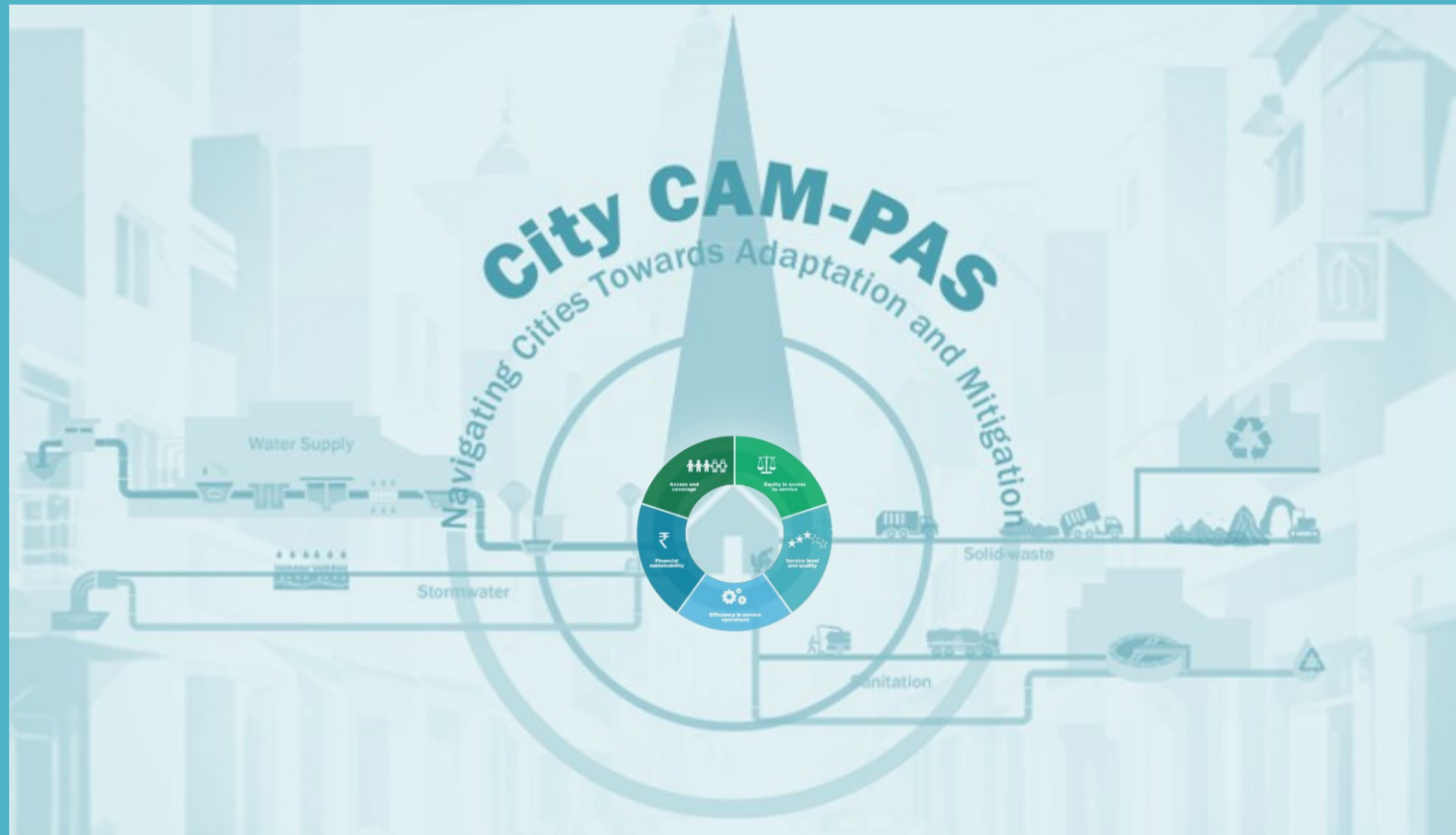# Developing a Climate Indicators Framework for Urban-Integration with Performance Assessment System (PAS)

Project by:

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PUI22052

Guided by:

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Aim

- Developing a Climate Indicators Framework for Urban- Integration with Performance Assessment Systems (PAS)
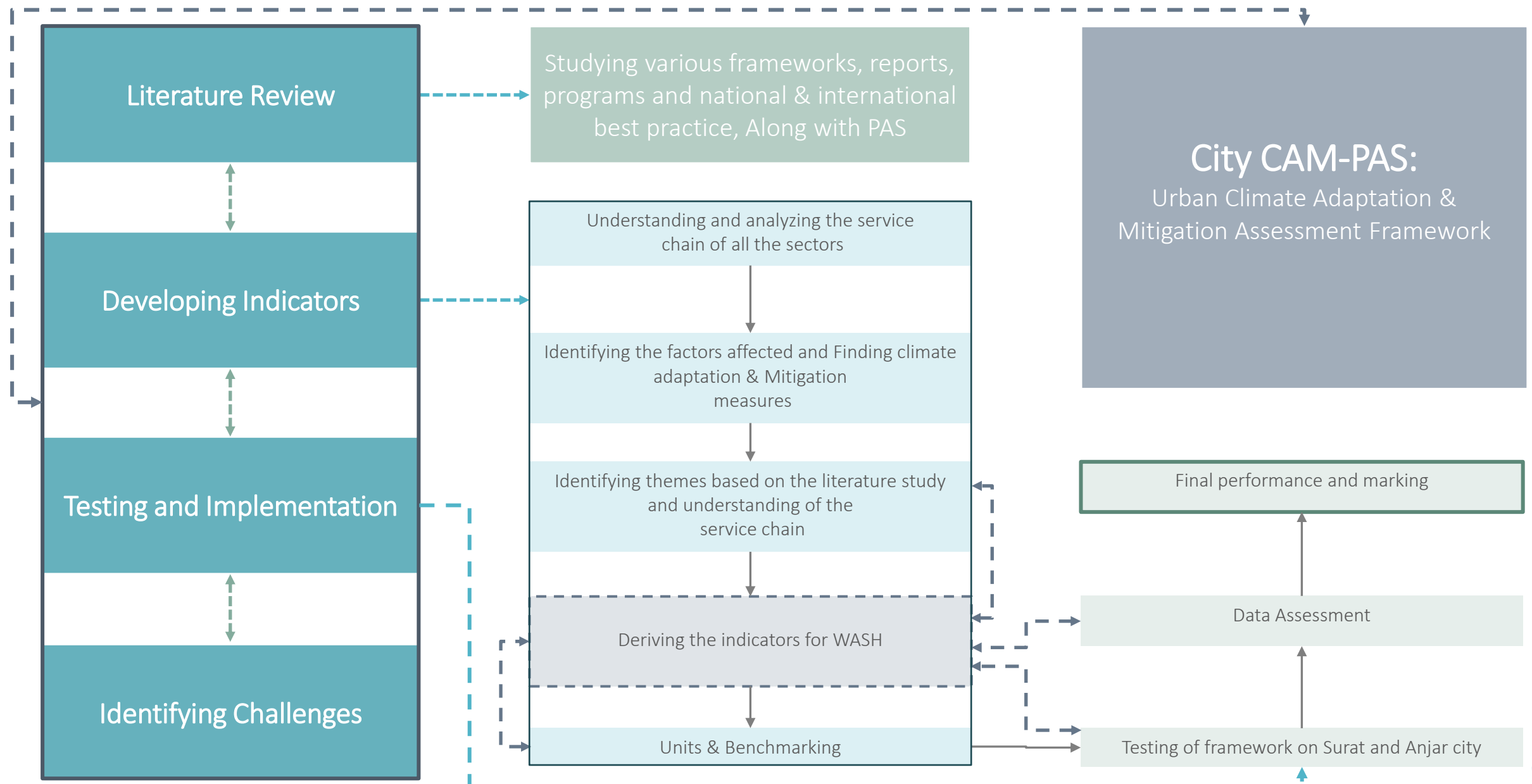
Objective

- Conducting a literature review consisting of various national and international Frameworks, Reports, Case studies and various benchmarking methodologies.

- Drafting the indicators-based literature study and Integration with Performance Assessment Systems (PAS) to ensure practical applicability.

- Identify data limitations and challenges and ways to overcome them.

Scope & Limitations

- The research will focus solely on WASH services in the city.

- The framework developed will be broadly applicable to any urban area.

- The study will be for Urban areas only.

- Study will focus on climate adaptation and mitigation. The assessment framework will help to assess the status of climate adaptation of Indian cities.

- We are not detailing the typologies of the cities in terms of shocks faced by the Indian cities.

Methodology

Literature Review → Studying various frameworks, reports, programs and national & international best practice, Along with PAS

Developing Indicators

Testing and Implementation

Identifying Challenges

City CAM-PAS:
Urban Climate Adaptation & Mitigation Assessment Framework

Understanding and analyzing the service chain of all the sectors

↓

Identifying the factors affected and Finding climate adaptation & Mitigation measures

↓

Identifying themes based on the literature study and understanding of the service chain

↓

Deriving the indicators for WASH

↓

Units & Benchmarking

Final performance and marking

Data Assessment

Testing of framework on Surat and Anjar city

3

GHG Emission in Waste Sector

- ■ Domestic Wastewater
- ■ Industrial Wastewater
- ■ Solid Waste Disposal

11%

33%

56%

GHG Emissions by Sectors in India

- ● Energy
- ● Industry
- ● Agriculture
- ● Waste

7%

6%

4%

83%
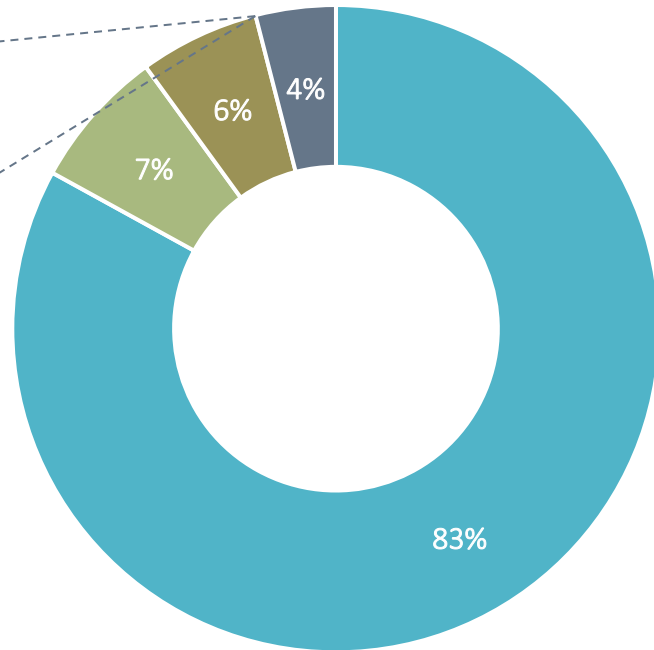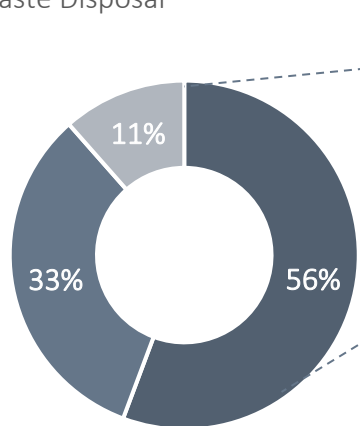
The Waste sector caters to 4% of total GHG Emissions

The numbers are small, but it is the most affected sector due to climate change

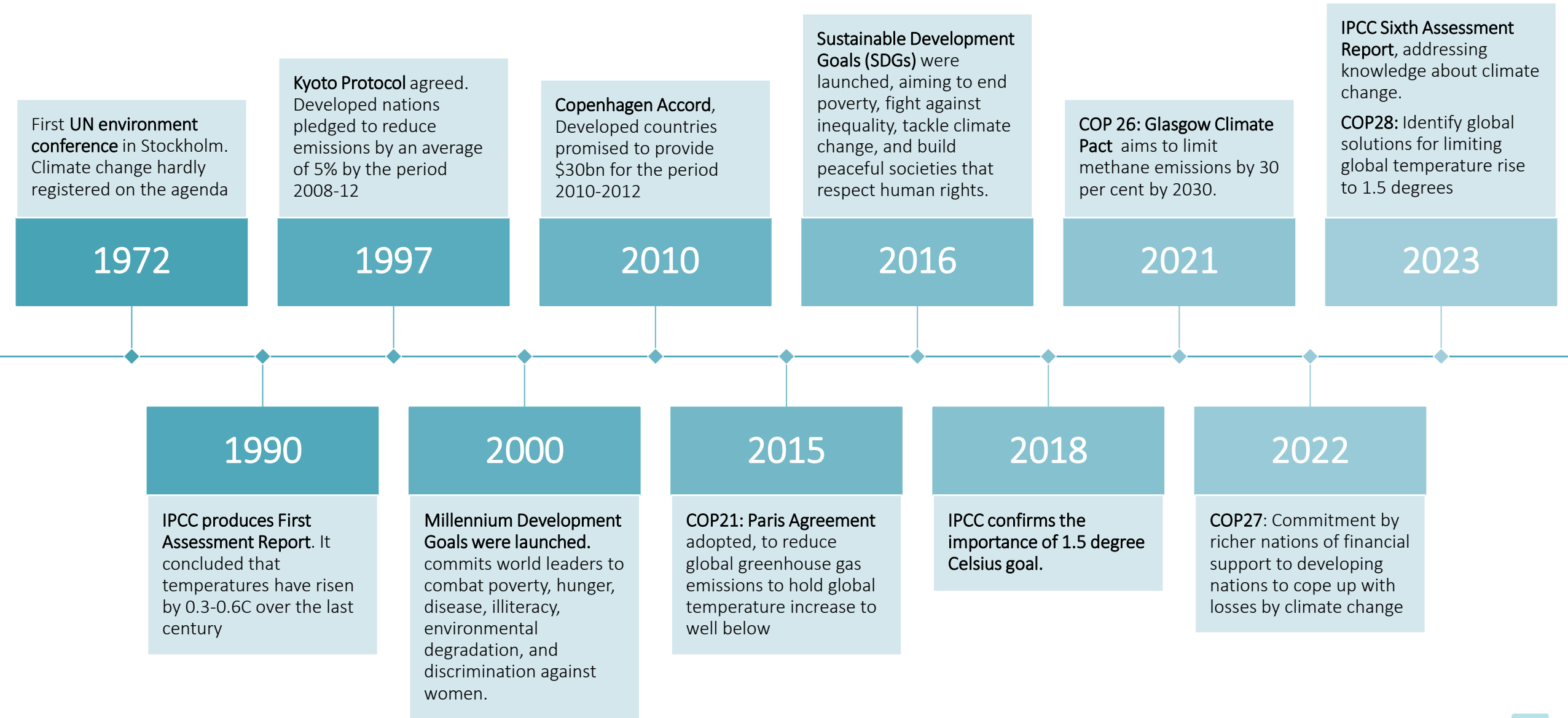|			
CO2	92%		8%
N2O	10%	60%	21%
CH4	13%	3%	64%	20%
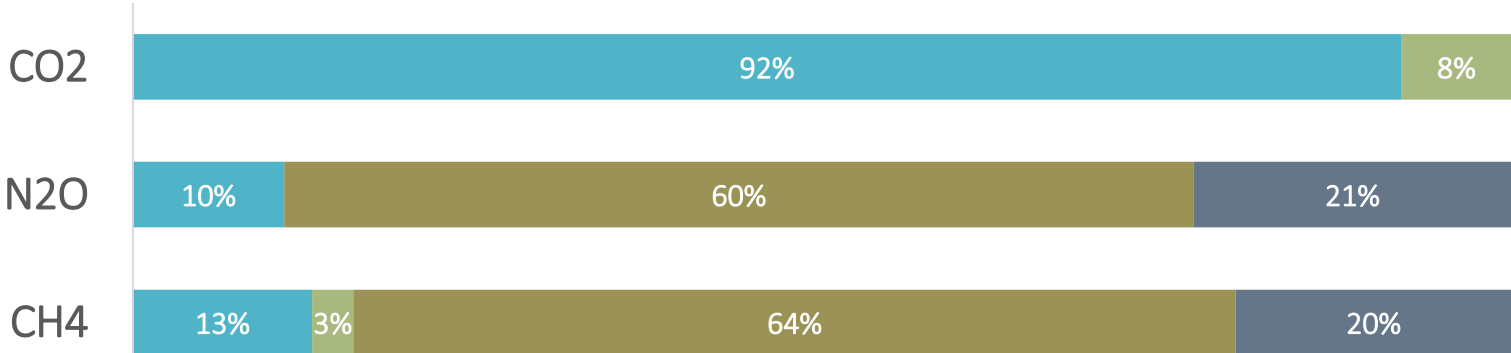
WASH Services: Despite Low GHG Contribution, Faces Greatest Impact from Climate Change

The primary cause of climate change in India, is the burning of fossil fuels, coal, oil, gas, etc., leading to the emission of greenhouse gases (GHGs) into the atmosphere. These gases trap heat, leading to global warming and associated changes in climate patterns.
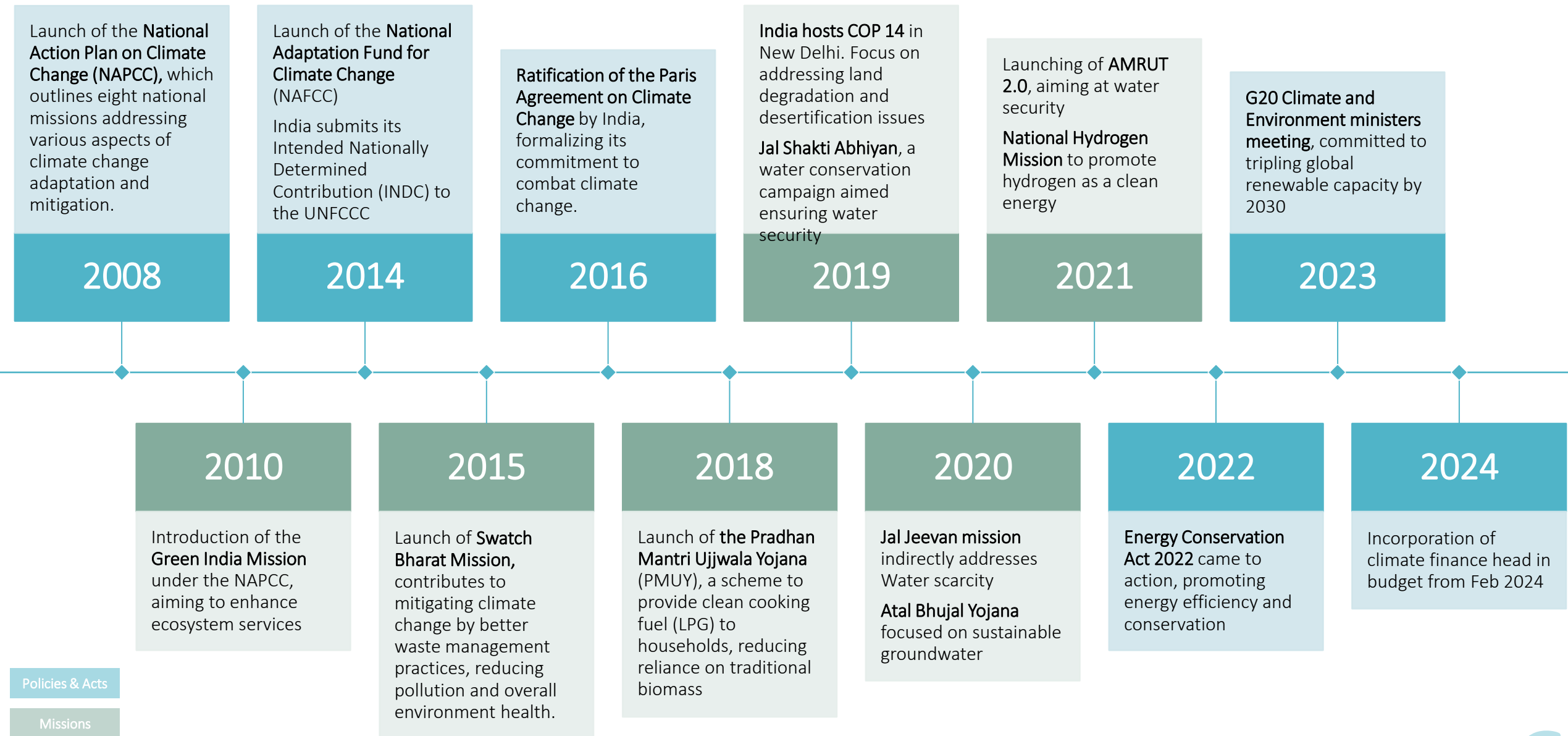
4

Timeline of Climate Initiatives: Global

First **UN environment conference** in Stockholm. Climate change hardly registered on the agenda

1972

Kyoto Protocol agreed. Developed nations pledged to reduce emissions by an average of 5% by the period 2008-12

1997

Copenhagen Accord, Developed countries promised to provide $30bn for the period 2010-2012

2010

Sustainable Development Goals (SDGs) were launched, aiming to end poverty, fight against inequality, tackle climate change, and build peaceful societies that respect human rights.

2016

COP 26: Glasgow Climate Pact aims to limit methane emissions by 30 per cent by 2030.

2021

IPCC Sixth Assessment Report, addressing knowledge about climate change.

COP28: Identify global solutions for limiting global temperature rise to 1.5 degrees

2023

1990

IPCC produces First Assessment Report. It concluded that temperatures have risen by 0.3-0.6C over the last century

2000

Millennium Development Goals were launched. commits world leaders to combat poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women.

2015

COP21: Paris Agreement adopted, to reduce global greenhouse gas emissions to hold global temperature increase to well below

2018

IPCC confirms the importance of 1.5 degree Celsius goal.

2022

COP27: Commitment by richer nations of financial support to developing nations to cope up with losses by climate change

Timeline of Climate Initiatives : India

2008
Launch of the **National Action Plan on Climate Change (NAPCC),** which outlines eight national missions addressing various aspects of climate change adaptation and mitigation.

2014
Launch of the **National Adaptation Fund for Climate Change** (NAFCC)
India submits its Intended Nationally Determined Contribution (INDC) to the UNFCCC

2016
Ratification of the Paris Agreement on Climate Change by India, formalizing its commitment to combat climate change.

2019
India hosts COP 14 in New Delhi. Focus on addressing land degradation and desertification issues
Jal Shakti Abhiyan, a water conservation campaign aimed ensuring water security

2021
Launching of **AMRUT 2.0**, aiming at water security
National Hydrogen Mission to promote hydrogen as a clean energy

2023
G20 Climate and Environment ministers meeting, committed to tripling global renewable capacity by 2030

2010
Introduction of the **Green India Mission** under the NAPCC, aiming to enhance ecosystem services

2015
Launch of **Swatch Bharat Mission,** contributes to mitigating climate change by better waste management practices, reducing pollution and overall environment health.

2018
Launch of **the Pradhan Mantri Ujjwala Yojana** (PMUY), a scheme to provide clean cooking fuel (LPG) to households, reducing reliance on traditional biomass

2020
Jal Jeevan mission indirectly addresses Water scarcity
Atal Bhujal Yojana focused on sustainable groundwater

2022
Energy Conservation Act 2022 came to action, promoting energy efficiency and conservation

2024
Incorporation of climate finance head in budget from Feb 2024

Policies & Acts

Missions

Climate Change: Causes & Effects

Climate change refers to long-term shifts in temperatures and weather patterns, like increasing temperature, rising sea levels, and catastrophic flooding, etc. the impacts of climate change are global in scope and unprecedented in scale.
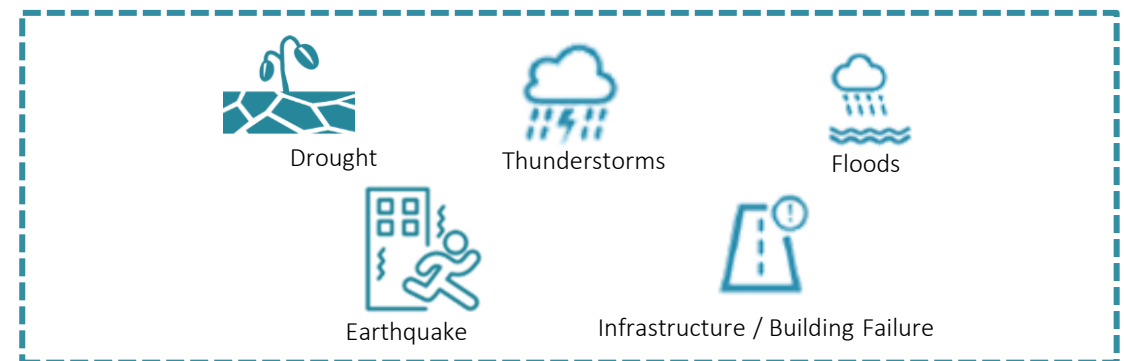
Causes

Rapid Urbanization   Industrial Activities   Deforestation

Transportation   Agriculture

GHG Emission

Effects

Extreme Weather Patterns   Natural Disasters   Global Warming

Hazard to nature and human life   Infrastructure damage & loss to economy

Stress

Water Scarcity

Aging Infrastructure

Emergency Services

Quality Of Living

Changing Demography

Regulatory Measures & Attitude

Lack Of Public Awareness

Shocks

Drought

Thunderstorms

Floods

Earthquake

Infrastructure / Building Failure

7

Literature Study: Frameworks, Reports, Programs & Missions

NIUA: ClimateSmart City Assessment Framework	C40: Urban Climate Action Impacts Framework	ICLEI: Climate Neutrality Framework	CURB: Climate Action for Urban Sustainability
• Urban Planning, Green Cover and Biodiversity • Energy and Green Buildings • Mobility and Air Quality • Water Management • Waste Management	Social • Health • Quality of life Economic • Wealth and Economy Environment • Environmental quality	• Low emission development • Nature-based development • Circular development • Resilient development • Equitable and people-centered development	• Private Building Energy • Municipal Building Energy and Public Lighting • Electricity Generation • Solid Waste • Water and Wastewater • Transportation

Pros

Covered most of the topics and sectors esp. WASH	Focused on socio-economic aspects of climate	Talked about resilience and mitigation	Focused on Specifically mitigation.

Cons

Quite generic and hasn't focused much on adaptation	Not WASH specific	No specific indicators were mentioned	Adaptation based indicator were missing

Literature Study: Frameworks, Reports, Programs & Missions

Pay Jal Survekshan

- Water Utility Services
- Used Water Utility Services
- Water Bodies
- Non-Revenue Water estimation
- Best Practices and Innovation

Pros: Community engagement and water management

Cons: Only focused on water sector

Swatch Bharat Mission

Social
- Health
- Quality of life

Economic
- Wealth and Economy

Environment
- Environmental quality

Pros: Promoting cleanliness and sanitation

Cons: SWM and Sanitation specific only, no direct climate focus

URDPFI: Sustainability Guidelines

- Zero Waste and Waste Recycling
- Greenhouse Gas Mitigation Measures for Wastewater
- Decentralized Wastewater Management:
- Energy recovery
- Reducing the need for Pumping

Pros: Guidelines specifically for Indian cities

Cons: These are the guidelines, not specific indicators

Other Literatures

- UN Habitat: Urban Planning Law for Climate Smart Cities
- Municipal Acts and Bye-laws
- Mumbai Climate Action Plan 2022
- World bank Climate Change Action Plan
- IPCC Sixth Assessment Report: Climate Change Impact and Mitigation
- IPCC Sixth Assessment Report: Climate Change Adaptation & Mitigation
- Water for Women: Knowledge and Practice Gaps in Climate Resilient Inclusive WASH

Pros

Cons

Climate Resilience, Adaptation & Mitigation

There are 3 Concepts to fight the *CLIMATE CHANGE*

Adaptation	Resilience	Mitigation

"CLIMATE ADAPTATION IS SOMETHING THAT HELPS THE CITY TO CREATE SUCH INFRASTRUCTURE WHICH WILL HELP CITY TO HAVE SUSTAINABLE AND IMPROVED WASH SERVICES."

This Climate concept helps the city To have sustainable infrastructure and able to mitigate the upcoming risks and to become climate resilient city.

(This concept may be novel, but the expectation for cities to proactively prepare for climate impacts is not new.)

Literature Study: National & Global Practices

Water

Sanitation

Solid Waste

Stormwater

Vancouver's climate-responsive water supply includes **rainwater harvesting and efficient water use**
Vancouver, Canada

drought-resilient water supply involve **water conservation, recycled water programs,** and groundwater recharge
Los Angeles, USA

New York City, USA

Post-Hurricane Sandy include upgrading wastewater treatment plants and sewer systems

Quito, Ecuador

sustainable water supply program integrates water conservation measures, **watershed protection, and community engagement**

Implementing **green infrastructure and permeable surfaces,** to address urban flooding
São Paulo, Brazil

Montevideo, Uruguay

SWM approach of **recycling, composting, and waste-to-energy** initiatives to reduce landfill dependence

circular water management approach emphasizes closing the water cycle, including **stormwater capture and reuse,** to enhance sustainability.
Amsterdam, Netherlands

Barcelona, Spain

Adaptive water management, including **sustainable drainage systems,** due to changing precipitation patterns.

sustainable stormwater management, including **green roofs and permeable surfaces,** to mitigate flooding risks
Oslo, Norway

Copenhagen, Denmark

climate-adaptive drainage systems, for heavy rainfall and sea-level rise while ensuring resilient sanitation

Dubai, UAE

sustainable desalination and efficient water supply strategies to address water scarcity

Cape Town, South Africa

Water Resilience Plan incorporates stormwater management and drought response measures

Cheonggyecheon River Restoration project integrates water supply improvements and revitalizes urban spaces with sustainable stormwater management.
Soul, South Korea

Typhoon-Resilient early warning systems, enhance preparedness and response to typhoons and heavy rainfall events.
Tokyo, Japan

Singapore

climate-resilient water management, emphasizing **water recycling, desalination, and sustainable wastewater treatment.**

Incorporating **green infrastructure and decentralized solutions** to address urban flooding.
Sydney

Melbourne, Australia

Rainwater harvesting and green infrastructure

Source: World Bank (2023), INEP(2020), UNEP(2018)

11

Performance Assessment Systems (PAS)

- Quality of water supplied
- Regular annual assessment of available sources
- Studies/ actions on detailed energy audits
- Studies and actions for preliminary water audit

28 KPIs

100+ LAIs

Intake, Treatment

- Coverage of water supply connections
- Extent of Non Revenue Water
- Spatial coverage of distribution network
- % water losses from source to water treatment plant (WTP)
- % water losses from WTP to water distribution station (WDS)
- % water losses from WDS to final consumption (includes both leakage on service connections and unauthorized consumption)
- Number of pipe breaks per km length of network
- % of network refurbished

Distribution

- Per capita supply of water (At consumer end)
- Extent of metering of water connections
- Efficiency in redressal of customer complaints
- Cost recovery in water supply services
- Efficieny in collection of water supply related charges
- % of connections that are metered
- % of meters that are functional
- Periodic monitoring and analysis of complaints
- Total complaints in water supply per 1000 connections per year

- Extent of segregation of municipal solid waste
- Efficiency in redressal of customer complaints

Consumer

- % treatment capacity to solid waste generated
- Adequacy of solid waste treatment facilities

Recycle/Disposal

Collection

- Household level coverage of solid waste management services

Conveyance

Water Supply

Solid waste

Stormwater

Sanitation

performance assessment system

Access and coverage | Equity in access to service | Financial sustainability | Service level and quality | Efficiency in service operations

19 KPIs

36 LAIs

KPIs

LAIs
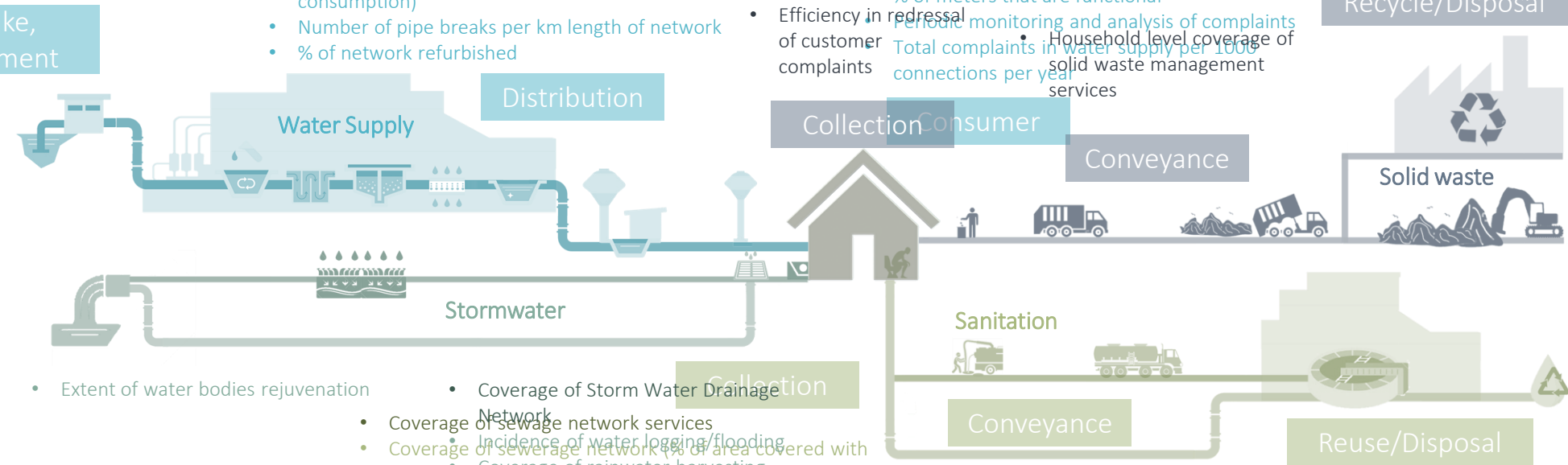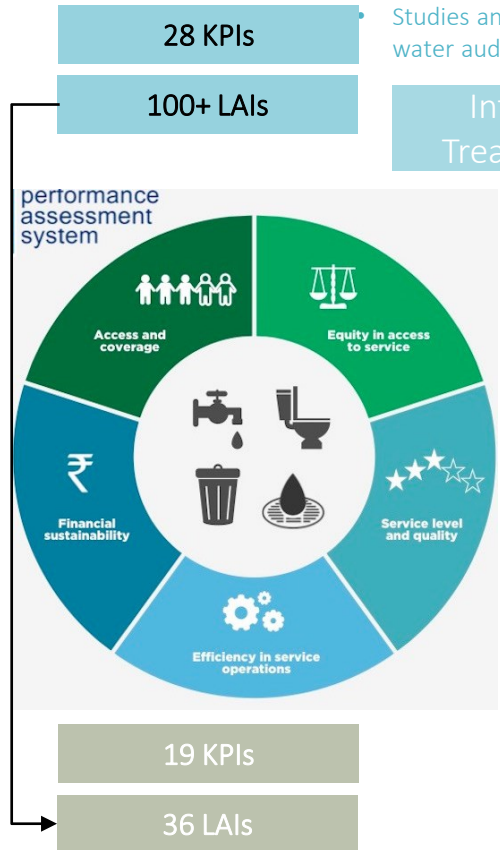
- Extent of water bodies rejuvenation

- Coverage of Storm Water Drainage Network
- Incidence of water logging/flooding
- Coverage of rainwater harvesting structure

Collection

- Coverage of sewage network services
- Coverage of sewerage network (% of area covered with sewer network)
- Coverage of sullage/greywater network (open+covered)
- % of HHs connected to sewer network
- % of HHs connected to septic tank*
- % of septic tanks as per design standards
- % of HHs connected to twin pit / other safe system
- % of septic tanks connected to settled sewer/ drains for effluent disposal*
- % of septic tanks connected to soak pit for effluent disposal*
- % of septic tanks cleaned annually
- Efficiency in redressal of customer complaints
- Total complaints in waste water per 1000 connections

Conveyance

- Collection efficiency of sewerage networks
- Frequency of sewer overflows
- Quality of septage treatment*
- Quality of effluent and grey water treatment*
- Extent of cost recovery in sewage management
- Efficiency in collection of sewage charges

Reuse/Disposal

- Extent of reuse and recycling of sewage
- Extent of reuse and recycling in sanitation system (weighted average)
- Extent of reuse and recycling of treated septage*
- Extent of reuse and recycling of treated effluent (from septic tank and grey water) *

Literature Study: National & Global Practices

Water

Sanitation

Solid Waste

Stormwater

India

Jaipur, Rajasthan
encourages **rooftop rainwater harvesting to recharge groundwater**, reduce water scarcity

Delhi
Biodiversity Park focuses on restoring and conserving the natural ecosystems along the Yamuna River, providing a green buffer against floods

Indore, Madhya Pradesh
Solid waste management model emphasizes **source segregation, waste-to-energy projects, and efficient landfill** management

Gangtok, Sikkim
watershed management program focus on protecting water catchment areas, reforestation, and community-based water resource management.

Surat, Gujarat
Sustainable solid waste management practices, including **waste-to-energy projects, recycling**, and community participation.

Nagpur, Wai, Sinner, Maharashtra
Solar based FSTP IN WAISmart water supply systems with **GIS-based monitoring, enhancing water supply efficiency**

Bengaluru, Karnataka
lake rejuvenation projects contribute to sustainable water supply by improving water quality and recharge of groundwater

Thiruvananthapuram, Kerala
Decentralized sewage treatment plants, improving sanitation infrastructure and reducing the environmental impact

Chennai, Tamil Nadu
The **comprehensive Stormwater Drain (CSD) project** focuses on enhancing stormwater drainage capacity, preventing urban flooding, and improving water quality.

Bhubaneshwar, Odisha
Permeable (Sponges) surface along roads to help absorb extra rainwater and prevent flooding and stagnant water.

Kolkata, West Bengal
Kolkata's **wetland areas implement eco-friendly sanitation practices**, emphasizing sustainable waste management and stormwater filtration.

Learning from the Front Runner city- a case of Surat

11 Intake well

8 WTP

46 WDS

94% Water Supply coverage
1500 MLD Daily supply

Tapi River as a source of water

Water Supply

1200 MLD wastewater generated per day

11 STP

86% Sewage network coverage

Sanitation

3150 Metric tone waste generated per day

84% Collection efficiency

90% Household Coverage for SWM

Solid waste Management

Stormwater Management

69% Stormwater network coverage
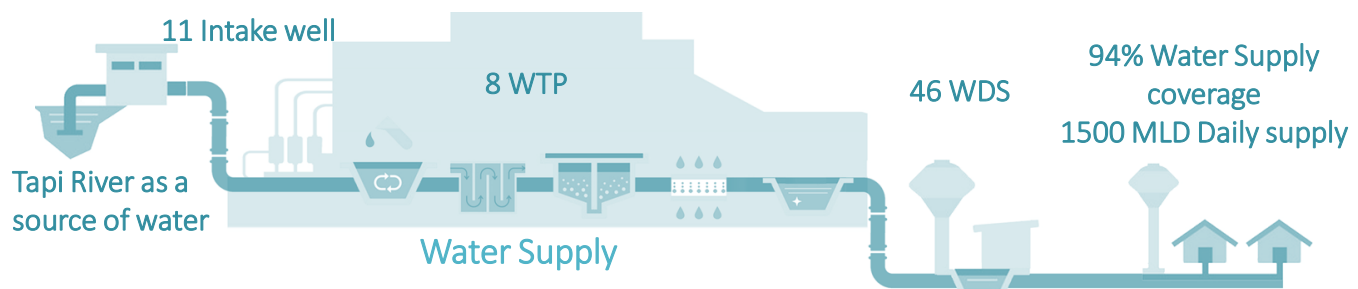
Resource Management
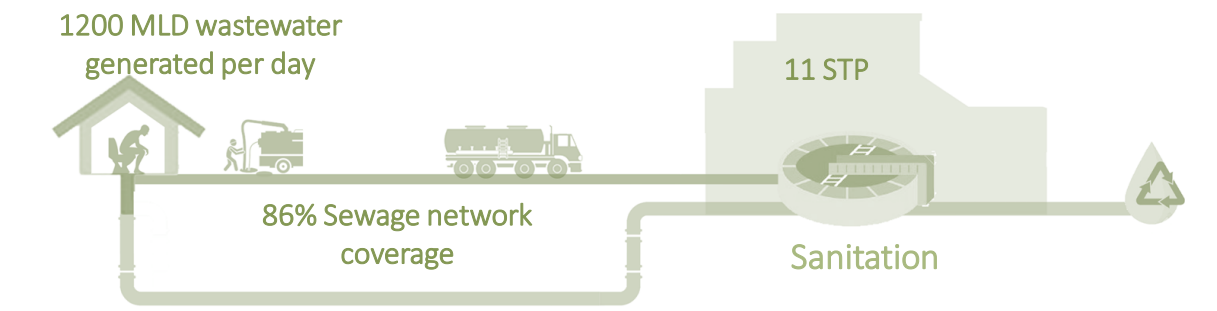
Infrastructure & Technology

Emergency Response

Policy & Bye-laws

Public Awareness

Best practices

24X7 Water supply & Metering

Grid supply network for emergency response

Tertiary wastewater treatment plant

ODF++ City

SBM Rank 1

C&D Waste Management Plant

Centralized Plastic Waste management plant

Surat Stormwater Action Plan 2019

ICCC Flood Management & Monitoring System

Source: Surat Municipal Corporation (2023)

First draft of the framework

- Identifying the themes for the framework

- Shortlisting PAS indicators for incorporation.

- Identified new areas and developed new

  indicators related to climate adaptation and

  mitigation
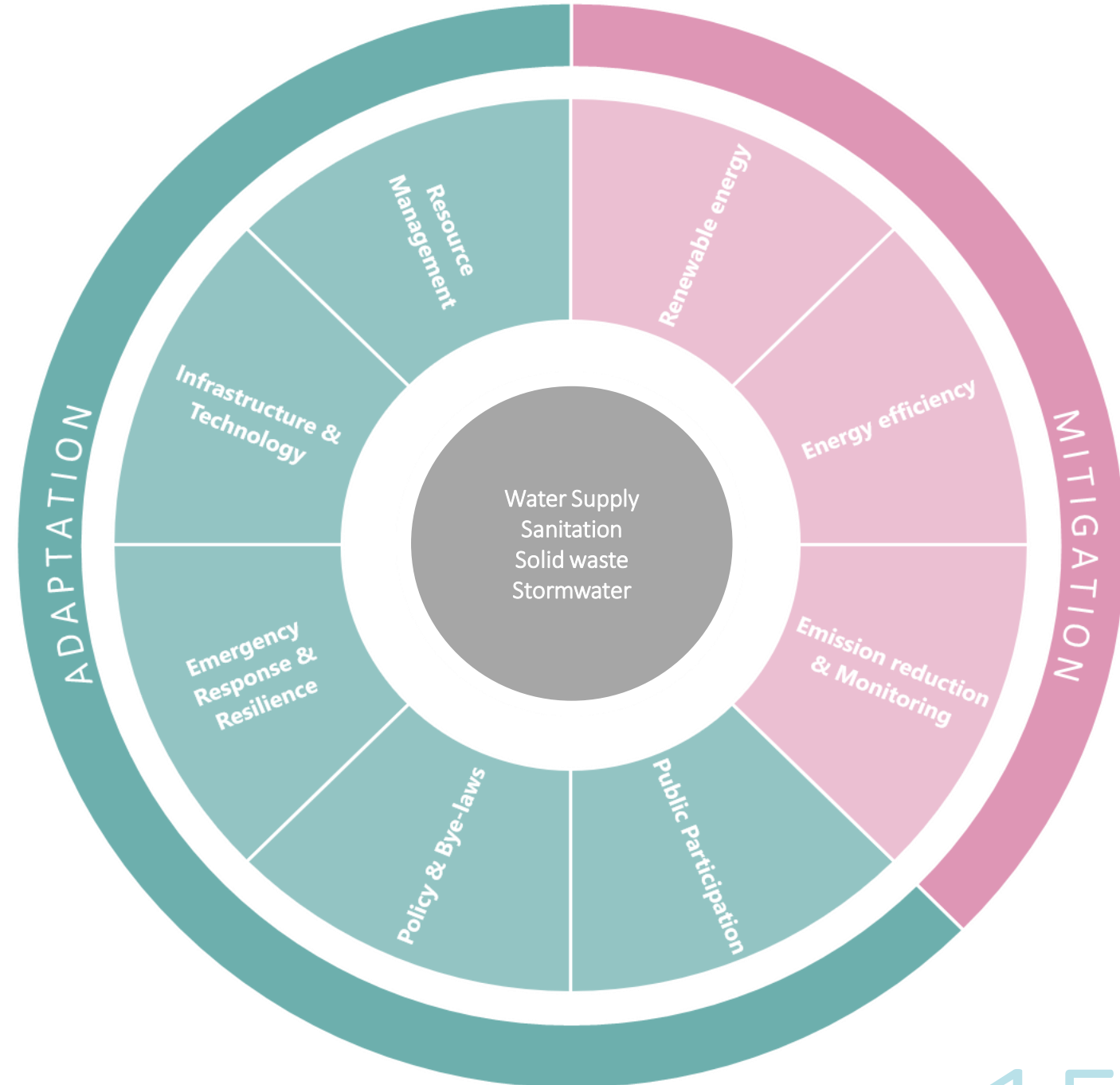
After interviews with the sector experts and city officials were done, which helped us identify the additional areas of assessment that need to be considered to understand the status of climate adaptivity of any Indian city and the readiness to mitigate climate risks.

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Developing Assessment Framework- Integrating with PAS

City CAM-PAS:

Urban Climate Adaptation & Mitigation Assessment Framework

Navigating Cities Towards Climate Adaptation & Mitigation

Service Delivery + Climate Measures

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Concept

Framework
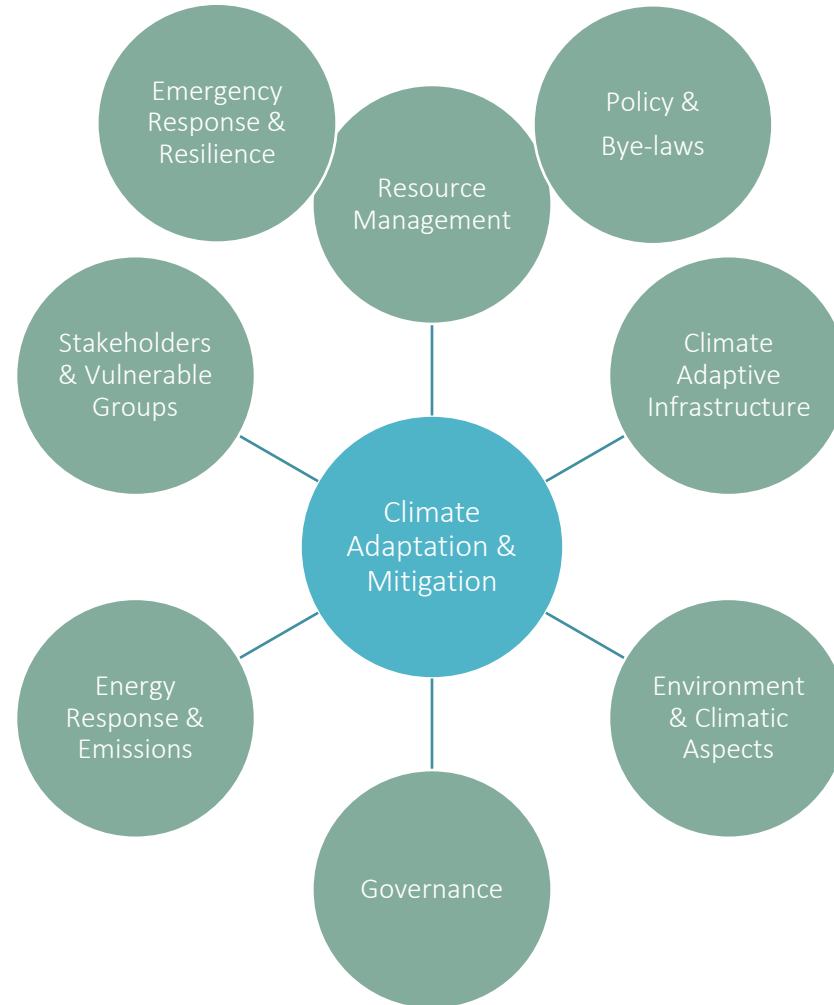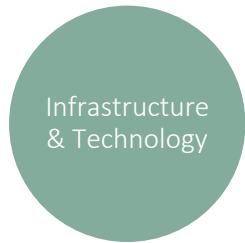
Framework: Indicators

Resource Management

- Demand Water Management (Demand Vs Supply)
- Capacity addition/augmentation to present supply Degree of surface water dependency (on single source)
- Ratio of storage capacity to water supply
- Gravity led water supply
- Per capita water supplied at consumer end
- Ground water management

Infrastructure & Technology

- Water supply coverage
- Non-revenue water
- Water metering
- Renewable energy options
- Energy efficiency
- Emission Reduction

Emergency Response & Resilience

- Resilient infrastructure to withstand disasters
- Complaints Response in Water Supply
- Water Quality

Policy & Bye-laws

- Water conservation policies, Implementation & Monitoring at city level.
- Incorporation of climate data in water management planning

Financing Climate Adaptive Infrastructure

- Proportion of budget for climate-oriented projects
- Provision of funds for Vulnerable population
- Cost recovery in water supply services
- Collection efficiency in water supply-related charges

Stakeholder Engagement

- Public awareness and engagement for water conservation

Water Supply

PAS

Framework : Indicators

Resource Management
- Extent of sewage recycle and reuse
- Sewage quality check before discharging into nature

Infrastructure & Technology
- Sewer Network Coverage
- Real-time monitoring
- Nature-based treatment technology
- Renewable energy options
- Energy efficiency
- Emission Reduction

Emergency Response & Resilience
- Resilient infrastructure to withstand disasters
- Complaint redressal (open spillage)
- Disease due to sewage spillage

Policy & Bye-laws
- Sanitation policies & programs currently in place, implementation and monitoring
- Incorporation of climate data in sanitation management planning

Financing Climate Adaptive Infrastructure
- Proportion of budget for climate-oriented projects
- Provision of funds for Vulnerable population
- Cost recovery in sanitation services
- Collection efficiency in sanitation related charges

Stakeholder Engagement
- Public awareness and engagement for sanitation & wastewater reuse

Sanitation

PAS

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Framework: Indicators

Resource Management

- Waste recycled and reused
- Waste to energy initiative
- Open Burning of waste

Infrastructure & Technology

- Coverage of solid waste management services
- Waste treatment efficiency
- Waste management of littering in the city
- Percentage of E-Vehicles
- Landfill distance from the city

Emergency Response & Resilience

- Complaint redressal (littering)
- Disease due to waste accumulation around
- Time to restore waste management services after a disaster

Policy & Bye-laws

- SWM policies & programs currently in place, implementation and monitoring
- Incorporation of climate data in waste management planning

Financing Climate Adaptive Infrastructure

- Proportion of budget for climate-oriented projects
- Provision of funds for Vulnerable population
- Cost recovery in SWM
- Collection efficiency in SWM related charges

Stakeholder Engagement

- Public awareness and engagement for SWM

Solid waste Management

Framework: Indicators

Resource Management
- Rainwater harvesting at city level
- Green infrastructure
- Reduction in urban heat island intensity
- Blue Infrastructure management
- Stormwater network present in the city

Infrastructure & Technology
- Stormwater network present in the city
- Stormwater network coverage
- Real-time monitoring

Emergency Response & Resilience
- Resilient infrastructure to withstand disasters
- Complaint redressal (water logging)
- Flood-risk mapping
- Disease due to water logging

Policy & Bye-laws
- Flood risk reduction policies & programs currently in place
- Incorporation of climate data in stormwater management planning

Financing Climate Adaptive Infrastructure
- Proportion of budget for climate-oriented projects
- Provision of funds for Vulnerable population

Stakeholder Engagement
- Public awareness and engagement for stormwater management

Stormwater Management

PAS

About the Framework

Water Supply · Resource Management

Infrastructure & Technology

Sanitation · Emergency Response & Resilience

Solid waste · Policy & Bye-laws

Financing Climate Adaptive Infrastructure

Stormwater · Stakeholder Engagement

4 Sectors

6 Themes

Qualitative (23)	Quantitative (30)	Binary (22)

75 Indicators

146 Sub-Indicators

Percentage	Binary	Benchmarking	Aggregate

4 Scoring Methodology

https://docs.google.com/spreadsheets/d/1UkOu1ZmTAUAIxRNJdOSl9kohwFhRCG34/edit?usp=sharing&ouid=110845496411710583031&rtpof=true&sd=true

24

Type of Indicators

Each indicator is awarded 100 marks, and by totaling the score for each theme and sector, the city's overall performance can be identified. This helps in assessing the areas where the city is performing well and where it needs to focus.
Each theme is given equal 100% weightage

	Resource Management	Infrastructure & Technology	Emergency Response & Resilience	Policy & Bye-laws	Financing Climate Adaptive Infrastructure	Stakeholder Engagement	Sector Total (out of 100)
Water Supply							
Sanitation							
Solid waste Management							
Stormwater Management							
Theme Total (out of 100)							Overall City Score
	Output			Functional			

Identify the status of the city performance

Based on the total score obtained in the output and functional themes, the city's present status in climate adaptation and mitigation can be identified, with the help of this ladder
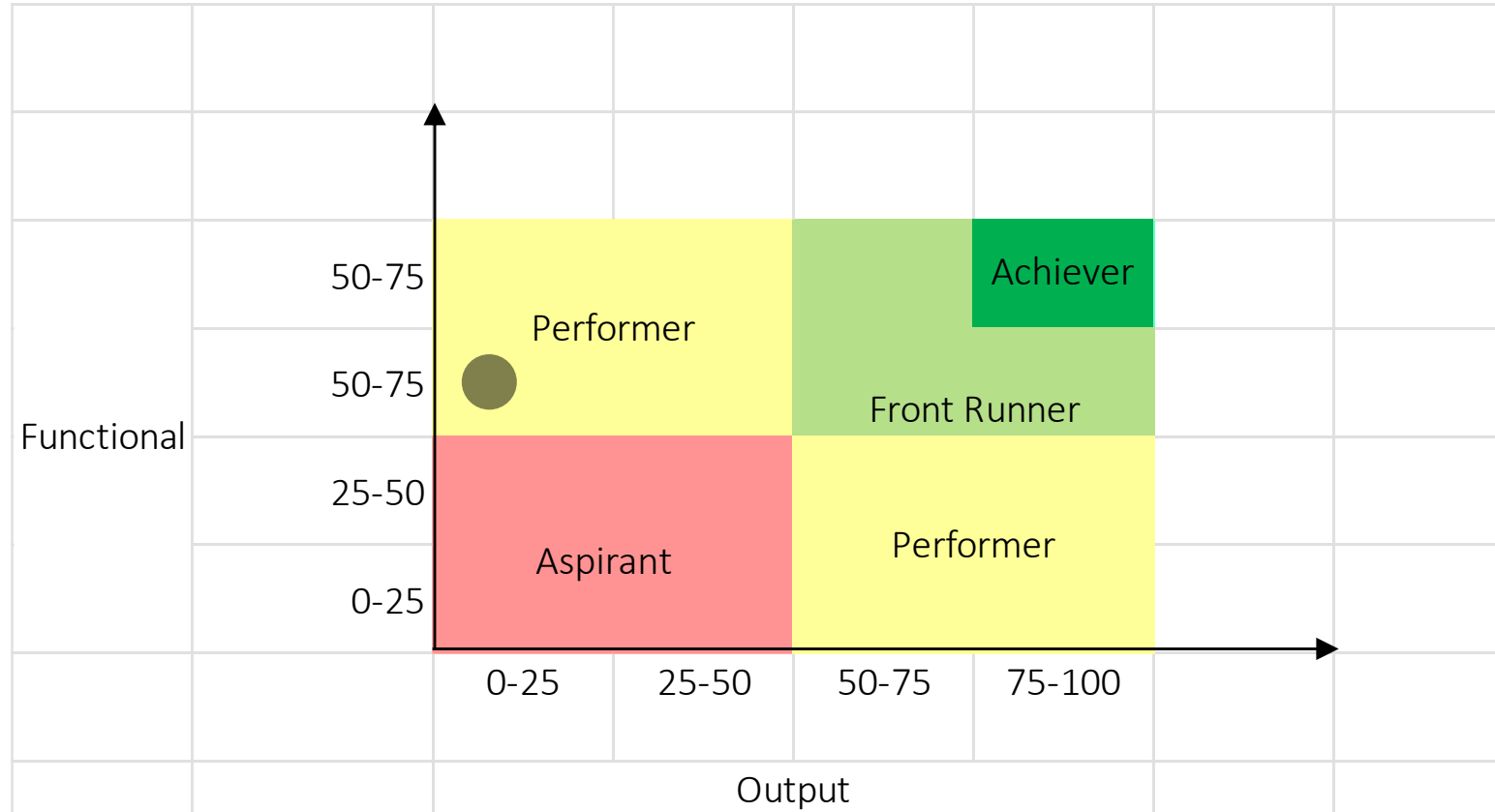
- If a city has low performance in both output and functional sectors, it is considered an aspirant city.
- If a city performs well in functional areas but poorly in output areas, or vice versa, it might be classified as a performer city.
- If a city does well in both output and functional areas, it is classified as an Achiever city.

City CAM-PAS Application

Case of Surat and Anjar
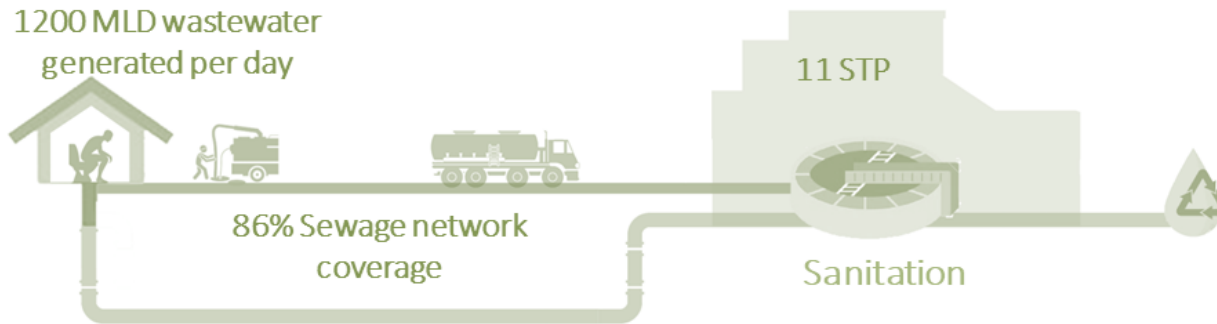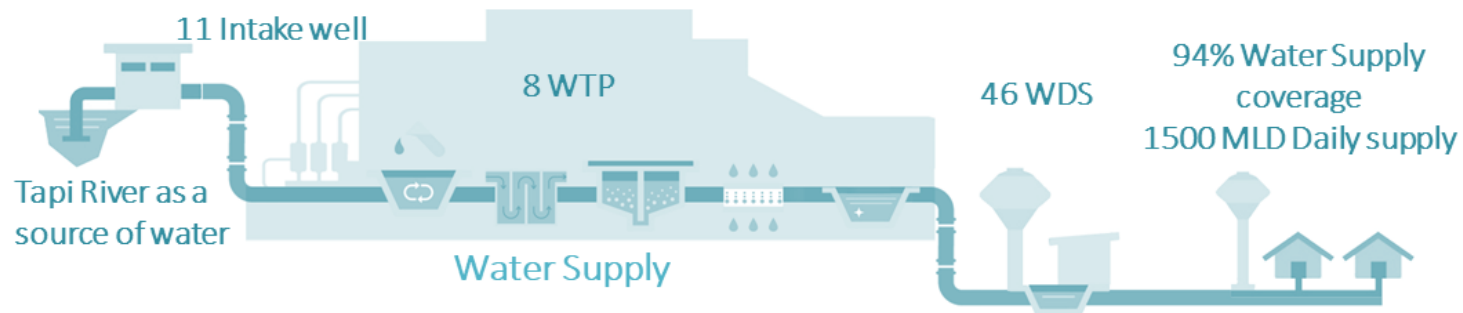
Applying the framework to identify the challenges: *Surat*

Location: Gujarat

Population (2011): 44,70,000

Population (Present): 78,70,000

Area: 462.2 Sq. Km

Surat Municipal Corporation oversees infrastructure services as the administrative body.

The city is taking many actions towards climate actions along with its infrastructure development

The city is currently 1st in SBM ranking and is ODF++ city.

Source: Anjar Nagarpalika (2024)

Present scenario and issues: *Surat*

Good Practices

- Tertiary wastewater treatment plant

- C&D Waste Management Plant

- Centralized Plastic Waste management plant

- 24X7 Water supply & Metering

- Grid supply network for emergency response

- Surat Stormwater Action Plan 2019

- ICCC Flood Management & Monitoring System

- SBM Rank 1

- ODF++ City

Issues

- Despite of being no 1 in SBM, city still faces issues of littering in the city, around the water bodies, creeks etc.

- Initiatives of rainwater harvesting need to be implemented.
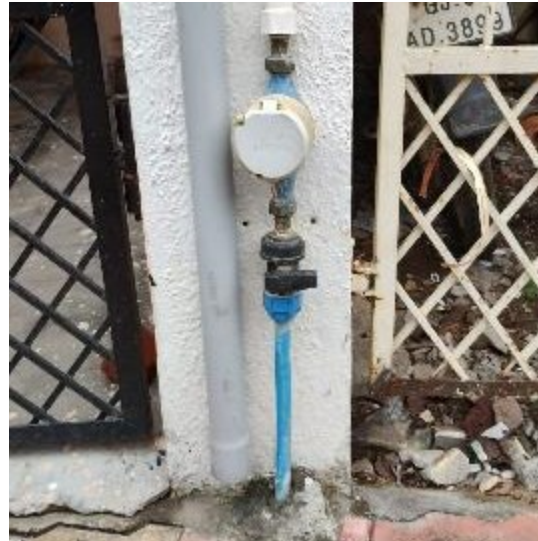
24X7 Water supply and Metering

Tertiary Wastewater treatment plant

Plastic Waste Recycle Facility

Littering and Open Burning of Waste

Applying the framework to identify the challenges: *Surat*

	Resource Management	Infrastructure & Technology	Emergency Response & Resilience	Policy & Bye-laws	Financing Climate Adaptative Infrastructure	Stakeholder Engagement
	Outcome			Function		
Water Supply	66.16	58.56	53.90	100.00	72.31	66.67
Sanitation	66.67	56.08	99.69	100.00	62.63	66.67
Solid waste Management	57.14	34.84	66.67	100.00	59.93	66.67
Stormwater Management	41.67	90.07	87.50	100.00	50.00	66.67
Theme Total (out of 100)	57.91	59.89	76.94	100.00	61.22	66.67
	64.91			75.96		

Water Supply Score **69.6%**

Sanitation Score **72.3%**

SWM Score **64.2%**

Stormwater Score **72.6%**

70.43 %

Functional

75-100 — Performer / Achiever
50-75 — Front Runner
25-50 — Aspirant / Performer
0-25

Output: 0-25 | 25-50 | 50-75 | 75-100
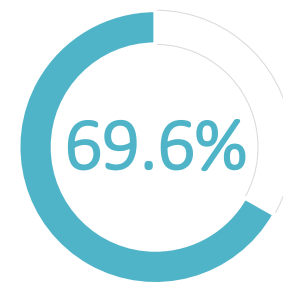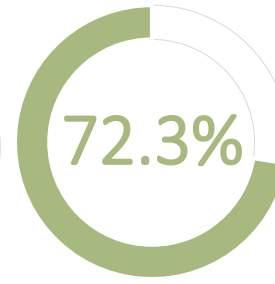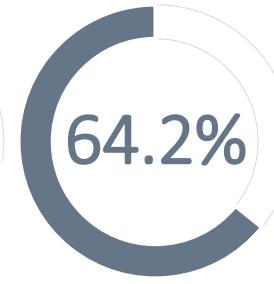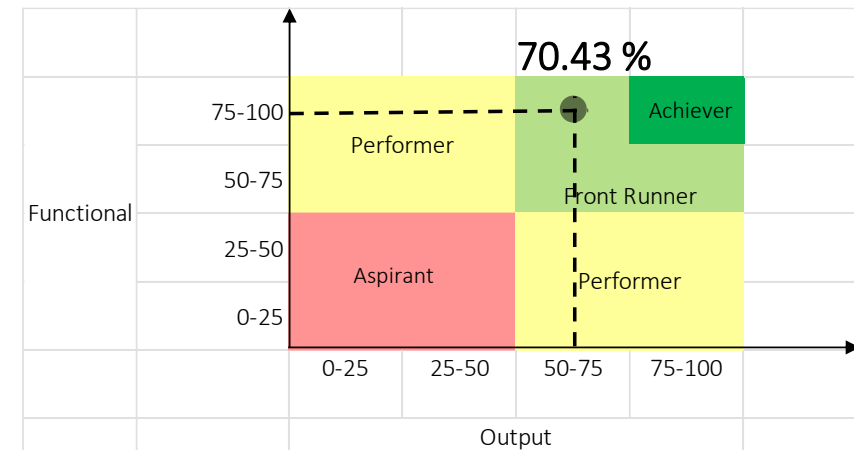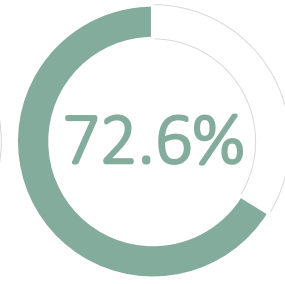
Identified areas for interventions: *Surat*

Groundwater monitoring and management	Waterbody rejuvenation and cleaning initiatives	Litter free city	Implementing rainwater harvesting initiatives at city and residential level	Seeking alternative water sources to alleviate pressure on groundwater resources.

Challenges

Lack of technical expertise and capacity	Inter-sectoral disputes because these water-bodies are polluted because of solid waste and wastewater	Public awareness and engagement, along with behavioral changes among the citizens.	Lack of awareness among ULB and other stakeholders.	Financial and regulatory constraints.

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1 Intake well

1 WTP

65.9% Water Supply Coverage
19 MLD Daily supply
(9 MLD Narmada, 10 MLD Groundwater)

6 ESR
7 GSR

Narmada River, Groundwater as a source of water

Water Supply

17 MLD wastewater generated per day

1 STP

100% Wastewater Reuse

47% Sewage network coverage

Sanitation

1515 Metric tone waste generated per day

100% Collection efficiency

100% Household Coverage for SWM

Solid waste Management

Stormwater Management

3% Stormwater network coverage

Applying the framework to identify the challenges: *Anjar*

Location: Kutch, Gujarat

Population (2011): 87,183

Population (Present): 1,13,338

Area: 17.81 Sq. Km

Anjar Nagarpalika oversees infrastructure services as the administrative body.

The city's efforts to address climate change are minimal, primarily concentrating on infrastructure advancement

The city is also part of various missions and programs like AMRUT 2.0 and SBM, and also conducts campaigns and public awareness regarding them.

Present scenario and issues: *Anjar*

Good Practices

- 100% Wastewater recycle and reuse.

- Good emergency response to the services, with in 24 hours.

- Rainwater harvesting and groundwater recharge projects implementation at pilot level.

- IEC and public awareness campaign held frequently for all the sectors.

Issues

- Infrastructure services not fully developed

- Energy efficiency and renewable energy are not there

- No proper monitoring mechanisms (GHG, water metering, GW monitoring)

- No recycling and reuse of solid waste

- Littering of solid waste in the city

- Stormwater infra coverage only 3%

- No proper mandate regarding RWH.

- No stakeholder engagement and incentives to citizens to motivate them towards climate actions

Rainwater harvesting

Groundwater Recharge

Littering and water logging

Poor infrastructure

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Applying the framework to identify the challenges: *Anjar*

	Resource Management	Infrastructure & Technology	Emergency Response & Resilience	Policy & Bye-laws	Financing Climate Adaptative Infrastructure	Stakeholder Engagement
	Outcome			Function		
Water Supply	49.29	20.01	84.14	37.50	52.97	66.67
Sanitation	100.00	31.79	95.13	37.50	45.89	66.67
Solid waste Management	33.33	53.33	100.00	37.50	30.23	66.67
Stormwater Management	41.67	34.33	75.00	50.00	50.00	33.33
Theme Total (out of 100)	56.07	34.87	88.57	40.63	44.77	58.33
	58.91			47.91		

Water Supply Score 49.9%

Sanitation Score 62.8%

SWM Score 53.5%

Stormwater Score 47.4%

Functional / Output

- 75-100: Performer
- 50-75: Achiever / Front Runner
- 25-50: Aspirant / Performer — 53.41 %
- 0-25

Output axis: 0-25 | 25-50 | 50-75 | 75-100
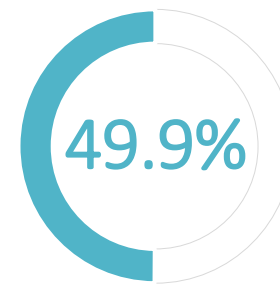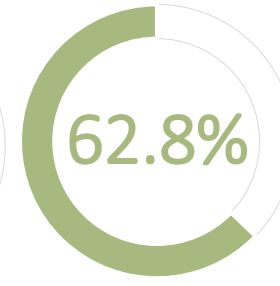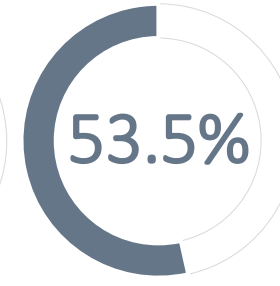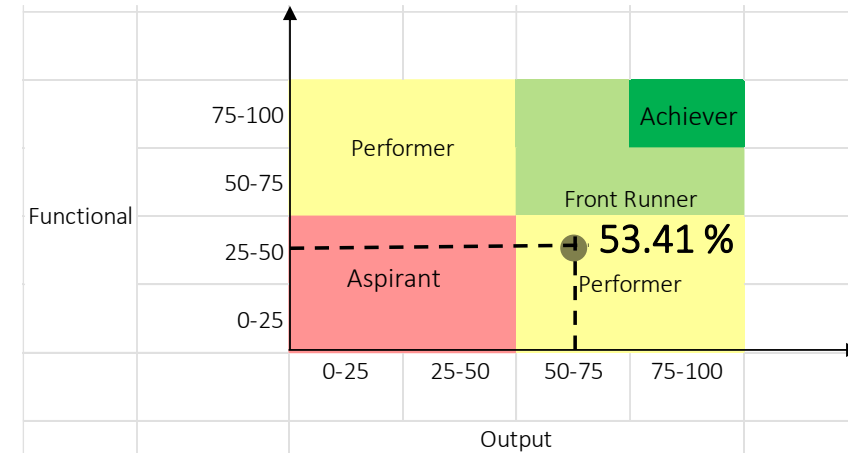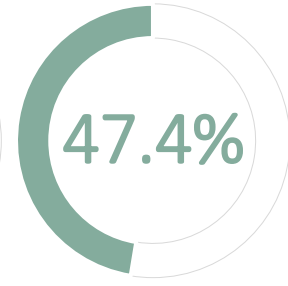
Identified areas for interventions: *Anjar*

Enhancing energy efficiency and exploring renewable energy solutions, particularly in sectors such as water and sanitation.	Measuring and monitoring greenhouse gas emissions across all sectors.	Initiating recycling and the reuse of solid waste.	Implementing residential rainwater harvesting initiatives.	Seeking alternative water sources to alleviate pressure on groundwater resources.
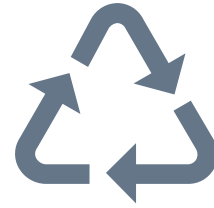
Challenges

Unavailability of municipal land for solar panels	Lack of awareness among ULB and citizens	Lack of technical expertise and capacity	No proper mandate and regulation, hindering the initiation	Financial and regulatory constraints.

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Challenges

Resource Management	Infrastructure and Technology	Emergency Response & Resilience	Policy and Bye-laws	Financing Climate Adaptive Infrastructure	Stakeholder Engagement
• Lack of proper regulations and infrastructure in order to safeguard the resources.	• Poor and old infrastructure, causing issues to citizens • No monitoring mechanism, due to which there is unavailability of data and calculation	• Unavailability of early warning systems, causing delay in taking actions. • Knowledge gap regarding these issues.	• No proper mandate and regulation regarding climate measures. • No monitoring and proper implementation of existing policies	• There is currently no climate specific heads in budget	• Lack of awareness and no incentives are provided to the citizens to have their involvement in climate actions.

Key Findings and Takeaways

Infrastructure Development Divide

- Large cities like Surat benefit from established infrastructure, enabling easier focus on climate measures, while small cities such as Anjar struggle with basic infrastructure needs, hindering climate action prioritization.

Opportunities for Sustainable Development

- Despite challenges, small cities have opportunities to leapfrog traditional development pathways and prioritize sustainable infrastructure.

Capacity and Awareness Gap

- Small cities face limitations in capacity and awareness regarding climate change impacts and mitigation strategies, causing challenges in implementation.

Need for Integrated Planning

- To be climate-adaptive, small cities must integrate climate considerations into infrastructure development and planning,

"If the city can optimize its resources, develops a sustainable & resilient infrastructure, implements suitable policies and regulations, with public awareness, then the city can become climate adaptive and will be able to mitigate impacts of climate change"

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Thank you

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Background...

EXTREME WEATHER

Extreme Weather and Climate Change

As the climate changes, the frequency and intensity of extreme weather events are increasing.

41
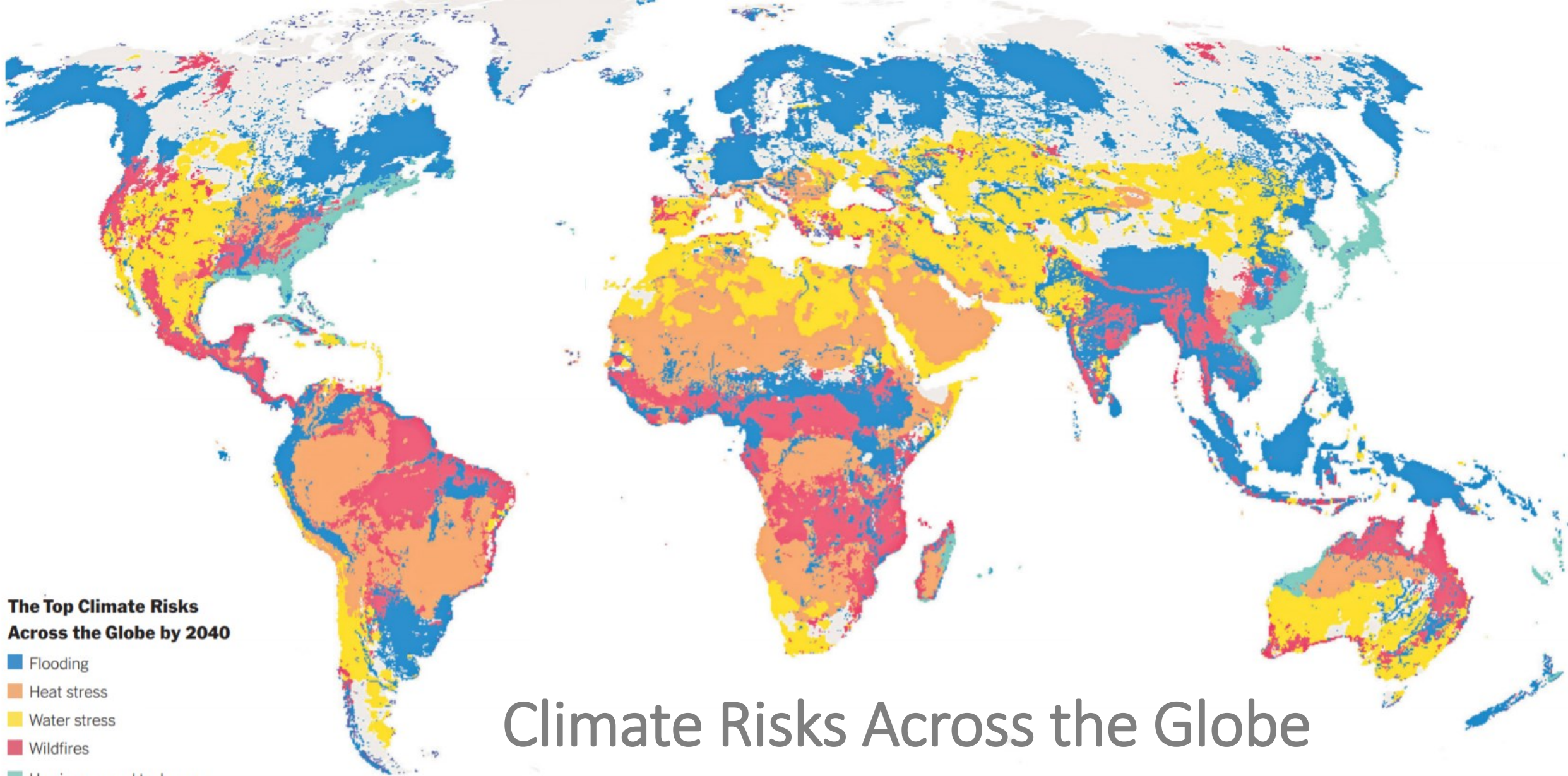
The Top Climate Risks Across the Globe by 2040

- Flooding
- Heat stress
- Water stress
- Wildfires
- Hurricanes and typhoons
- Sea level rise

Climate Risks Across the Globe

Source: nytimes.com// (2023)

Central Europe staggers toward recovery from catastrophic flooding: more than 200 killed

The worst floods in decades reflect the intensified rainfalls of a warming climate.

by BOB HENSON and JEFF MASTERS
JULY 21, 2021

The German state of Rhineland-Palatinate was among the hardest hit by the disastrous floods of mid-July 2021. (Image credit: Landesregierung Rheinland-Pfalz)

July 2021 was Earth's warmest month in recorded history, says NOAA

July featured two $25 billion flood disasters and Earth's hottest reliably measured temperature on record: 54.4°C (130°F) at Death Valley, California.

by JEFF MASTERS
AUGUST 13, 2021

Flooding in Altenahr, Rhineland-Palatinate, Germany, on July 20, 2021. (Photo credit: CnndrBrbr)

Extreme rainfall in China: over 25 inches falls in 24 hours, leaving 33 dead

Zhengzhou received more than a year's worth of rain on July 20.

by JEFF MASTERS
JULY 22, 2021

Extreme flooding in Zhengzhou, China, on July 20, 2021, after over 25 inches of rain fell in 24 hours. (Image credit: UN Climate Change Twitter feed)

Climate change drives Amazon rainforest's record drought, study finds

The drought that hit all nine Amazon rainforest countries - including Brazil, Colombia, Venezuela and Peru - is expected to worsen in 2024

January 25, 2024 05:06 pm | Updated 07:53 pm IST

REUTERS

COMMENTS   SHARE   READ LATER

Floating houses are seen stranded due to the severe drought affecting the Rio Negro, in the harbour of the Cacau Pirera district, in Iranduba, Amazonas state, Brazil September 25, 2023. | Photo Credit: Reuters

Doomsday Glacier Is Coming for Us All

New data suggests a massive collapse of the ice shelf in as little as five years. "We are dealing with an event that no human has ever witnessed," says one scientist. "We have no analog for this"

BY JEFF GOODELL
DECEMBER 29, 2021

The Real Prof. Katharine Hayhoe
@KHayhoe · Follow

Lytton is home to the Lytton First Nation, a Nlaka'pamux band. In Canada and beyond, Indigenous people are disproportionately affected by climate impacts and Indigenous knowledge has much to contribute to climate solutions.

India saw extreme weather events almost every day in first 9 months this year: Report

It said 2,923 people died, almost two million hectares of crops were ruined, 80,000 homes were destroyed and more than 92,000 animals were killed.

All 36 Indian states/UTs reported extreme weather events in 2023

The country experienced extreme weather events on 235 of the 273 days, or a little over 86% of the days from January 1 to September 30, 2023. These events claimed 2,923 human lives, affected 1.84 million hectares (ha) of crop area, damaged 80,563 houses and killed over 92,519 animals.

CLEAR LINK

In 2023, at least eight attribution studies and reports on India found that climate change made extreme events and related incidences more severe or more likely to occur

2015
Drought in Marathwada
"The risk of this kind of drought is found to be at least quintupled due to anthropogenic factors"

Attribution of the 2015 drought in Marathwada, India from a multivariate perspective | Mariam Zachariah, et al | March 2023 | Weather and Climate Extremes

1979-2021
Climate change is causing more frequent, intense cyclones on India's western coast
"Changes in the patterns of ocean and atmosphere warming are causing more frequent and severe tropical cyclones in the Eastern Arabian Sea, next to India's west coast."

Changes in the thermodynamical profiles of the subsurface ocean and atmosphere induce cyclones to congregate over the Eastern Arabian Sea | C S Abhiram Nirmal, et al | September 22, 2023 | Scientific Reports

1995-2023
Frequency of heatwaves rising in India due to global warming
"The frequency of heat waves and their duration over the main heat-prone areas of the country rose by around 2.5 days in the last 30 years due to global warming."

Meteorological Monograph: Heat and Cold Waves in India: Processes and Predictability | India Meteorological Department | April 2023

2022
Ganga, Mekong basins to see fewer but stronger tropical storms
"Ganga and Mekong floodplains will see a reduced frequency of tropical storms but the intensity of such events are projected to go up by 2050"

Fewer, but more intense, future tropical storms over the Ganges and Mekong Basins | Haider Ali, et al | August 31, 2023 | Geophysical Research Letters

April 2023
Extreme humid heat in South Asia
"Human-induced climate change made the April 2023 heat wave across India and Bangladesh 30 times more likely"

Extreme humid heat in South Asia in April 2023, largely driven by climate change, detrimental to vulnerable and disadvantaged communities | Zachariah, M, et al | 2023 | Imperial College London

June 2023
Climate change made UP heatwave at least two times more likely
"A three-day extreme heat event over Uttar Pradesh from June 14-16, 2023 was made at least two times more likely by human-caused climate change."

Climate Shift Index map, Climate Central | June 2023

June-August 2023
Human-driven climate change behind record temperatures in 11 states/UTs
"During June-August 2023, 11 states/UTs experienced higher temperatures that were made at least three times more likely by climate crisis."

Climate Shift Index map, Climate Central | September 7, 2023

2041-2080
Groundwater depletion rates may triple in India because of global warming
"The rates of net groundwater loss for 2041–2080 could be three times current depletion rates."

Warming temperatures exacerbate groundwater depletion rates in India | Nishan Bhattarai, et al | September 1, 2023 | Science Advances

Himalayan region, Northeast India likely to experience more flash drought events in near future, flags expert

The findings of the study conducted at the Indian Institute of Technology-Gandhinagar (IITGN) by research scholar Shanti Shwarup Mahto further reveal that over 80 per cent of the country-level flash droughts occurred during the monsoon season.

Sea-level rise a major threat to India, other nations: WMO

By Jayashree Nandi

Feb 15, 2023 12:17 AM IST   Live Updates

Global mean sea-level increased by 0.20m between 1901 and 2018, with an average rate increase of 1.3 mm/ year between 1901 and 1971, 1.9 mm/year between 1971 and 2006, and 3.7 mm/year between 2006 and 2018, WMO said in its report

World Meteorological Organisation flagged large-scale impacts on Mumbai, Chennai, Kolkata and other coastal cities in the country. (Archives)

Scarcity of food and abundance of filth hit several Chennai pockets amid aftereffects of Cyclone Michaung

The 200-feet radial road connecting Pallavaram and Shollinganallur is out of bounds for the people and the rain due to Cyclone Michaung has left several streets in Chennai inundated.

India floods: 14 killed and 102 missing after lake overflows and highways washed away

Catastrophic overflow of Lhonak Lake in state of Sikkim caused a dam to partially collapse and submerged army bases

Glacial lake bursts its banks, triggering flash floods in north-east India – video

Source: CSE India(2023)

Literature Study: Frameworks, Reports & Programs

UN Habitat: Urban Planning Law for Climate Smart Cities

- This emphasizes **the integration of climate resilience and sustainability principles** into urban planning processes
- It also recognizes the central role of **WASH in promoting sustainable urban development, public health, and climate resilience,** and seeks to integrate these considerations into urban planning processes and policies.

Municipal Acts and Bye-laws

- The Bombay Municipal Corporation Act, 1888: "*a concession in payment of property tax in respect of building and land, wherein any such socially or ecologically beneficial scheme.*"
- **Magarashtra Comprehensive Uniform Building Code, 2013:** Rainwater harvesting, solar water heating and wastewater recycling & reuse.
- **Comprehensive Development Control Regulations – 2017, Gujarat:** Rainwater harvesting, solar water heating, wastewater recycling & reuse, Solid waste management, Tree plantation and Energy efficiency.

Mumbai Climate Action Plan 2022

- "*The MCAP is committed to a net zero and climate-resilient Mumbai by 2050*"
- MCAP recognizes that actions must be taken on priority across six strategic areas - **Sustainable waste management, Urban greening & biodiversity, Urban flooding & water resource management, Energy & buildings, Air quality and Sustainable mobility.**

Climate Action Plan Chennai 2022

- "*Resilient and Pro-active Chennai*"
- CCAP focused on sectors like **Decarbonizing the electric grid, Energy efficiency, Transportation, Sustainable waste management, Managing urban flood & water scarcity and Public health.**

World bank Climate Change Action Plan

- The action plan focused on the impact of **climate finance**, aiming for measurable improvements in adaptation and resilience and measurable **reductions in GHG emissions.**

IPCC Sixth Assessment Report: Climate Change Impact and Mitigation

- Global assessment of climate change **mitigation progress** and pledges and examines the sources of **global emissions**. It explains developments in emission **reduction and mitigation efforts, assessing the impact** of national climate pledges in relation to long-term emissions goals.

IPCC Sixth Assessment Report: Climate Change Adaptation & Mitigation

- Report assesses the **impacts of climate change, looking at ecosystems, biodiversity,** and human communities at global and regional levels. It also reviews **vulnerabilities and the capacities** and limits of the natural world and human societies to adapt to climate change.

Water for Women: Knowledge and Practice Gaps in Climate Resilient Inclusive WASH

- This report outlines the **unique strengths and contributions that Water for Women** can make to building climate **change resilience and adaptation in inclusive water, sanitation and hygiene (WASH),** through contributions to the regional and global WASH sector and enhanced internal capacity

NIUA: ClimateSmart City Assessment Framework

- Focused on overall assessment of **Urban infrastructure**

C40: Urban Climate Action Impacts Framework

- Catered to **Socio-economic and environmental** aspects.

ICLEI: Climate Neutrality Framework

- This framework covers the **Resilient Development**

CURB: Climate Action for Urban Sustainability

- **Scenario planning tool** designed to assist cities in climate action.

URDPFI: Sustainability Guidelines

- Integrating sustainability principles in planning process and development

Performance Assessment Systems (PAS)

- PAS is an assessment framework for service delivery of a city, it helps the ULB to identify areas of well-performing and poorly-performing areas in the three sectors.

- The Framework developed around **5 themes and a set of 28 Key Performance Indicators**

- A set of **100+ local action indicators are also developed** to assist the ULB in keying down the local ULB-level actions

- The framework has in total **4 sectors, Water Supply, Sanitation, Solid waste and Stormwater.**

5 Themes   28 KPIs   100+ LAIs

Water Supply

29 Indicators

Measure	Indicator	Unit
Resource Management	Number of alternate water sources	Number
	Distance of water source from the city	Km
	Amount of water extraction from the source	MLD
	Ratio of storage capacity to water demand	%
	Per capita water consumption	Lpcd
	Groundwater extraction for water supply	Y/N
	Groundwater monitoring	Y/N
	Groundwater extraction as per the limit allocated	Y/N
	Aquifer management plan	Y/N
Infrastructure & Technology	Water supply coverage	%
	Location of WTP at a higher topographical level (gravity-led system)	Y/N
	Real-time monitoring	Y/N
	Water metering	Y/N
	Extent of non-revenue water	%
	Conducting of water audit	Y/N
	Conducting of energy audit	Y/N
	Renewable energy options	Y/N
	Percentage of total electricity consumption from renewable sources	%
Emergency Response & Resilience	Resilient infrastructure to withstand disasters	Y/N
	Complaint redressal (line breakage)	Y/N
	Waterborne disease	Y/N
	Time to restore water supply services after a disaster	Hours
Policy & Bye-laws	Water conservation policies & programs currently in place	Y/N
	Incorporation of climate data in water management planning	Y/N
	Energy efficiency and GHG reduction policies & programs in water supply infrastructure	Y/N
	Implementation of these policies & programs at city level	Y/N
	Monitoring of the policies & programs	Y/N
	Percentage of budget for climate-oriented projects	%
Public Participation	Public awareness and engagement for water conservation	Y/N

	Water
Resource Management	9 (1) (1)
Infrastructure & Technology	9 (5)
Emergency Response & Resilience	4 (1)
Policy & Bye-laws	7
Public Participation	1 (1)

47

Measure	Indicator	Unit
Resource Management	Extent of wastewater recycle and reuse	%
	Extent of fecal sludge recycle and reuse	%
	Sewage quality check before discharging into nature	Y/N
Infrastructure & Technology	Infrastructure Coverage	%
	Location of STP at a lower topographical level (gravity-led system)	Y/N
	Integrated sewer system or separate lines for stormwater	Y/N
	Availability of Fecal sludge treatment plant	Y/N
	Real-time monitoring	Y/N
	Nature-based treatment technology	Y/N
	Conducting of energy audit	Y/N
	Renewable energy options	Y/N
	Percentage of total electricity consumption from renewable sources	%
Emergency Response & Resilience	Resilient infrastructure to withstand disasters	Y/N
	Complaint redressal (open spillage)	Y/N
	Disease due to sewage spillage	Y/N
	Time to restore sanitation services after a disaster	Hours
Policy & Bye-laws	Sanitation policies & programs currently in place, resilience	Y/N
	Incorporation of climate data in sanitation management planning	Y/N
	Energy efficiency and GHG reduction policies & programs in sanitation infrastructure	Y/N
	Implementation of these policies & programs at city level	Y/N
	Monitoring of the policies & programs	Y/N
	Proportion of budget for climate-oriented projects	%
Public Participation	Public awareness and engagement for wastewater reuse for non-portable uses	Y/N
	Promoting dual plumbing system at residential level for grey water reuse	Y/N

Sanitation
24 Indicators

	Sanitation
Resource Management	3 (2)
Infrastructure & Technology	9 (2)
Emergency Response & Resilience	4 (1)
Policy & Bye-laws	7
Public Participation	2

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Solid Waste Management

26 Indicators

Measure	Indicator	Unit
Resource Management	Percentage of reduction in waste generation	%
	Waste diverted from landfill	Y/N
	Dry waste recycled and reuse	Y/N
	Organic waste recycled and reuse	Y/N
	E-waste collection and treatment	Y/N
	Medical waste collection and treatment	Y/N
	C&D waste collection and treatment	Y/N
	Waste to energy initiative	Y/N
	Open Burning of waste	Y/N
	Littering of waste in the city	Y/N
Infrastructure & Technology	Waste segregation at source	Y/N
	Regular Door-to-door Collection	Y/N
	Drainage blockage due to waste	Y/N
	Waste accumulation in and around water bodies	Y/N
	Percentage of E-Vehicles	%
	Landfill distance from the city	Km
Emergency Response & Resilience	Complaint redressal (littering)	Y/N
	Disease due to waste accumulation around	Y/N
	Time to restore waste management services after a disaster	Hours
Policy & Bye-laws	Waste management and reduction policies & programs currently in place	Y/N
	Incorporation of climate data in waste management planning	Y/N
	Energy efficiency and GHG reduction policies & programs in waste management infrastructure	Y/N
	Implementation of these policies & programs at city level	Y/N
	Monitoring of the policies & programs	Y/N
	Proportion of budget for climate-oriented projects	%
Public Participation	Public awareness and engagement for waste reduction	Y/N

	Solid waste
Resource Management	10 (5)
Infrastructure & Technology	6 (1) (1)
Emergency Response & Resilience	3 (1)
Policy & Bye-laws	7
Public Participation	1 (1)

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Measure	Indicator	Unit
Resource Management	Rainwater harvesting at city level	Y/N
	Green infrastructure area (parks, urban forests, sponges)	%
	Reduction in urban heat island intensity	Y/N
	Lake interlinking projects	Y/N
	Water body rejuvenation and revitalization projects	Y/N
	Water body cleaning initiatives	Y/N
Infrastructure & Technology	Stormwater network present in the city	Y/N
	Real-time monitoring	Y/N
Emergency Response & Resilience	Resilient infrastructure to withstand disasters	Y/N
	Early warning system for flooding	Y/N
	Complaint redressal (water logging)	Y/N
	Disease due to water logging	Y/N
	Percentage of area under flood-risk map	%
Policy & Bye-laws	Flood risk reduction policies & programs currently in place	Y/N
	Implementation of these policies & programs at city level	Y/N
	Monitoring of the policies & programs	Y/N
	Incorporation of climate data in stormwater management planning	Y/N
	Proportion of budget for climate-oriented projects	%
Public Participation	Public awareness and engagement for flood risk	Y/N
	Rainwater harvesting policy at building level	Y/N

Stormwater Management

22 Indicators

	Stormwater
Resource Management	7 (2)
Infrastructure & Technology	2
Emergency Response & Resilience	5
Policy & Bye-laws	6
Public Participation	2

50

Type of Indicators

There were 3 categories of indicators based on their character and scoring method

	Qualitative	Quantitative	Binary
Water Supply	7	13	3
Sanitation	6	7	5
Solid waste Management	5	7	6
Stormwater Management	5	3	8
Total	23	30	22

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