency:** Sanitation department, JuMC
2. A greenbelt/greenway should be developed on both sides of the embankment, for controlling erosion, reducing sediment load of the main channel and reduce pollution	**Medium Term**	**Proposal type:** Project **Responsible agency:** Garden department., JuMC
3. Plantation of Bio-filtration Plant Species on the river edge of Kalva and Lol rivers in Junagadh by designing a planting layout that maximizes water filtration and bank stabilization. Incorporate a mix of deep-rooted and surface-rooted plants to create a robust bio-filtration system	**Medium Term**	**Proposal type:** Plan **Responsible agency:** Water Works & Garden department, JuMC
4. Enforcement of GDCR-JUDA (2031) regulation on Environmental Management to provide minimum clearances of 9mts (for new construction) between the boundary of any other water body such as lake (talav), canal or nala and any building or part thereof.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Building department, JuMC
5. Conservation and rejuvenation of Damodar Kund, a historic structure built over Sonrekh by installing waste collection bins and segregation units around the Kund to manage religious offerings and other waste properly	**Short Term**	**Proposal type:** Project **Responsible agency:** Water Works & Sanitation department, JuMC

Thrust Area E: Sustainable tourism and heritage management

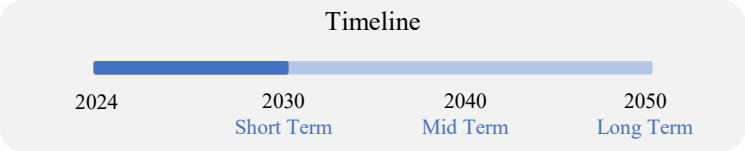
Objective E1: Low Emission Zones (LEZs)

Promoting sustainable tourism and heritage management in Junagadh with Low Emission Zones (LEZs) involves restricting vehicle emissions in historical areas, promoting eco-friendly transportation options, and preserving cultural sites through responsible visitor practices. These initiatives aim to reduce environmental impact, preserve cultural heritage, and enhance the overall tourism experience while fostering sustainable development in the region.

Action: Heritage conservation for emission reduction

Thrust Area E: Sustainable tourism and heritage management

Objective E1: Low Emission Zones (LEZs)



MITIGATION & ADAPTATION

About

Junagadh, renowned for its cultural heritage, has the opportunity to leverage sustainable tourism and effective heritage management practices to significantly contribute to emission reduction. Preservation of historic sites and buildings helps mitigate carbon-intensive construction activities, while promoting eco-friendly tourism practices encourages responsible visitor behavior.

Recommendations

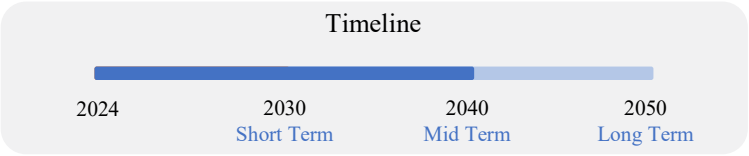
Description	Time frame	Proposal Detail
1. To effectively manage and preserve heritage sites, the following institutional arrangement should be undertaken: ● Establishment of a GIS cell within the Town Planning Department of Junagadh Municipal Corporation ● Establishment of Heritage and Tourism Department within Junagadh Municipal Corporation This would facilitate the accurate mapping and analysis of heritage assets, aiding in the development of strategies for their conservation and sustainable use	**Short Term**	**Proposal type:** Institutional Mechanism **Responsible agency:** Town Planning department, JuMC
2. Utilize GIS for heritage mapping and identify the ownership status of heritage sites to enable precise planning and management. It will help in understanding the spatial distribution of heritage assets, assessing their condition, and planning conservation efforts	**Short Term**	**Proposal type:** Project **Responsible agency:** Town Planning department, JuMC
3. Formulation of a comprehensive heritage restoration policy including: ● Directory of energy-efficient materials that can be used for restoration ● Detailed structural analysis of heritage structures within Junagadh city	**Short Term**	**Proposal type:** Research & Plan **Responsible agency:** Town Planning department, JuMC;

4. Conduct Skill Enhancement Trainings and Capacity Building for local contractors, architects, and laborers in heritage conservation techniques	**Short Term**	**Proposal type:** Capacity Building **Responsible agency:** Town Planning department, JuMC;
5. Provide property tax subsidies and incentives to owners of private heritage structures to convert their properties into homestays, aimed at enhancing tourism and generating revenue	**Short Term**	**Proposal type:** Policy **Responsible agency:** Town Planning & Property tax department, JuMC; District Pravasan Vibhag

Action: Regulations for waste management

Thrust Area E: Sustainable tourism and heritage management

Objective E1: Low Emission Zones (LEZs)



MITIGATION & ADAPTATION

About

With a total of 26,00,000 tourists visiting Junagadh primarily in the months of February and November, the solid waste generated during these peak periods is significantly higher compared to the rest of the year. Additionally, energy consumption in hotels and guest houses also escalates during these months. To address these challenges, sustainable and green practices should be adopted and promoted through incentives and certifications.

Recommendations

Description	Time frame	Proposal Detail
1. Adoption of green practices by hotels and guesthouses such as: ● Set up separate bins for recyclable, organic and non-recyclable waste in guest rooms, lobby areas and kitchen ● Implementing greywater recycling systems to reuse water from sinks and showers for irrigation and non-potable uses	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Solid Waste & Sanitation department, JuMC
2. Introduce issuance of green certification to hotels and restaurants that follow sustainable practices **Case Study:** *Singapore Green Hotel Award (SGHA) by Singapore Tourism Board* Conrad Singapore Orchard was the recipient of the BCA Green Mark and the 2023/2024 Singapore Hotel Sustainability Awards, the hotel incorporates biophilic design, solar panels, energy-efficient systems, and waste reduction initiatives.	**Short Term**	**Proposal type:** Policy **Responsible agency:** Solid Waste department, JuMC & District Pravasan Vibhag
3. Bottles return/innovative waste recycling facilities such as reverse vending machines for bottle and can recycling **Case Study:** *Bottle Free Seas Project in Bangkok, Thailand* The initiative was inaugurated with the installation of a free water dispenser at the Central World shopping mall. They plan to set up 9 more drinking water dispensers across Bangkok. The campaign focuses on encouraging both residents and tourists to refill their water bottles to reduce disposal of plastic bottles	**Short Term**	**Proposal type:** Project **Responsible agency:** Solid Waste department, JuMC & GPCB
4. Effectively prohibit the use of disposable plastic and thermocol cutlery for large gatherings and tourists (particularly during Mahashivratri and Parikrama) **Case Study:** *Zero Waste initiative in Ahmedabad, Gujarat* Ahmedabad has become one of the first metropolitan cities from the developing world to adopt a zero waste goal. Almost 110,667 metric tonnes (MT) of solid waste is generated from the city every month. Around 98 percent of this is collected by AMC. The concept of Zero Waste aims to minimize use of resources and maximize the ongoing benefits of the intrinsic value within the waste generated by society.	**Short Term**	**Proposal type:** Policy **Responsible agency:** Solid Waste department, JuMC & GPCB

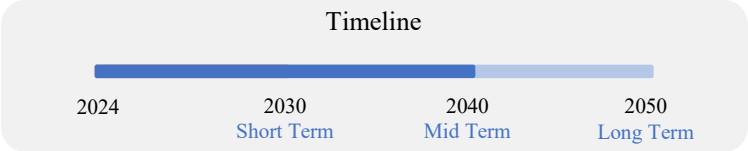
Objective E2: Reduction in carbon footprint through retention not demolition

Reducing Junagadh's carbon footprint through retention rather than demolition entails preserving existing infrastructure, promoting adaptive reuse of buildings, and implementing energy-efficient retrofitting. These strategies aim to conserve resources, preserve historical and cultural identity, and mitigate carbon emissions associated with new construction, fostering sustainable urban development in the city.

Action: Space Optimization - design level interventions

Thrust Area E: Sustainable tourism and heritage management

Objective E2: Reduction in carbon footprint through retention not demolition



MITIGATION & ADAPTATION

About

Junagadh city, with its numerous heritage residences, presents a unique opportunity to leverage these structures for their spatial and energy efficiency benefits. Rather than demolishing these historical buildings, adaptive reuse should be prioritized, allowing their traditional knowledge to inform contemporary development. By integrating traditional construction techniques and materials, these residences can maintain optimal indoor climates and significantly reduce energy consumption.

Recommendations

Description	Time frame	Proposal Detail
1. Reuse existing heritage buildings to retain their embodied energy, making the project significantly more environmentally sustainable compared to new construction	**Short Term**	**Proposal type:** Project **Responsible agency:** Town Planning & Building department, JuMC
2. Promoting the use of traditional knowledge-based passive design strategies in residences for climate control and energy efficiency such as: ● Utilizing cross-ventilation techniques through strategically placed windows, doors, and ventilators ● Leveraging materials with high thermal mass to maintain a stable indoor temperature ● Using vegetation on roofs and walls to act as natural insulators, reducing heat gain Case Study: *Adobe House Renovation in Santa Fe, New Mexico, USA* Renovation of adobe houses in Santa Fe used adobe's natural thermal mass, strategic window placement for ventilation, and traditional shading devices that improved energy efficiency and enhanced sustainability of the building.	**Medium Term**	**Proposal type:** Policy **Responsible agency:** Town Planning & Building department, JuMC

Thrust Area F: Adopting climate-sensitive planning approaches

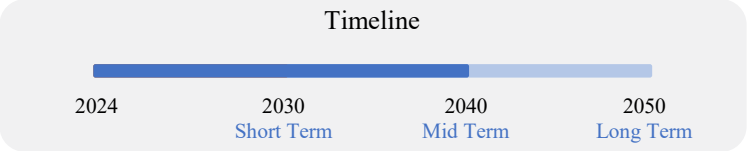
Objective F1: Flood Management

Flood management in Junagadh focuses on enhancing drainage infrastructure, implementing floodplain zoning regulations, and promoting early warning systems. These measures aim to mitigate flood risks, protect vulnerable communities, and enhance resilience against extreme weather events in the region.

Action: Mitigating floods

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F1: Flood Management



MITIGATION & ADAPTATION

About

Junagadh faced severe floods in July 2008 and 2023, largely due to the lack of storm water drainage and sewerage networks. The city's deficiency in green and percolative spaces exacerbates flood risks by preventing efficient water absorption. To mitigate this, Junagadh should develop robust drainage and sewer systems, and incorporate green infrastructure like parks and rain gardens to enhance water absorption and reduce runoff.

Recommendations

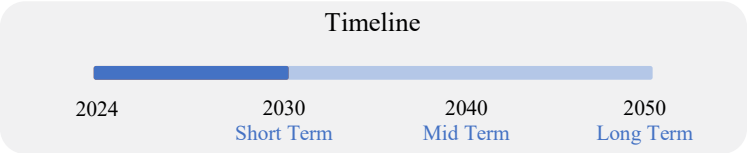
Description	Time frame	Proposal Detail
1. Implement semi-permeable pavements in public spaces, parks, and new developments. Pilot projects can be conducted in areas prone to waterlogging.	**Short Term**	**Proposal type:** Project **Responsible agency:** Engineering & Garden department, JuMC
2. Provide 100% sewerage network in the City	**Medium Term**	**Proposal type:** Project **Responsible agency:** Engineering & Sanitation department, JuMC
3. Enforcement of existing GDCR laws in Junagadh to prohibit any development within 30 meters from the riverbank, or 15 meters if no embankment exists, as well as within 9 meters from kans, nalas, canals, talabs, lakes, and other water bodies.	**Short Term**	**Proposal type:** Policy **Responsible agency:** Town Planning department, JuMC

Description	Time frame	Proposal Detail
4. Enforcement of stringent regulations against dumping construction and demolition (C&D) waste to maintain the integrity of canals and water bodies	**Short Term**	**Proposal type**: Policy **Responsible agency:** Solid Waste department, JuMC
5. Climate Resilient Infrastructure: Implement measures to ensure the resilience of electricity, water, and waste network etc. including: ● Reinforcing power lines and substations against storms and floods ● Installing backup generators at key water facilities ● Modernizing waste treatment plants to withstand extreme weather events ● Regular maintenance and emergency preparedness drills Case Study: *New York City's Con Edison Storm Hardening Initiatives* After Hurricane Sandy, Con Edison invested in reinforcing its electrical infrastructure to withstand future storms. Measures included elevating substations, installing submersible equipment, and using smart grid technology to quickly isolate and address outages. Backup generators were also strategically placed to ensure continuous power supply during emergencies.	**Medium Term**	**Proposal type:** Plan/ Project **Responsible agency:** PGVCL, Water Works, Solid Waste & Sanitation department, JuMC
6. Undertake a comprehensive restructuring of its canals and water bodies to prevent flooding. This includes dredging and widening channels, desilting, development of percolation wells/tanks, plantation of tress with high water holding capacity	**Medium Term**	**Proposal type:** Project **Responsible agency:** Water Works, JuMC
7. Develop a robust storm water drainage network to manage heavy rainfall effectively. This involves constructing new drainage systems in flood-prone areas, upgrading existing drains, and incorporating green infrastructure such as rain gardens and bioswales	**Medium Term**	**Proposal type:** Project **Responsible agency:** Sanitation department, JuMC

Action: Mitigating flood impacts

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F1: Flood Management



MITIGATION & ADAPTATION

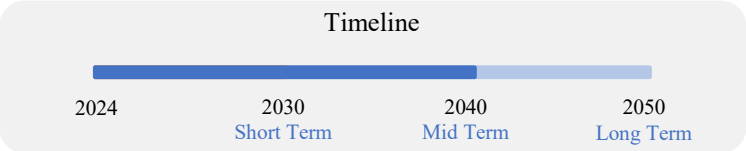
Recommendations

Description	Time frame	Proposal Detail
1. Conduct a comprehensive study to understand the impact of floods/change in precipitation patterns on agricultural produce to inform scientific actions such as: ● Introduction of flood-resistant crop varieties ● Development of Integrated Flood Management Plans that include creating floodplains and constructing water retention basins to manage excess rainfall ● Establishment of Early Warning Systems to alert farmers	**Short Term**	**Proposal type:** Research & Plan **Responsible agency:** Junagadh Agriculture University (JAU), Disaster Management department, JuMC & District Agriculture department
2. Establish a robust early warning systems at Bhawnath Case Study: *Advanced meteorological stations were installed in the Himalayan region in Uttarakhand* These stations, located in key areas like Kedarnath, use radar and automatic weather systems to collect real-time data on temperature, humidity, rainfall, and wind speed. The data is analysed using predictive models to forecast heavy rainfall and flood risks. Early warnings are disseminated through SMS, mobile apps, social media, radio, and TV. Since their implementation post-2013 Kedarnath floods, these systems have reduced casualties and property damage, significantly improving community resilience.	**Short Term**	**Proposal type:** Project **Responsible agency**: Disaster Management department, JuMC & District Agriculture department

Action: Reducing the impact of floods on vulnerable communities

Thrust Area F: Adopting climate-sensitive planning approaches

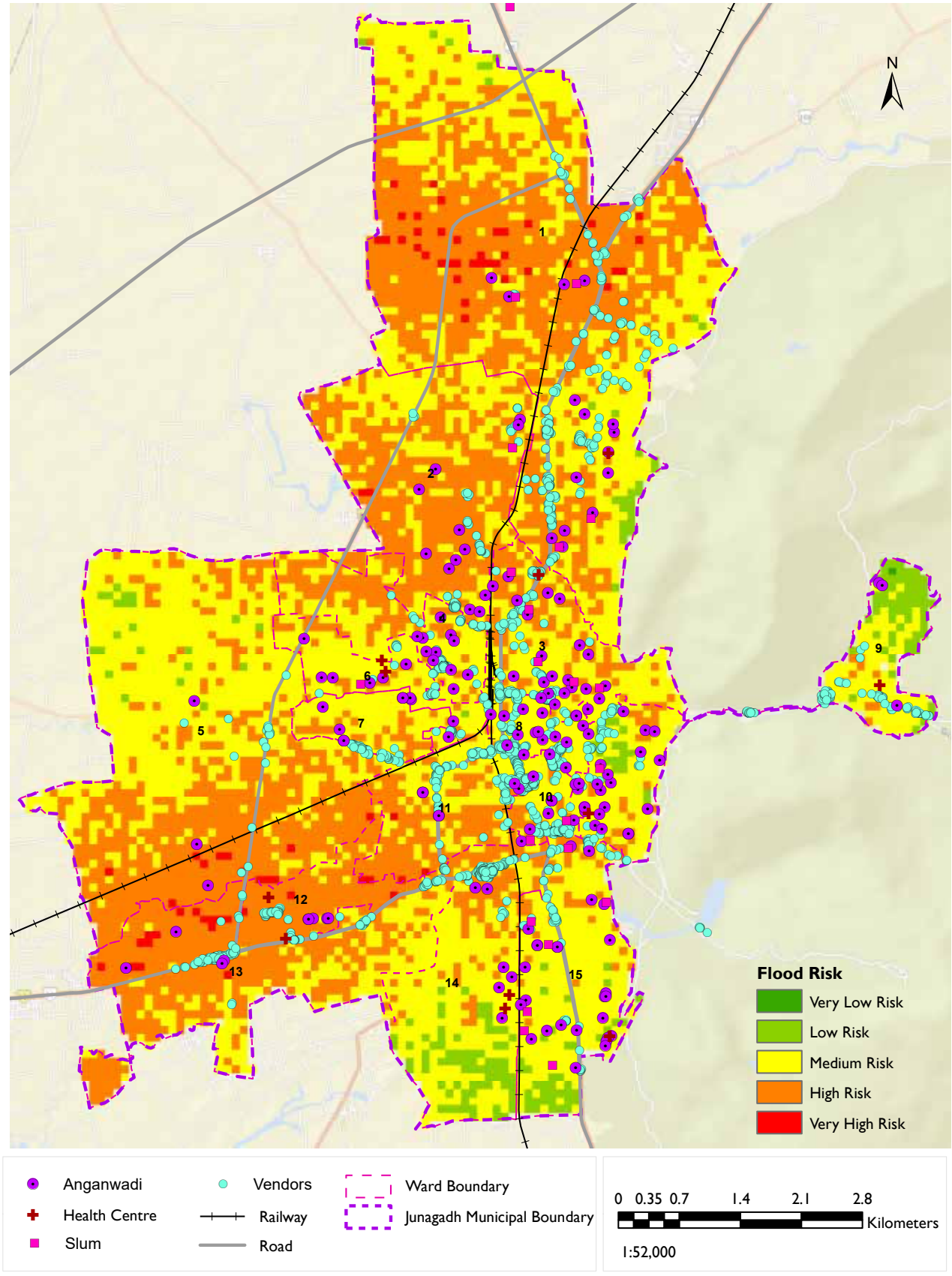
Objective F1: Flood Management



MITIGATION & ADAPTATION

Recommendations

Description	Time frame	Proposal Detail
1. Conduct a study on impact of flood on the health and economy of informal sector	**Short Term**	**Proposal type:** Research & Plan **Responsible agency:** Disaster Management department & NULM, JuMC
2. Develop and enhance flood-resilient infrastructure for informal sector workers. Construct elevated platforms and flood-proof structures in areas prone to flooding.	**Short Term**	**Proposal type:** Project **Responsible agency:** Disaster Management department & NULM, JuMC
3. Conduct regular drills and training sessions for street vendors on emergency response procedures.	**Short Term**	**Proposal type:** Capacity Building **Responsible agency:** Disaster Management department & NULM, JuMC
4. Promote micro-insurance schemes tailored for the informal sector to cover flood-related damages	**Short Term**	**Proposal type:** Policy **Responsible agency:** Disaster Management department & NULM, JuMC
5. Engineer anganwadi centres to withstand floods and enhance resilience. stock emergency supplies and create contingency plans to ensure continuity of care during and after floods.	**Medium Term**	**Proposal type:** Policy/ Project **Responsible agency:** Disaster Management department & ICDS, JuMC



Map 20: Social infrastructure and vulnerable communities

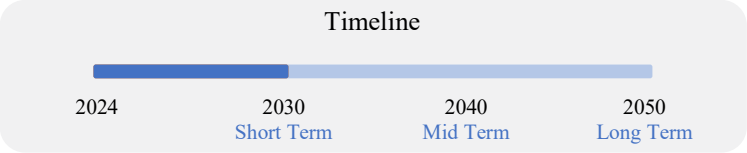
Objective F2: Reduction of Heatwave Impact

Junagadh faces significant vulnerability to heat waves, affecting anganwadi centers, slums, PHCs, UHCs, and GSRTC bus depot. With temperatures often exceeding 40°C, vulnerable populations and over 1,000 small-scale industries are at risk. Enhancing green cover, incorporating cool roofing and shade structures, and developing comprehensive heat action plans are essential to protect public health and ensure economic stability during peak summer seasons.

Action: Building level measures

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F2: Reduction of Heatwave Impact



MITIGATION & ADAPTATION

About

Junagadh city comprises 179 anganwadi centres, 29 slums, 2 Primary Health Centres (PHCs), and 7 Urban Health Centres (UHCs), along with other public buildings that are highly susceptible to the adverse effects of heat waves. Given the rising frequency and intensity of heat waves, there is an urgent need to enhance the thermal comfort of these structures to protect public health and improve living conditions.

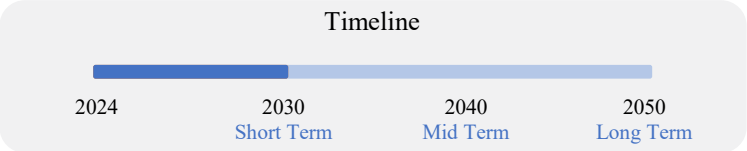
Recommendations

Description	Time frame	Proposal Detail
1. Identify and prioritize anganwadi centres based on their usage and occupancy, slums, public buildings, and health centres to assess the current roofing conditions and thermal comfort levels	**Short Term**	**Proposal type:** Project **Responsible agency:** Slum department & ICDS, JuMC
2. Implement cool roof on few selected buildings as pilot projects to demonstrate effectiveness. Monitor and document improvements in thermal comfort and energy savings.	**Short Term**	**Proposal type:** Project **Responsible agency:** Building, Slum department & ICDS JuMC
3. Seek technical support and funding from government programs, NGOs, and private sector partnerships dedicated to energy efficiency and community development	**Short Term**	**Proposal type:** **Responsible agency:** Building department, JuMC
4. Conduct workshops and informational sessions to educate local communities about the benefits of cool roof. Train local contractors and workers on proper installation techniques to ensure quality and longevity	**Short Term**	**Proposal type:** Capacity Building **Responsible agency:** Building department, JuMC

Action: Measures for Bus Depot

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F2: Reduction of Heatwave Impact



MITIGATION & ADAPTATION

About

Junagadh city has a GSRTC bus depot, with 1,060 intercity buses visiting the city on a daily basis. To address the severe impact of heat waves, the GSRTC, in collaboration with the Junagadh Municipal Corporation, can undertake substantial measures to enhance the functionality, comfort, and sustainability of the GSRTC bus depot, this can be a learning for GSRTC to implement the same to the other bus depots across the state. These improvements will significantly elevate the commuter experience and contribute to the city's resilience against heat waves.

Recommendations

Description	Time frame	Proposal Detail
1. Install solar panels on the rooftop of the GSRTC bus depot and design the installation to also serve as shading structures for parked buses	**Short Term**	**Proposal type:** Project **Responsible agency:** GRSTC, PGVCL
2. Redesign waiting areas using passive and active cooling techniques to improve thermal comfort and air quality. Install energy-efficient fans and misting systems for active cooling.	**Short Term**	**Proposal type:** Project **Responsible agency:** GSRTC
3. Adjust the orientation of buses at bus stops to minimize heat absorption and improve passenger comfort. Conduct a study to determine the optimal orientation for buses to reduce heat exposure. Reconfigure bus parking and stopping zones according to the findings.	**Short Term**	**Proposal type:** Research **Responsible agency:** GSRTC
4. Install water taps and heat refuge shelters (cooling pods) at bus stops to provide relief during extreme heat.	**Short Term**	**Proposal type:** Project **Responsible agency:** GSRTC

Action: Mitigating heatwaves

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F2: Reduction of Heatwave Impact

MITIGATION & ADAPTATION

About

With temperatures frequently soaring above 40°C during peak summer months in Junagadh, vulnerable populations, including the elderly, children, street vendors, labourers, slum dwellers and those with pre-existing health conditions, face heightened risks of heat-related illnesses. The impact is compounded by factors like inadequate access to cooling facilities, densely built urban areas amplifying heat retention, and limited green spaces for natural cooling. Implementing measures such as enhancing green cover, improving urban planning to incorporate cool roofing and shade structures, and developing comprehensive heat action plans are essential steps towards mitigating these impacts, promoting community well-being, and building a more climate-resilient Junagadh.

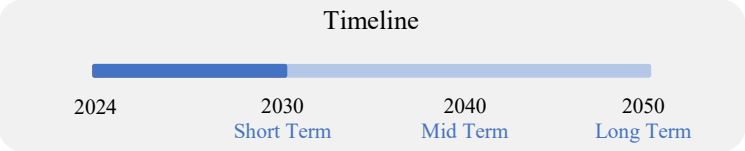
Recommendations

Description	Time frame	Proposal Detail
1. Conduct a detailed mapping of heat pockets within Junagadh to identify areas most affected by extreme heat. Formulate a comprehensive Heat Action Plan (HAP) to mitigate the impact of heat waves and protect vulnerable populations.	**Short Term**	**Proposal type:** Research & Plan **Responsible agency:** Disaster Management department, JuMC
2. Application of thermal insulation coatings on bus roofs and monitor the temperature reduction and thermal comfort improvement inside the coated buses.	**Short Term**	**Proposal type:** Project **Responsible agency:** GSRTC
3. Conduct a thorough inspection of buses and bus stops to catalog all metal parts that contribute to heat retention. Prioritize components based on their impact on thermal comfort, such as seats, handrails, and shelter structures. Replace metal components with materials of low thermal conductivity, high durability, and weather resistance	**Short Term**	**Proposal type:** Project **Responsible agency:** GSRTC
4. Identify suitable locations for afforestation along river edges, roundabouts, and roads. Select native and drought-resistant tree species that are well-adapted to the local climate.	**Short Term**	**Proposal type:** Project **Responsible agency:** Garden & Town Planning department, JuMC

Action: Reducing the impact of heatwaves on vulnerable communities

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F2: Reduction of Heatwave Impact



MITIGATION & ADAPTATION

About

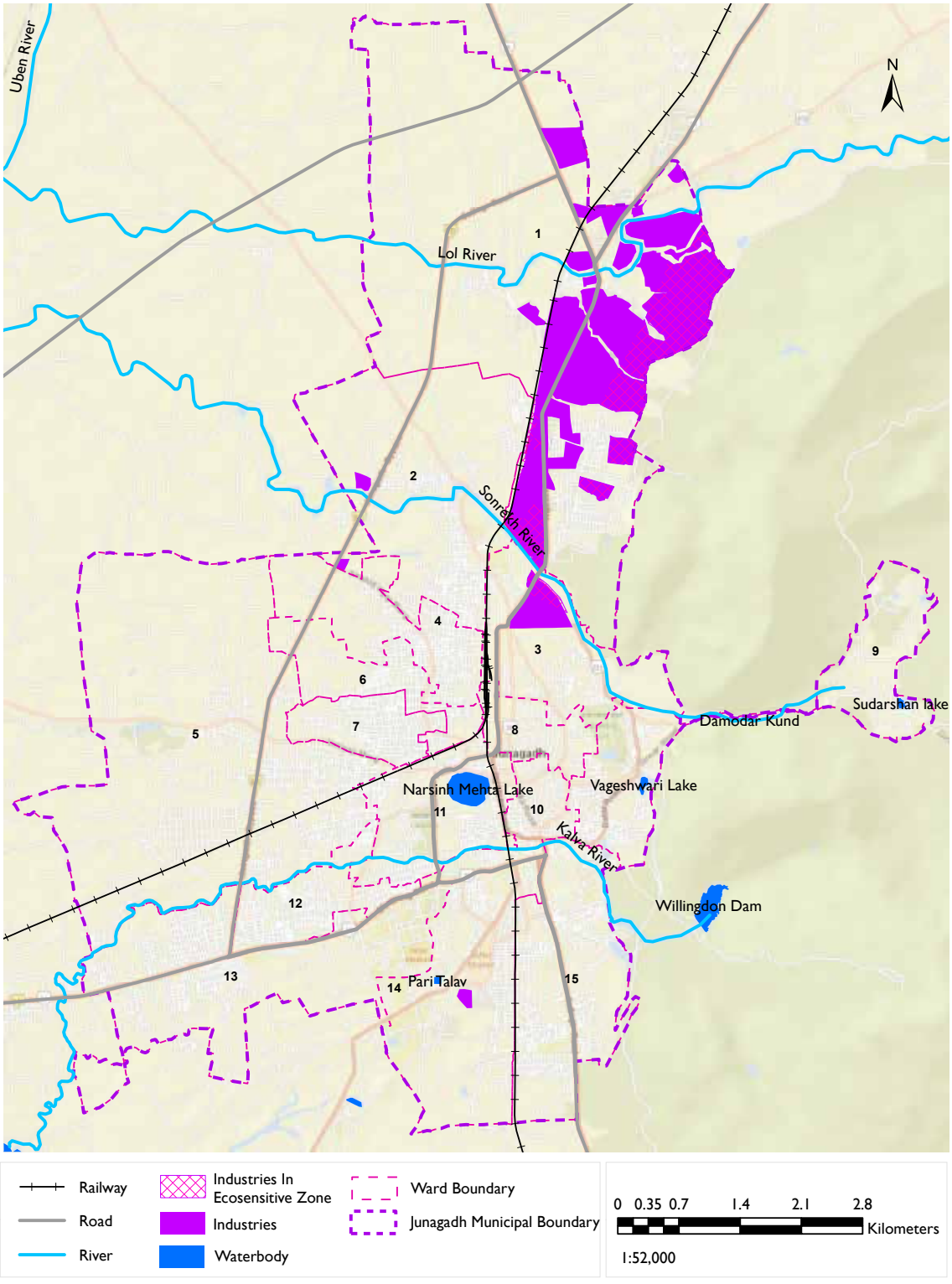
Junagadh, a city with over 1000+ small scale industries, enterprises, and vending zones, experiences significant disruptions during peak summer seasons due to heatwaves. These heatwaves not only affect the health and productivity of workers but also hinder the operational efficiency of businesses. Providing thermal comfort in these areas is crucial to ensure the well-being of workers and the smooth functioning of economic activities.

Recommendations

Description	Time frame	Proposal Detail
1. Implement health insurance coverage specifically for informal workers vulnerable to heatwaves	**Short Term**	**Proposal type:** Policy **Responsible agency:** Health department, JuMC
2. Develop and implement a SOP to protect construction workers during heatwaves including: ● Formulate guidelines for work hours, rest breaks, and hydration protocols during hot weather conditions ● Provide mandatory training sessions for construction workers and supervisors on recognizing heat-related illnesses and emergency response procedures ● Ensure adequate provision of shaded rest areas, cool drinking water, and access to medical assistance on construction sites	**Short Term**	**Proposal type:** Plan, Capacity Building **Responsible agency:** Disaster Management & Health department, JuMC
3. Identify high-traffic vending areas prone to heat exposure and lacking shade. Install sturdy shade structures and seating areas equipped with water dispensers.	**Short Term**	**Proposal type:** Project **Responsible agency:** NULM, JuMC
4. Apply reflective and heat-resistant coatings to tin roof home shelters of workers that reduce heat absorption and improve indoor comfort	**Short Term**	**Proposal type:** Capacity Building **Responsible agency:** JuMC

Objective F3: Biodiversity Conservation

Junagadh is renowned for its rich biodiversity, encompassing a variety of flora and fauna within its diverse ecosystems. The region's unique combination of forests, grasslands, and wetlands supports numerous endangered and endemic species, contributing significantly to its ecological importance. Conservation measures are crucial to preserving this biodiversity. Strategies such as habitat restoration, anti-poaching initiatives, and community-based conservation programs are essential. Additionally, promoting sustainable agricultural practices and implementing stringent land-use regulations can mitigate human-wildlife conflicts and habitat degradation. By integrating these measures, Junagadh can safeguard its natural heritage while promoting sustainable development.

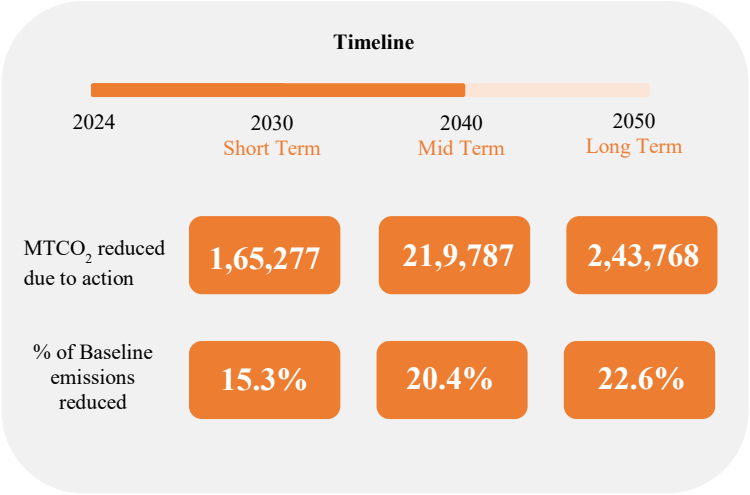


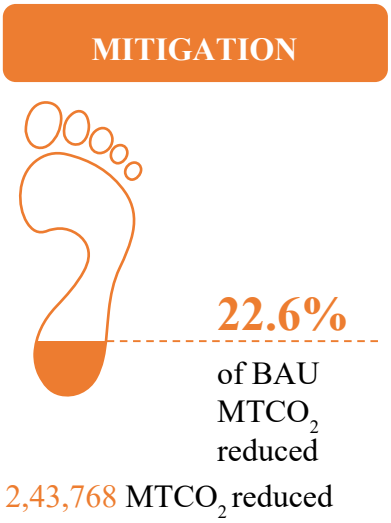
Map 19: Industrial areas in eco-sensitive zone

Action: Afforestation initiatives

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F3: Biodiversity Conservation





About

Junagadh has established a Biodiversity Management Committee (BMC). However, the city's biodiversity initiatives have been inadequate. Given that the city's industrial zone is situated within an eco-sensitive area, it is imperative to take comprehensive actions towards biodiversity management and conservation.

Recommendations

Description	Time frame	Proposal Detail
1. Conduct an extensive tree census, enforcing the mandatory planting of indigenous species, and encouraging the planting of native species in neighbourhoods	**Short Term**	**Proposal type:** Project **Responsible agency:** BMC, Garden department, JuMC & State Forest department
2. Preparation of Public Biodiversity Register (PBR) and Local Biodiversity Strategy and Action Plan (LBSAP)	**Short Term**	**Proposal type:** Planning **Responsible agency:** BMC, JuMC
3. Organize awareness campaigns and host tree-planting events and encourage community participation	**Short Term**	**Proposal type:** IEC activities **Responsible agency:** BMC & Garden department, JuMC

Description	Time frame	Proposal Detail
4. As per population in 2050, establish a minimum requirement of two trees per person within Junagadh city to ensure adequate public green cover and enhance the urban environment	**Medium Term**	**Proposal type:** Planning **Responsible agency:** BMC, Garden department, JuMC & State Forest department
5. Effective management of wildlife corridors including: Phase 1: ● Identify and map potential wildlife corridors connecting fragmented habitats ● Conduct a comprehensive survey to identify existing wildlife habitats and movement patterns Phase 2: ● Consider construction of wildlife passages such as underpasses, overpasses, and culverts at critical points to reduce human wildlife conflict Phase 3: ● Establish buffer zones with reduced human activity around wildlife corridors Phase 4: ● Establish a robust monitoring system to track the effectiveness of wildlife corridors	**Short Term**	**Proposal type:** Project **Responsible agency:** BMC, Garden department, JuMC & State Forest department

Action: Regulations for new construction

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F3: Biodiversity Conservation

ADAPTATION

About

Junagadh city in Gujarat has reported multiple incidents of human-wildlife conflicts in recent years. This increase in conflicts is attributed to habitat fragmentation and urban expansion encroaching on natural habitats. In response, the city should implement measures to mitigate these conflicts and promote harmonious coexistence between humans and wildlife.

Recommendations

Description	Time frame	Proposal Detail
For every new construction project, a green factor of 30% must be incorporated. This entails allocating 30% of the total area for green spaces such as gardens, parks, and vegetation	**Short Term**	**Proposal type:** Planning **Responsible agency:** Town Planning department, JuMC

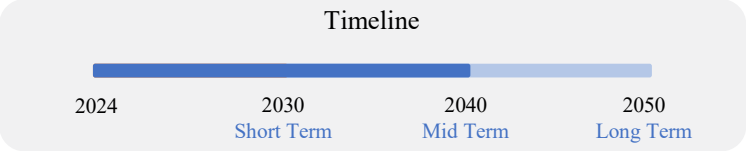
Objective F4: Air Quality Management

India's National Clean Air Programme (NCAP), launched in 2019, aims to reduce air pollution by 20-30% by 2024 compared to 2017 levels. The program targets 131 cities with poor air quality, prioritizing reductions in Particulate Matter (PM10 and PM2.5). In Junagadh city, PM10 values exceed the threshold level, indicating significant air quality issues. Despite this, Junagadh is classified as a non-attainment city, meaning comprehensive actions and studies have not yet been conducted. To address this gap, upcoming measures propose essential studies to assess the city's air quality, the establishment of monitoring systems, and the implementation of targeted improvement actions. These initiatives aim to promote cleaner air in Junagadh, aligning with the broader objectives of the NCAP and contributing to a healthier environment for its residents.

Action: Air quality monitoring

Thrust Area F: Adopting climate-sensitive planning approaches

Objective F4: Air Quality Management



MITIGATION & ADAPTATION

About

Junagadh city currently lacks sufficient number of air quality monitoring stations, resulting in inadequate and inaccurate air quality monitoring. Despite these limitations, available data indicates that PM10 levels consistently exceed the threshold limits. To address this issue, it is imperative for Junagadh to establish additional air quality monitoring stations across strategic locations in the city. Furthermore, conducting source apportionment studies will be essential to identify the primary sources of emissions and develop targeted strategies for their reduction.

Recommendations

Description	Time frame	Proposal Detail
1. Identify strategic locations for the placement of monitoring stations and sensors to select sites that represent various pollution sources, including industrial zones, residential areas, and traffic intersections. Ensure coverage in both high-risk areas (e.g., near factories) and background locations to compare pollution levels.	**Short Term**	**Proposal type:** Project **Responsible agency:** GPCB
2. Conduct a Source Apportionment Study to monitor emissions in Junagadh: Phase 1: Identify and select strategic locations for air quality monitoring. ● Conduct a preliminary survey to identify areas with significant industrial activities and potential pollution hotspots. Ensure a balanced distribution of monitoring stations to capture a comprehensive data set. Phase 2: ● Monitor air quality over a representative period to account for temporal variations ● Use statistical and chemical analysis methods to identify the contribution of different sources to the overall pollution levels Phase 3: ● Formulate strategies to reduce industrial emissions based on study findings. ● Recommend specific control measures for identified major sources of pollution. ● Propose technological upgrades, process modifications, and best practices to minimize emissions. ● Develop regulatory guidelines and policies to enforce emission reduction measures.	**Medium Term**	**Proposal type:** Policy/ Project **Responsible agency:** GPCB

ANNEXURE I:

Emission Factors to Estimate Emissions from Various Sources

The emission factors used to estimate the carbon emissions from various sources are listed in Table 1. The Global Warming Potential (GWP) of gases is listed in Table 2. 2.

Table 1 : Emission factors for India 2021-22

S. No.	Electricity/Fuel	Emission factor	Unit	Emission factor	Unit
1	Electricity	0.815	tCO2/MWh	815	tCO2/kWh
2	Electricity	0.715	tCO2/MWh	715	tCO2/kWh
3	(including RE)	2.20307	tCO2/kL	2203.07	tCO2/L
4	Petrol	2.62694	tCO2/kL	2626.94	tCO2/L
5	Diesel	0.48066	tCO2/kL	480.66	tCO2/L
6	CNG	1.51906	tCO2/kL	1519.06	tCO2/L
7	LPG	0.48066	tCO2/kL	480.66	tCO2/L
Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf					

Table 2 *Global Warming Potential of Gases*

S. No.	Name	Formula	GWP
1	Carbon Dioxide	CO2	1
2	Methane	CH4	28
3	Nitrous Oxide	N2O	265
4	Sulphur hexafluoride	SF6	23,500
5	Carbon tetrafluoride	CF4	6,630
6	Hexafluoroethane	C2F6	11,100
7	HFC-23	CHF3	12,400
8	HFC-134a	-	1,300
Source: IPCC 5th Assessment Report			

Formulas and Calculations

For most of the emissions sources, GHG emissions are estimated by multiplying activity data by an emission factor associated with the activity being measured as mentioned in Eq. Activity data is a quantitative measure of a level of activity that results in GHG emissions taking place during a given period of time. An emission factor is a measure of the mass of GHG emissions relative to a unit of activity

$$\text{Emissions} = \text{Activity data} \times \text{Emission Factor} \quad (1)$$

Emissions from consumption of grid-supplied energy within the city boundary

For estimating CO2 emissions from consumption of grid-supplied energy the data on kilowatt-hours (kWh) of electricity used is multiplied by the emission factor (tCO2/kWh) for electricity, which will depend on the technology and type of fuel used to generate the electricity. The emission factors considered for electricity are shown in Table 1.

Emissions from fuel combustion within the city boundary

For estimating CO2 emissions from fuel combustion, the data on Litres (L) of type of fuel sales (volume of fuel purchased within the city boundary) is multiplied by the respective emission factor (tCO2/L) for Petrol, Diesel, CNG, LPG and PNG. The emission factors considered for all fuel type are mentioned in Table 1.

Emissions from in-boundary waste treatment

The IPCC methodology for estimating CH4 emissions from SWDS is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon, DOC) in waste decays slowly throughout a few decades, during which CH4 and CO2 are formed. If conditions are constant, the rate of CH4 production depends solely on the amount of carbon remaining in the waste. As a result, emissions of CH4 from waste deposited in a disposal site are highest in the first few years after deposition, then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

The equations for estimating the CH4 generation are given below. As the mathematics are the same for estimating the CH4 emissions from all waste categories/waste types/materials, no indexing referring to the different categories/waste materials/types is used in the equations below.

First order of decay (FOD) model

- Methane Emissions

The CH_4 emissions from solid waste disposal for a single year can be estimated using Equation 2. CH4 is generated as a result of degradation of organic material under anaerobic conditions. Part of the CH_4 generated is oxidised in the cover of the SWDS, or can be recovered for energy or flaring. The CH_4 actually emitted from the SWDS will hence be smaller than the amount generated.

$$CH_4\ Emissions = \left[\sum_x CH_4\ generated_{x,T} - R_T\right] X\ (1 - OX_T) \quad (2)$$

Where:
CH_4 Emissions = CH_4 emitted in year T, Gg
T = inventory year
x = waste category or type/material
R_T = recovered CH4 in year T, Gg
OX_T = oxidation factor in year T, (fraction)

The CH_4 recovered must be subtracted from the amount CH4 generated. Only the fraction of CH4 that is not recovered will be subject to oxidation in the SWDS cover layer.

- Methane Generation

The CH_4 potential that is generated throughout the years can be estimated on the basis of the amounts and composition of the waste disposed into SWDS and the waste management practices at the disposal sites. The basis for the calculation is the amount of Decomposable Degradable Organic Carbon (DDOCm) as defined in Equation 3. DDOCm is the part of the organic carbon that will degrade under the anaerobic conditions in SWDS. It is used in the equations and spreadsheet models as DDOCm. The index m is used for mass.

$$DDOC_m = W\ X\ DOC\ X\ DOC_f\ X\ MCF \quad (3)$$

Where:
DDOCm = mass of decomposable DOC deposited, Gg
W = mass of waste deposited, Gg
DOC = degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste
DOCf = fraction of DOC that can decompose (fraction)
MCF = CH4 correction factor for aerobic decomposition in the year of deposition (fraction)

CH_4 generation potential (Lo) is defined as the product of DDOCm, the CH_4 concentration in the gas (F) and the molecular weight ratio of CH4 and C (16/12) as mentioned in Equation 4.

$$L_0 = DDOC_m\ X\ F\ X\ \frac{16}{12} \quad (4)$$

Where:
Lo = CH4 generation potential, Gg CH4
DDOCm = mass of decomposable DOC, Gg
F fraction of CH4 in generated landfill gas (volume fraction)
16/12 molecular weight ratio CH4/C (ratio)

Using DDOCm (DDOCm accumulated in the SWDS) from the spreadsheets, the above equation can be used to calculate the total CH4 generation potential of the waste remaining in the SWDS.

The IPCC Waste Model allows the user to change the default delay of six months to a different value. It is good practice to choose a delay time of between zero and six months. Values outside this range should be supported by evidence.

Emissions from in-boundary wastewater treatment

"Wastewater can be a source of methane (CH4) when treated or disposed of anaerobically. It can also be a source of nitrous oxide (N2O) emissions. Carbon dioxide (CO2) emissions from wastewater are not considered in the IPCC Guidelines because these are of biogenic origin and should not be included in national total emissions. Wastewater originates from a variety of domestic, commercial and industrial sources and may be treated on-site (uncollected), sewer to a centralized plant (collected) or disposed untreated nearby or via an outfall. Domestic wastewater is defined as wastewater from household water use, while industrial wastewater is from industrial practices only."

Source 2006 IPCC Guidelines.

- CH4 emissions from domestic wastewater

$$CH_4\ Emissions = \left[\sum \left(U_i\ X\ T_{i\ j}\ X\ EF_j\right)\right](TOW - S) - R \quad (8)$$

Where:

CH_4 Emissions = CH_4 emissions in inventory year, kg CH_4/yr

TOW = total organics in wastewater in inventory year, kg BOD/yr

S = organic component removed as sludge in inventory year, kg BOD/yr

U_i = fraction of population in income group i in inventory year

$T_{i,j}$ = degree of utilisation of treatment/discharge pathway or system, j, for each income group fraction i in inventory year

I = income group: rural, urban high income and urban low income

J = each treatment/discharge pathway or system

EF_j = emission factor, kg CH4 / kg BOD

R = amount of CH4 recovered in inventory year, kg CH4/yr

- CH4 emissions factor for each domestic wastewater treatment/discharge pathway or system

The emission factor for a wastewater treatment and discharge pathway and the system is a function of the maximum CH4 producing potential (Bo) and the methane correction factor (MCF) for the wastewater treatment and discharge system, as shown in Equation 9. The Bo is the maximum amount of CH4 that can be produced from a given quantity of organics (as expressed in BOD or COD) in the wastewater. The MCF indicates the extent to which the CH4 producing capacity (Bo) is realised in each type of treatment and discharge pathway and system. Thus, it is an indication of the degree to which the system is anaerobic.

$$EF_j = B_o\ X\ MCF_j \quad (9)$$

Where:

EFj = Emission factor, kg CH4/kg BOD

j = Each treatment/discharge pathway or system

Bo = Maximum CH4 producing capacity, kg CH4/kg BOD

MCFj = methane correction factor (fraction)

- Totally organically degradable material in domestic wastewater

The activity data for this source category is the total amount of organically degradable material in wastewater (TOW). This parameter is a function of the human population and BOD generation per person. It is expressed in terms of biochemical oxygen demand (kg BOD/year). The factor I values in Equation 10 expresses the BOD from industries and establishments (e.g., restaurants, butchers or grocery stores) that are co-discharged with domestic wastewater.

$$TOW = P\ X\ BOD\ X\ 0.001\ X\ I\ X 365 \quad (10)$$

Where:
TOW = total organics in wastewater in inventory year, kg BOD/yr
P = country population in inventory year, (person)
BOD = country-specific per capita BOD in inventory year, g/person/day
0.001 = conversion from grams BOD to kg BOD
I = correction factor for additional industrial BOD discharged into sewers (for collected the default is 1.25, for uncollected the default is 1.00)

Carbon Sequestration from Trees and Forests

Carbon sequestration in plant biomass is determined using the above ground biomass (AGB) and below ground biomass (BGB) method. To calculate this, the girth at breast height (GBH) and height of the trees were obtained from scientific literature. The AGB and BGB were then calculated using following formulas:

Basal area (m^2) = $(GBH)^2/(4\pi)$
Bio-volume (m^3) = Basal area x Height of the tree
AGB (kg) = Bio-volume x Wood density (kg/m^3)
BGB (kg) = AGB x 0.26 (where 0.26 = Root to Shoot ratio)
Total Biomass (TB) in kg/tree = AGB + BGB
Total Carbon Sequestered (TC) = (in kg/tree) TB/2

The wood density of the individual tree species is considered from the literature. The CO2 equivalent was calculated using the following formula: :

$$CO_{2\text{-eq.}} = (TC \times 44)/12$$

Where, 44 and 12 are the molecular and atomic weight of CO2 and C, respectively.

Carbon sequestration is influenced by both the species and the girth at breast height (GBH) of trees. As plants age, their biomass accumulation increases until they reach death. It is important to note that both above and below ground biomass of plants play a significant role in sequestering terrestrial carbon.

ANNEXURE II: Flood Risk Assessment Methodology

In the study, the Analytical Hierarchy Process (AHP) is employed as a key method in the multi-criteria decision-making (MCDM) framework to determine the relative importance of various flood-controlling factors. This approach facilitates the assignment of weights to each factor, aiding in the identification and mapping of flood-prone areas. Weights were assigned based on the local physical characteristics of the study area and insights from previous research. Each factor received a value between 1 and 9, representing its relative importance, with 1 indicating equal importance and 9 indicating extreme importance, allowing for the construction of a pairwise comparison matrix. Following this, a normalized pairwise comparison matrix was generated to compute the weight of each factor. To ensure the validity of the comparisons, a consistency check was conducted using the equations provided. The Consistency Index (CI) was calculated as follows:

$$\mathbf{CI} = (\lambda_{max} - n) / (n-1)$$

where CI is the consistency index, n is the number of factors compared, and λ_{max} is the highest eigenvalue of the matrix. The maximum eigenvalue was then determined. The Consistency Ratio (CR) was calculated using:

$$\mathbf{CR} = CI / RI$$

where CR is the consistency ratio, CI is the consistency index, and RI is the random index, which varies based on the number of factors. A CR value below 0.10 indicates acceptable consistency; values of 0.10 or above suggest inadequate consistency, necessitating a repeat of the comparison process until an acceptable CR is achieved. After reclassifying each flood-controlling factor to a common scale of 1 (very low) to 5 (very high) using GIS software and applying the AHP-derived weights, the spatial layers were integrated using the weighted overlay technique. The flood susceptibility map of the study area was generated using the following equation:

$$\mathbf{FS} = \sum_{i=0}^{n} x_i * w_i$$

where FS represents flood susceptibility, n is the number of decision criteria, x_i is the normalized criterion, and w_i is the corresponding weight. The values of the raster layers were multiplied by their AHP-derived weights, and the results were summed to create the final flood risk assessment map.

Data Collection from Departments, NGOs and Existing Reports

Data	Departments
Climate	Junagadh Agricultural University
Solid Waste	Junagadh Municipal Corporation (JuMC)
Electricity	PGVCL Electrical department, JuMC
Water	Water Works Department, JuMC
Wastewater	Junagadh Municipal Corporation (JuMC)
Transport	Regional Transport Office (RTO)
Petrol, Diesel, CNG, other fuels	District Supply Office Indian Oil Corporation Ltd. (IOCL) Hindustan Petroleum Corporation Limited (HPCL) Bharat Petroleum Corporation Limited (BPCL) Torrent Gas
Green cover/Land cover	Garden Department, JuMC Junagadh Agricultural University
Disaster	District Disaster Management Department City Disaster Management Department
Air Quality	Gujarat Pollution Control Board (GPCB) Junagadh Agricultural University
Heritage & Tourism	District Pravasan Vibhag Town Planning Department, JuMC Savani Heritage Conservation Pvt. Ltd.
Biodiversity	Junagadh Municipal Corporation (JuMC) Gaushalas District Animal Husbandry Department

ANNEXURE III: Stakeholder Consultation

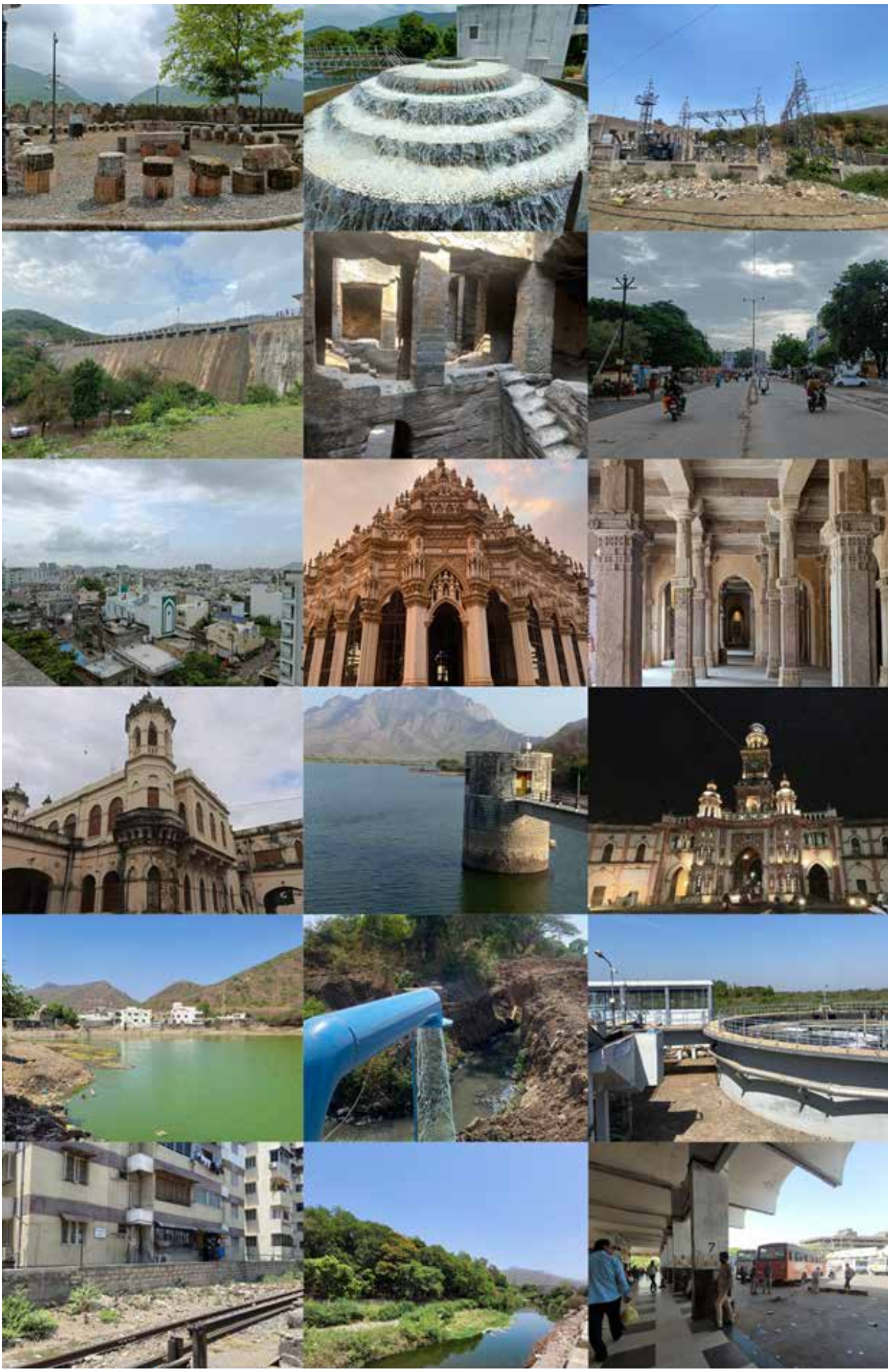
City Official Consulted

S. No.	Name	Designation	Department
1	Vatsala S. Dave	Programme Officer	ICDS, JuMC
2	Nidhi Mer	Account Officer	JuMC
3	Mudrika Parmar	Programme Associate	ICDS, JuMC
4	Dr. Shailesh R. Chudasama	MOH	Urban Health, JuMC
5	Rajesh B. Trivedi	Executive Engineer	JuMC
6	Hajabhai K. Chudasama	Electrical Engineer	JuMC
7	Chavda A.P.	Executive Engineer	JuMC
8	Rajesh L. Pasmas	Garden	JuMC
9	Jignesh M. Ambusanu	Jr. Engineer	JuMC
10	Gautum R. Bambhaeiya	Assistant Engineer	JuMC
11	Parth		Collector Office
12	Jani Dipak Kumar N.	Chief Fire Officer	JuMC
13	Jiten N. Somaiya	SI	ITI
14	K.S. Trivedi	DPO-GSDMA	Collector Office
15	Bhatu Sagarkumar J.	AIMV	RTO
16	Solanki Uttamkumar	ARTO	RTO
17	Shrimali Ramesh P.	Div. Controller	GSRTC
18	S.B. Parmar	Regional Officer	GPCB
19	H.S. Baraiya	Sci. Officer	GPCB
20	Jaykishun Naimiji	KPMG	JuMC
21	Darshil M. Vora	KPMG	JuMC
22	Himendra Singh	KPMG	JuMC
23	Bharat P. Myatra	Deputy Engineer	PGVCL
24	V.L. Bhimani	EEJND	PGVCL
25	Dr. Pandey Swayam Prakash		JuMC Health Department
26	M.D. Ganatra	EE Rural-2	PGVCL
27	J.K. Malvi	Deputy Engineer	PGVCL
28	I.G. Jhala		Collectorate
29	D.N. Gerdhesariyer	Jr. Clerk	
30	Divyesh Bhimani	Assistant Manager	Torrent Gas
31	Balbhadrasinh Jadeja	Superintendent	Prohibition & Excise
32	Bhuvesh D. Bhus	Dowry Prohibition Officer	Women & Child Office
33	Kalpesh Tolia	Secretary	JuMC
34	S.N.J. Trufik	Police Sub Inspector	Police Department
35	Y.S. Divraniya	ASWO (PO)	DD (Scehduled caste welfare)
36	Nikul P. Desai	Assistant Geologist	Geology & Mining
37	Sanket S. Gajera	Agriculture Officer	Department of Agriculture
38	Prakash Kachhela	Research Officer	District Planning Office
39	Gaurang dave		
40	V.L. Chavda		
41	Pooja Bavda	Dy. MC.	JuMC

NGOs Consulted

S. No.	Name	Designation	Department
1	Darshun M. Sinojiya	Consultant Engineer	Shilanyas Architects
2	Niraj C. Bhut	Developer	Ananta Developers
3	Nirav R. K.	Developer	Ananta Developers
4	Sushil R. T.		PR
5	Jaydish M. Maru	Petrol pump owner	
6	Mayank P. S.	Developer	Shivam Developers
7	Vedant Dhaduk	Civil Engineer	Nimathar Construction
8	Sanjay K. Koradia	MLA Junagadh	Junagadh Vidhan
9	Divyesh Bhimani	Assistant Manager	Torrent Gas
10	Pranav Vayhashiya	Founder	VNC-NGO
11	Mayur Patel	Bus	
12	Ririt K.M.	Developers	Builder
13	Suresh D.	Developers	Builder
14	Chandrakant G. Bhut	Developers	Builder
15	Fashion Shoes	Member	Shops Association
16	Piyush Madhvani		
17	B. Fayaz		
18	Zakhru Sahil		
19	Bharat B.		
20	Sanjay Patel		
21	Rohit Patel		

ANNEXURE III: Stakeholder Consultation



Notes:

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