

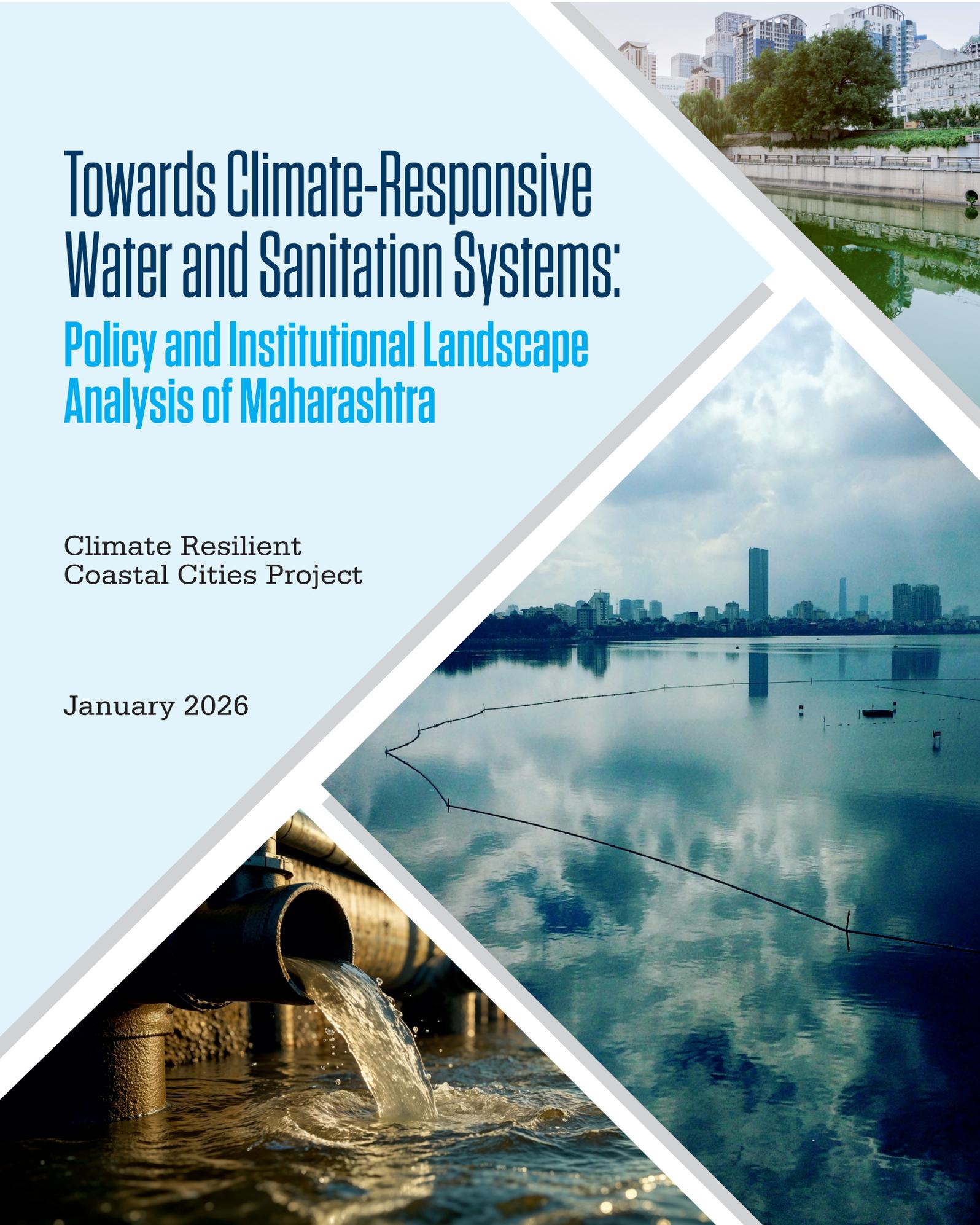
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Towards Climate-Responsive Water and Sanitation Systems: Policy and Institutional Landscape Analysis of Maharashtra

Climate Resilient
Coastal Cities Project

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The collective research work undertaken through this initiative represents an important step towards advancing climate-responsive water and sanitation planning along India's west coast. The findings and recommendations presented in this report are intended to support urban local bodies and policymakers in strengthening the resilience, adaptability, and sustainability of WaSH systems.

Preface

Evidence indicates a marked increase in the frequency and intensity of cyclonic events along India's west coast, accompanied by rising sea levels, saline intrusion, and extreme rainfall. These climate-related pressures are being compounded by rapid urbanisation, population growth, and expanding economic activity in coastal cities, placing significant stress on freshwater aquifers and essential urban services such as water and sanitation. Recognising this, HSBC India, India Sanitation Coalition (ISC) at FICCI, the Ashank Desai Centre for Policy Studies (ADCPS) at Indian Institute of Technology - Bombay (IIT Bombay), and the Consortium for DEWATS Dissemination India (CDD India) formed a strategic partnership in July 2023 to address the emerging climate risks confronting coastal urban regions. This collaboration was formalised as the *Climate Resilient Coastal Cities (CRCC)* initiative in September 2023. Phase I of the initiative was implemented between September 2023 and December 2025 across four coastal states along India's western seaboard: Goa, Gujarat, Karnataka, and Maharashtra.

Within this context, the CRCC initiative focuses on strengthening the climate resilience of Water, Sanitation, and Hygiene (WaSH) infrastructure and service delivery systems-critical foundations for public health, environmental sustainability, and the long-term viability of coastal urban settlements. The initiative adopts an integrated approach that combines applied research with targeted implementation to support informed planning and decision-making. The project was guided by four interrelated objectives: (i) assessing the climate resilience of WaSH infrastructure and services in selected coastal towns; (ii) analysing the water-energy-climate policy landscape relevant to coastal urban systems; (iii) designing and implementing targeted interventions to enhance resilience in priority locations; and (iv) developing practical, scalable recommendations to strengthen system-level climate resilience.

Under the CRCC initiative, ADCPS-IIT Bombay, as the core research partner, conducted town-level situation assessment studies along with national and state policy and institutional landscape analyses. The town studies assessed the status, challenges, risks, financial sustainability, and greenhouse gas (GHG) footprint of water and sanitation systems, and proposed recommendations to enhance the resilience of such systems. These studies were carried out in twelve towns-three each in Goa (Canacona, Mapusa, and Mormugao), Gujarat (Mandvi, Devbhumi Dwarka, and Valsad), Karnataka (Karwar, Kundapura, and Mangalore), and Maharashtra (Alibag, Ratnagiri, and Vengurla). The policy and institutional landscape analysis covered the national level and the four states, with the aim of examining how urban water, sanitation, and climate change policies interact to shape broader governance and planning frameworks for resilient urban water and sanitation systems. CDD India as a research and implementation partner focused on three coastal towns in Maharashtra (Dahanu, Guhagar, and Malvan), translating assessment findings into actionable Climate Resilient Sanitation Plans (CRoSAPs) to support local implementation and decision-making.

Implementation activities under the CRCC initiative included policy consultations, capacity-building workshops, and field exposure visits for government officials and key local stakeholders, including Self-Help Groups (SHGs). These activities were jointly facilitated by CDD India, ADCPS-IIT Bombay and ISC. The initiative also enabled structured engagement with sector experts and practitioners. Complementing these efforts, CDD India led community-level mobilisation activities in the study towns, including awareness campaigns and tree plantation drives, to foster local ownership and strengthen community participation in climate resilience efforts.

India Sanitation Coalition (ISC) at FICCI has served as the anchor organisation for the initiative, leading advocacy and outreach efforts and supporting the dissemination of evidence, best practices, and policy-relevant insights. ISC has also contributed to the editorial review of the reports to enhance clarity, coherence, and accessibility. In addition, ISC has articulated the potential role of corporate actors in supporting similar climate-responsive WaSH initiatives in the future. HSBC India has provided financial support for the research, implementation, and outreach components of the initiative. In parallel, the initiative seeks to catalyse larger-scale investments in climate-resilient WaSH infrastructure by aligning with and leveraging resources already committed under the Swachh Bharat Mission (SBM) 2.0.

The findings and learnings from the initiative are being disseminated through a comprehensive suite of outputs comprising one National Report, four State Reports (Goa, Gujarat, Karnataka, and Maharashtra), and fifteen Town Reports-three each from Goa, Gujarat, and Karnataka, and six from Maharashtra. This report constitutes one of the twenty reports produced under the CRCC initiative.

It is hoped that the insights from the study will inform future policy and planning actions and investments aimed at strengthening climate-resilient water and sanitation infrastructure and services in India's coastal towns.

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Executive Summary

Maharashtra, one of India's most urbanised and climate-vulnerable states, faces escalating risks from floods, droughts, sea-level rise, and cyclones. Recognising the critical link between climate change and resilient water, sanitation, and hygiene (WaSH) services, this study examines how climate, water, and sanitation policies interact at the state and local levels. Drawing on fieldwork in the towns of Vengurla, Alibag, Ratnagiri, Dahanu, Malvan, and Guhagar, it identifies systemic policy, institutional, and implementation challenges. It proposes actionable recommendations across five key areas: financial schemes and programmes, institutional structures, climate policy integration, infrastructure resilience, and coastal adaptation strategies.

Despite the presence of climate action and disaster management frameworks, Maharashtra's capacity to adapt remains constrained, especially in smaller towns. These towns suffer from inadequate WaSH infrastructure, weak service quality, and financial fragility, all of which undermine their resilience to climate impacts. Sewerage projects continue to be under-prioritised in comparison to water supply projects. Urban Local Bodies (ULBs) now heavily rely on state and central transfers, are facing financial distress due to low-cost recovery, and have weak revenue mobilization. This is limiting Maharashtra ULB financial autonomy and decision-making power. While there has been progress in areas like faecal sludge management and energy-efficient technologies, mitigation efforts to reduce GHG emissions in the WaSH sector remain poorly developed and weakly integrated into broader policy frameworks.

The analysis reveals that Maharashtra's policy and funding focus is strongly skewed towards adaptation efforts of improving service, which is understandable given that none of its towns currently meet the Service Level Benchmarks (SLBs) for water supply and sanitation. This focus on improving service delivery over reducing GHG emissions highlights a central policy blind spot: the lack of explicit, evidence-based mitigation strategies. Compounding this gap is the limited capacity of ULBs to understand or address the intersection of climate change and WaSH, as well as significant fragmentation in institutional mandates and inter-agency coordination. Crucially, there is little integration between WaSH infrastructure planning and disaster risk reduction efforts.

Nonetheless, the study documents positive examples at the local level, particularly in Vengurla, where decentralised wastewater treatment systems, proactive solid waste management, rooftop solar initiatives, and mangrove conservation efforts contribute meaningfully to both adaptation and mitigation goals. Malvan also reflects several positive practices, including proactive solid waste management, mangrove conservation activities, focused Marine Sanctuary management efforts, and relatively well-maintained public facilities owing to its tourism-driven character. Guhagar demonstrates similar strengths, particularly in solid waste management optimization and ongoing mangrove conservation work that enhance ecological resilience. While these elements are encouraging, both towns still require further refinement and strengthening of their systems to improve long-term climate resilience. At the same time, beyond these positive aspects, several contrasting challenges continue to exist across the coastal towns—Malvan, Guhagar, Dahanu, Alibag, and Ratnagiri illustrate key infrastructure and governance deficits—including the absence or poor functioning of faecal sludge treatment plants.

Based on these findings, the study recommends several strategic interventions. Maharashtra has benefited from increased funding through AMRUT and SBM, but water supply and sanitation remain among the least-funded sectors, with water supply consistently prioritized over sewerage. While allocations are rising, especially for smaller and medium towns, ULBs face financial distress due to low cost recovery, weak revenue mobilization, and heavy reliance on grants, which undermines their autonomy. Case studies from Malvan, Guhagar, Dahanu, Ratnagiri, and Vengurla reveal persistent fiscal deficits, outdated tariffs, and systemic weaknesses in financial management. Strengthening the sector requires rebalancing priorities toward sanitation, ensuring adequate fiscal devolution, improving ULB revenue systems, revising tariffs, and adopting alternative financing. Integrated planning, cost-control measures, and performance-based grants will be critical to building resilient, financially sustainable, and inclusive water and sanitation systems. Institutional reforms are needed to clarify roles and reduce duplication among state agencies, integrate ULBs into infrastructure planning and disaster governance frameworks, and extend regulatory oversight to household-level sanitation systems. Policy integration must be strengthened to incorporate mitigation into existing WaSH and climate strategies, accelerate the adoption of energy-efficient technologies, promote rainwater harvesting and wastewater reuse, and address horizontal policy coherence gaps.

In terms of infrastructure resilience, it is critical to mainstream climate-resilient design and planning in all new WaSH projects. This includes incorporating climate projections, flood forecasting, and early warning systems into planning processes, enforcing hazard-based land-use and building regulations, retrofitting vulnerable infrastructure, and utilising advanced technologies such as IoT sensors and GIS-based risk mapping to monitor and manage systems proactively. Finally, Maharashtra's coastal regions, which are highly vulnerable to climate

risks such as sea-level rise, saline intrusion, and cyclones, require a dedicated focus. Currently, there is no national mission for coastal climate resilience, and enforcement of existing policies remains fragmented. The state's adaptation plan (MSAAPC) acknowledges coastal vulnerabilities and promotes protective measures, such as groundwater recharge, rainwater harvesting, and wastewater treatment. Local initiatives in Vengurla, such as mangrove restoration, traditional Bandhara construction, and decentralised waste management, illustrate effective ecosystem-based approaches. Similar efforts are also emerging in towns like Malvan and Guhagar, where optimization in existing solid waste management and ongoing mangrove conservation contribute to local resilience. These must be scaled and replicated across other coastal towns. Nationally, a mission focused on coastal adaptation should be established, accompanied by more vigorous enforcement of CRZ guidelines, expanded measures to counter saltwater intrusion, enhanced local institutional capacity, and cross-agency coordination for coastal infrastructure resilience.

Overall, this study concludes that Maharashtra's policy landscape must evolve to systematically address both adaptation and mitigation challenges in the WaSH sector towards achieving climate resilience. Bridging governance gaps, strengthening financial mechanisms, and investing in local capacity building will be crucial to ensuring sustainable, climate-resilient water and sanitation services—particularly in the state's most vulnerable and rapidly growing coastal towns.

1. INTRODUCTION

Global Climate Risk Index 2021 ranks India as the seventh-most exposed and vulnerable country to climate extremesⁱ. With high risk of concurrent flood incidents, the country is amongst the most climate-vulnerable, as per an IPCC report (Intergovernmental Panel on Climate Change, 2023). This is especially true for the nearly 171 million population in coastal districts. India is highly susceptible to cyclones and related hazards such as storm surges, intense winds, and extreme rainfall. More than 300 extreme events have occurred in the country in recent decades, resulting in financial losses exceeding INR 5,600 billion (Mohanty, et al., 2020). A recent evaluation indicates that more than 75% of districts in India, including 95% of coastal districts, are hotspots for extreme events (Mohanty, et al., 2020).

West Coast: Increasing Climate Risks

While the east coast has faced greater exposure to tropical cyclones (TC), recent trends highlight the Arabian Sea (west coast) with increased cyclonic formations (Deshpande, et al., 2021). The Arabian Sea has emerged as a key region for tropical cyclones in recent years, that have led to severe impacts across the western coast of India (Thomas & Lekshmy, 2022). Between 2001 and 2019, the frequency of cyclonic storms in the Arabian Sea surged by 52%, while the Bay of Bengal (east coast) recorded an 8% decline (Deshpande, et al., 2021). Coastal districts of Gujarat, in particular, have become increasingly vulnerable (Boragapu, Guhathakurta, & Sreejith, 2023). This rise in frequency and intensity of Arabian Sea cyclones has been attributed to the rapid increase in sea surface temperatures (Deshpande, et al., 2021). Compounding these risks, west coast states are more vulnerable to sea level rise; every one-metre rise in sea level can inundate approximately 5,763 km² of land (Woodruff, BenDor, & Strong, 2018). The situation is further aggravated by significant loss of mangrove ecosystems, which are projected to continue declining beyond 2100, as per UNFCCC-IPCC 2023 report.

Climate Risks and Water and Sanitation Infrastructure and Services: Amplifying Inequalities

Access to basic services such as housing, improved sanitation, and safe drinking water forms the first line of defence against the potential impacts of climate change. These services are essential for enhancing people's resilience and adaptive capacity. Especially following climate hazards such as heavy rainfall, ensuring access to appropriate and reliable WaSH services plays a vital role in protecting populations from water-related diseases and flooding (Carlton, et al., 2014).

Further exacerbating the risks posed by climate change is the inadequate infrastructure and services in critical areas such as housing, sanitation, water, and public health, particularly for socio-economically disadvantaged groups (Rumbach, 2018); (Yenneti, Tripathi, Wei,

Chen, & Joshi, 2016). This is particularly critical in small towns, which are already finding it challenging to provide universal access to water and sanitation services (Central Pollution Control Board, 2021), and are now exposed to climate change-related risks. Climate change-induced water stress and insecurity can increase the incidence of waterborne infectious diseases, thereby hindering or reversing advancements made in related Sustainable Development Goals (SDG) targets and amplifying inequalities (Braks & Husman, 2013). The IPCC views universal access to WaSH, i.e., achieving SDG 6.1 and 6.2, as a critical adaptation strategy, with high confidence (Caretta, 2022) and a low-regret adaptation measure (Cutter, 2012). Further, SDG 1 (No Poverty) is found to be statistically linked to SDG 6 (Clean Water and Sanitation), as reducing poverty enhances adaptive capacity in alignment with the Paris Agreement's adaptation goals (Pradhan, 2019) (Pradhan, 2019). Likewise, achieving SDG 3 (Good Health and Well-being) depends heavily on reliable access to water and sanitation infrastructure (Toni Delany-Crowe, 2019). The Intergovernmental Panel on Climate Change (IPCC) recognises universal access to water, sanitation, and hygiene (WaSH)—as targeted in SDGs 6.1 and 6.2—as a critical, low-regret adaptation strategy, supported by high confidence (Caretta, 2022) (Cutter, 2012). Moreover, ensuring universal access to WaSH not only contributes directly to SDG 11 (sustainable cities and communities) but also promotes social equity and environmental sustainability.

Studies have predicted substantial economic losses across various sectors in India due to climate change (Chaturvedi, 2015); (Kumar & Maiti, 2024). For Mumbai, sea-level-rise-induced damage to building foundations between 2005 and 2050 is estimated at INR 1,501,725 crores. (Kumar, Jawale, & Tandon, 2008). Furthermore, a 2.5% decrease in growth rate is expected for India with a one-degree Celsius temperature increase (Jain, O'Sullivan, & Taraz, 2020). Such economic losses may ensue from the diminished functionality of the infrastructure and, consequently, the provision of related services (Kreibich, et al., 2014) such as critical services like water and sanitation. For example, in Alibag (a small coastal town in Raigad district, Maharashtra), power lines were damaged, which led to the disruption of the water supply. This lasted for 8 hours since the town did not have the necessary alternative infrastructure to restore the power supply. In this context, IPCC underscores the importance of making WaSH infrastructure climate-resilient (Ben A. Smith, 2015); Shah et al., 2020) (Ashfaq Ahmad Shah, 2020). Resilient infrastructure systems should not only be able to absorb and resist the impacts of disasters but also ensure uninterrupted service delivery during crises. Moreover, they must recover quickly in a manner that reduces future vulnerabilities. Integrating resilience into the design, planning, and operation of water and sanitation systems is critical for safeguarding public health and ensuring sustainable service delivery in a changing climate. Further, beyond implementing new infrastructure, the expansion and replacement of existing WaSH systems offer crucial opportunities to integrate

climate-resilient approaches and reduce greenhouse gas (GHG) emissions (Boholm & Prutzer, 2017), (Dickin, Bayoumi, Giné, Andersson, & Jiménez, 2020).

With this understanding, a landscape study on climate resilient water and sanitation infrastructure across four west coast states was initiated under the *Climate Resilient Coastal Cities* project – a collaborative initiative of HSBC India, the India Sanitation Coalition (ISC) at FICCI, the Ashank Desai Centre for Policy Studies at IIT-Bombay (henceforth will be referred to as IIT-Bombay, unless specified otherwise) and CDD India. The initiative aims to (i) assess the climate resilience of WaSH infrastructure and services in fifteen coastal towns across the four states (ii) analyse the related water-energy-climate policy landscape, (iii) design and implement town-level solutions in select locations, and (iv) propose recommendations to strengthen the resilience of WaSH systems. IIT-Bombay and CDD India were the research and implementation partners. Both partners conducted town-level assessments of existing WaSH infrastructure, with CDD India focused on three towns in Maharashtra and translating the assessments into actionable climate resilient sanitation plans (CRSAPs), and IIT-Bombay, focused on the remaining twelve towns (three per state) within the scope of understanding the water-energy-climate policy landscape. IIT-Bombay additionally focused on providing similar analysis and understanding at the state level (for each state) and national level.

Among the selected states, **Maharashtra is listed among the top three most climate-vulnerable states.** (Mohanty & Wadhawan, 2021). Karnataka ranks among India's top four most climate-vulnerable regions. (Mohanty & Wadhawan, 2021). Gujarat, with a 1,600 km-long coastlineⁱⁱ—the longest in India—and nearly 9.9 million people living across 40 coastal talukas, faces heightened exposure to climate-related hazards, including sea-level rise, cyclones, storm surges, strong winds, heavy rainfall, and salinity ingress. Goa too is highly vulnerable, with projections indicating that a 1-meter rise in sea level could affect nearly 7% of its population, potentially submerging key coastal areas.

This report focuses on presenting the study findings for the state of Maharashtra, which has a 720 kmⁱⁱⁱ long indented coastline that is vulnerable to cyclones and tsunamis. (National Centre for Disease Control , 2022). **Maharashtra is also observing higher temperatures in coastal cities, such as Mumbai, Dapoli, and Ratnagiri.** (National Centre for Disease Control , 2022). **The state, the third most urbanised state in India, is also one of the major contributors towards urban domestic wastewater related methane emissions in the country** (Shroff, Caleb, Kolsepatil, & Mishra, 2019); (Mohanty, et al., 2020). **The heightened vulnerabilities to disaster risks in Maharashtra can be attributed to an expanding population, urbanisation, industrialisation, development within high-risk zones, environmental degradation, and climate change.** (National Centre for Disease Control ,

2022). The state has established a Climate Cell to facilitate the integration of climate change considerations across various sectors. However, there is an urgent need to update the State Action Plan on Climate Change to reflect current realities, as the last version was released a decade ago in 2014. Nevertheless, Maharashtra has introduced several policies and programmes that directly or indirectly contribute to adaptation and mitigation efforts in the water and sanitation sector.

The findings provide insights on the policy and governance landscape in Maharashtra concerning urban water, sanitation, and climate change, focusing on how these sectoral policies interact and the implications for both. This includes a review of relevant policies, programmes, and schemes to assess how they address these intersections—whether through the lens of adaptation, mitigation, or infrastructure resilience. **Particular attention is paid to how climate change impacts water and sanitation infrastructure and services (adaptation, adaptive capacity, and infrastructure resilience dimensions), and conversely, how these sectors contribute to climate change (mitigation dimension).** This analysis draws on the Intergovernmental Panel on Climate Change (IPCC) understanding of Adaptation, *Adaptive capacity, and Mitigation*^{iv}. **Within the IPCC’s framework of “universal access” to WaSH, the key adaptation strategies highlighted are source water protection and augmentation (through conservation), integrated urban water management, strengthened water governance, rainwater harvesting, water conservation, leak reductions and infrastructure investments for resilience (Caretta, 2022).**

This study specifically aims to identify such solutions, while drawing on insights from the town-level studies (Alibag, Ratnagiri, Vengurla, Dahanu, Malvan, and Guhagar) that assesses implementation status and the challenges encountered on the ground. Mitigation refers to human interventions aimed at reducing greenhouse gas (GHG) emissions or enhancing carbon sinks. Accordingly, the **study analysis focuses on identifying policies and programmes that directly or indirectly contribute to GHG mitigation.** Further, infrastructure resilience to disasters is referred to as the capacity of disaster-resilient infrastructure systems to withstand and absorb shocks, maintain service continuity during crises, and recover rapidly in ways that reduce future risks (CDRI)^v. **Accordingly, this report also examines whether and how the state policies incorporate resilience principles into the design, planning, and operation of critical infrastructure—particularly water and sanitation systems.** The analysis also maps the roles and responsibilities of key agencies involved in water, sanitation, and climate change.

For clarity, the report is organised into seven sections. Section 1 offers a brief overview of the importance of studying west coast in relation to climate change and its impact on the water and sanitation infrastructure services in Maharashtra and vice-versa. Section 2 outlines the methodology adopted for data collection, followed by a brief profile of Maharashtra in Section

3. Section 4 explores the state’s climate exposure and vulnerability, with particular emphasis on the water and sanitation sector. Section 5 examines the prevailing funding landscape across key national and state-level programmes related to urban water supply and sanitation, while highlighting significant implementation challenges. Section 6 analyses the institutional framework by examining key actors across three tiers of governance and their respective roles in delivering water and sanitation services. It further explores the policy landscape at the intersection of water, sanitation, and climate change, with a particular emphasis on coastal policies, highlighting the state’s adaptation, mitigation, and infrastructure resilience measures. Drawing on town-level assessments, the section also reflects on ground-level implementation and institutional effectiveness. The report concludes by synthesising key insights and providing reflections to inform future planning and policy integration.

2. METHODOLOGY

This section highlights the methodologies adopted by the two research implementing partners, IIT-Bombay (IIT-B) and CDD India, for the Maharashtra study. IIT-B conducted a comprehensive state-level policy and governance analysis, as well as town assessments, of Alibag, Ratnagiri, and Vengurla. Meanwhile, CDD India employed a participatory approach to assess the vulnerabilities and adaptation strategies of three towns: Dahanu, Malvan, and Guhagar.

IIT-Bombay (IIT-B)

The study primarily relied on secondary data sources (as outlined in Table 1). A comprehensive desk-based review was conducted, systematically analysing national and state-level portals to compile an inventory of key policies and programmes related to urban water, sanitation, and climate change within the water and sanitation sector. This review also facilitated the identification of relevant stakeholders and their respective institutional roles in service delivery. Additionally, it provided an overview of the status of urban water and sanitation infrastructure and services in the state, as well as data on climate exposure, vulnerability, and projected impacts at the state and district levels—particularly important in the absence of such data at the town scale.

To complement the desk review, semi-structured interviews were conducted with key stakeholders and subject-matter experts to capture contextual insights on the policy and institutional frameworks governing water and sanitation, as well as climate change, in the state. The study also draws on town-level assessments conducted in Alibag, Ratnagiri, and Vengurla, which included field investigations and interviews with Urban Local Body (ULB) officials and district disaster management authorities (Table 2). These town-level assessments provided a grounded understanding of how state and national policies are being implemented at the local level (detailed findings are presented in the respective town assessment reports).

Table 1: IIT-B Data Collection Methods

Sl. No.	Objective	Data Collection Method	Data Sources
1.	To understand climate change projections, impacts and vulnerability	Secondary Data through Literature Review	Government reports: state climate change action plan, vulnerability assessment reports.
		Stakeholder semi-structured Interviews	District Disaster Officer, Alibag

2	To understand the status of WaSH services in the study area	Secondary Data through Literature Review	CPCB inventory reports, State government reports, Performance Assessment System (PAS) website
3	To understand linkages between climate change and WaSH policies	Secondary Data through Literature Review	
		Expert and stakeholder semi-structured Interviews	MoHUA, WRI, CEEW
4	To map the current institutional environment	Secondary Data through Literature Review	
		Expert and stakeholder semi-structured Interviews	MoHUA, WRI, District Disaster Officers
5	To map current financial sources for climate change and WaSH	Secondary Data through Literature Review	Performance Assessment System (PAS) website, SBM (urban)

The three towns were selected from a potential list after consultations with the State Mission Director of SBM-Urban, Maharashtra. Selection criteria included climate change vulnerability, sanitation ladder position, city size, and governance structure to ensure diverse policy evidence linking WaSH and climate change.

CDD India

A structured mixed-methods approach involving both primary research and secondary desk research was used to gain a deep understanding of the three towns of Dahanu, Malvan, and Guhagar. This included **various field surveys** regarding: **Status of household WaSH infrastructure and services** – This survey focused on gathering information regarding age, occupation, type of household WaSH infrastructure, accessibility to water, issues regarding water supply, toilet accessibility and functionality, type of containment system available, desludging frequency, wastewater management practices, and solid waste management. Stratified random sampling was used to obtain a representative sample of each town. The survey was conducted online via the Survey2Connect Field Force application. **Climate change perception in the town – It primarily focused on assessing the perception of climate change among town residents and the issues they face related to** climate change. Respondent exposure to climatic activities occurring in the towns, such as changes in the frequency of

climatic events (like the intensity of storms/cyclones), shifts in rainfall patterns, and consequences of climate change on their health, was captured via this survey. Changes in fish populations and the impact of climatic events on both the town and individual households were also captured. Respondents' attitudes towards climate change, as well as ways to mitigate climate change from the perspective of residents, were also probed. Additionally, the survey inquired about the local culture and the impact of tourism on towns in terms of employment. For a representative sample of each town, stratified random sampling was employed leading to a sample size of 50 for each town. The survey was conducted online via Survey123 by ESRI. **Assessment of types of agriculture and plantations** – To gain a fundamental understanding of the types of agriculture and plantations in the towns and the livelihoods they generate, a survey incorporating random sampling was carried out. **Status of tourist accommodation and tourist views** – A survey to understand the perception of tourists regarding infrastructure facilities and their view on sanitation facilities of towns was conducted. Random sampling was used for the survey. A separate survey to assess accommodation facilities in each of the towns in reference to the type of accommodation available, number of rooms available, number of tourists who booked their stay in the accommodation over the year, and the type of WaSH infrastructure available at the accommodation. **Status of water quality and salinity** – Water quality analysis was conducted on various samples collected from the towns of Mavan, Guhagar, and Dahanu. The samples included surface water bodies (taken from lakes and rivers), tap water (taken from town water supply), groundwater (collected immediately from shoreline and within 500 m and 1000 m from the shoreline), greywater, and marine water. For assessing quality of field water, groundwater samples at shoreline, within 500 m, within 1000 m, within 1500 m, and beyond were taken and analysed for salinity.

Key Informant Interviews (KII) and Focus Group Discussion (FGD) regarding: **Perceptions of fisherfolk** – To understand the livelihood of fisherfolk, their accessibility to the WaSH Infrastructure and their exposure to natural hazards, KIIs and 4 FGDs were carried out. Stratified random sampling was used to obtain a representative sample of this category of respondents for the KIIs.

Secondary research was conducted regarding Rainfall data, analysing 30 years of data spanning from 1993 to 2022 for the Malvan, Guhagar, and Dahanu weather stations to provide a comprehensive view of precipitation trends and shifts over three decades. The data was procured from IMD and enabled the examination of both decadal and seasonal variations, offering insights into long-term patterns and changes in weather conditions across these regions. **Temperature data** – Analysis spanning the same years, 1993 to 2022, for the three towns of Malvan, Guhagar, and Dahanu was also conducted, which further contributed to the examination of both decadal and seasonal variations in weather conditions. Insights,

long-term patterns, and changes were drawn from IMD ground-based gridded minimum and maximum temperature data for each of these towns.

Overall, for the state of Maharashtra, the project focused on the six Urban Local Bodies (ULBs) in Raigad (Alibag), Ratnagiri (Ratnagiri, Guhagar), Sindhudurg (Vengurla, Malvan), and Palghar (Dahanu) districts (Table 2).

Table 2: List of Towns Selected in Maharashtra

Town	District	Population (2011)	Class
Alibag	Raigad	20,743	Class-III
Ratnagiri	Ratnagiri	76,229	Class-II
Vengurla	Sindhudurg	12,392	Class-IV
Town	District	Population (2011)	Tier*
Dahanu	Palghar	5,0287	Tier-II
Malvan	Sindhudurg	1,8648	Tier-IV
Guhagar	Ratnagiri	7,299	Tier-V

* Population based categorization

Study Limitations

The findings presented in this report should be viewed in consideration of a few study limitations: **Representation of Urban Areas** – Six towns were examined in greater detail to illustrate local realities. While these case examples provide valuable insights, they may not fully represent the diversity of conditions across all urban areas in the state. **Differences in Research Focus** – The research implementation partners had differing research objectives. Consolidation of information has therefore been undertaken to the best extent possible, though some variation in comparability may remain. **Scope of the Report** – The study focuses on selected aspects of the water and sanitation sector that are most relevant for climate resilience and service delivery. It is not intended as an exhaustive review of the entire WaSH space but highlights priority areas where policy attention can strengthen outcomes. **District Boundary Changes** – Palghar district was carved out of Thane in 2014^{vi}. Since many key datasets (e.g., Census 2011, and in some cases NFHS-4, 2015–16) were compiled before or around this reorganisation, they often do not report Palghar separately. In such cases, figures reported for Thane include the present-day Palghar region. Accordingly, data for Thane before 2014 should be interpreted as encompassing both the current Thane and Palghar districts and

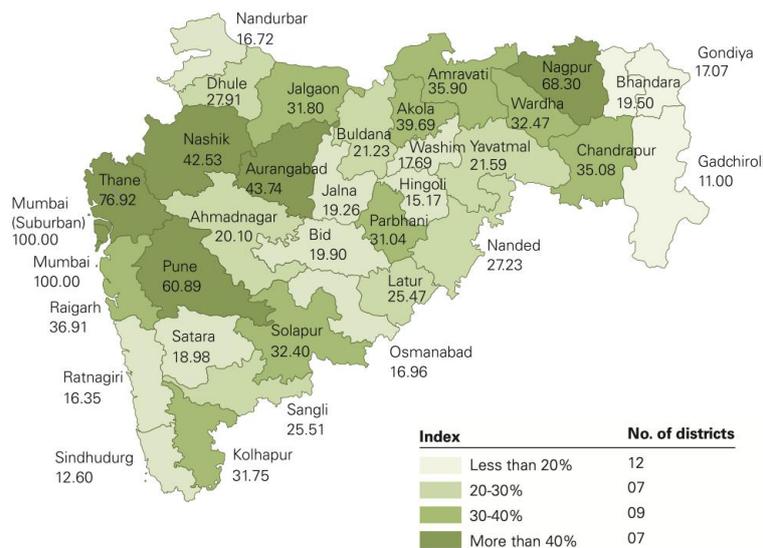


should only be indicative for the Palghar district. Wherever possible, more recent sources that distinguish Palghar have been used.

3. STATE OVERVIEW

Maharashtra, situated in Western and Central India, has a coastline of approximately 720 kmⁱⁱⁱ along the Arabian Sea. With a population of 112.4 million (Census 2011) and a geographical area of 0.308 million sq. km, the state ranks second in population and third in area among Indian states. (Water Resources Department, 2019). Maharashtra is the third most urbanised state in India, with 51 million urban population in 2011 (Mohanty, et al., 2020). Among different districts, urbanisation is highest in the Mumbai suburban district, Nagpur, Thane, and Pune (Figure 1). The urban population in the state increased by 24 per cent compared to 10 per cent in rural areas between 2001 and 2011 (Bhagat, 2019). With increasing urbanisation comes increased pressure on water resources and basic sanitation services.

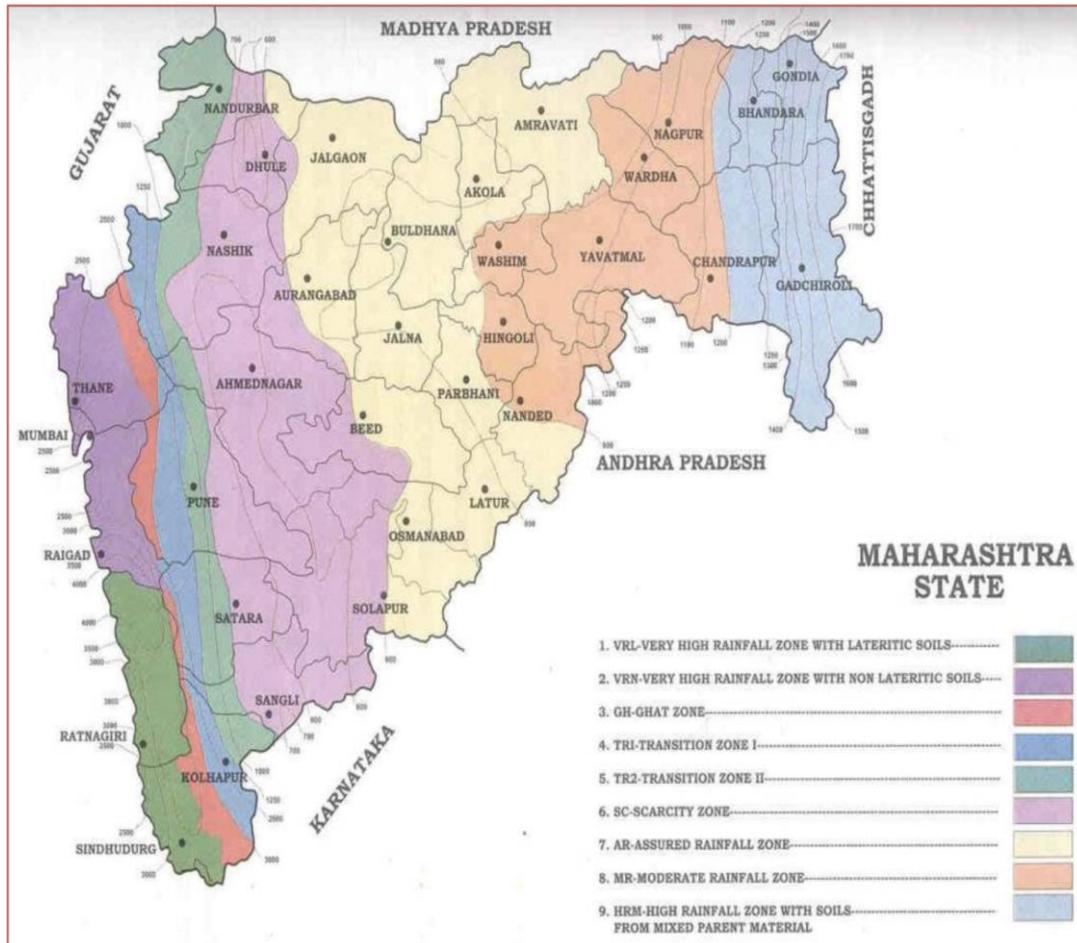
Figure 1: Level of Urbanisation in Districts of Maharashtra (Census 2011)



Source: (Maharashtra Directorate of Economics and Statistics, n.d.)

The state spans over seven agroclimatic zones, resulting in significant spatial and temporal variations in rainfall (Figure 2). Average annual precipitation ranges from 400 to 6000 mm, with frequent droughts affecting approximately 42.5% of the state's area (Mohanty, et al., 2020). The coastal regions fall into the hot humid-per humid eco-region, with hot and humid summers, warm winters and more than 2000 mm mean annual rainfall. (Institute for Sustainable Communities, 2021).

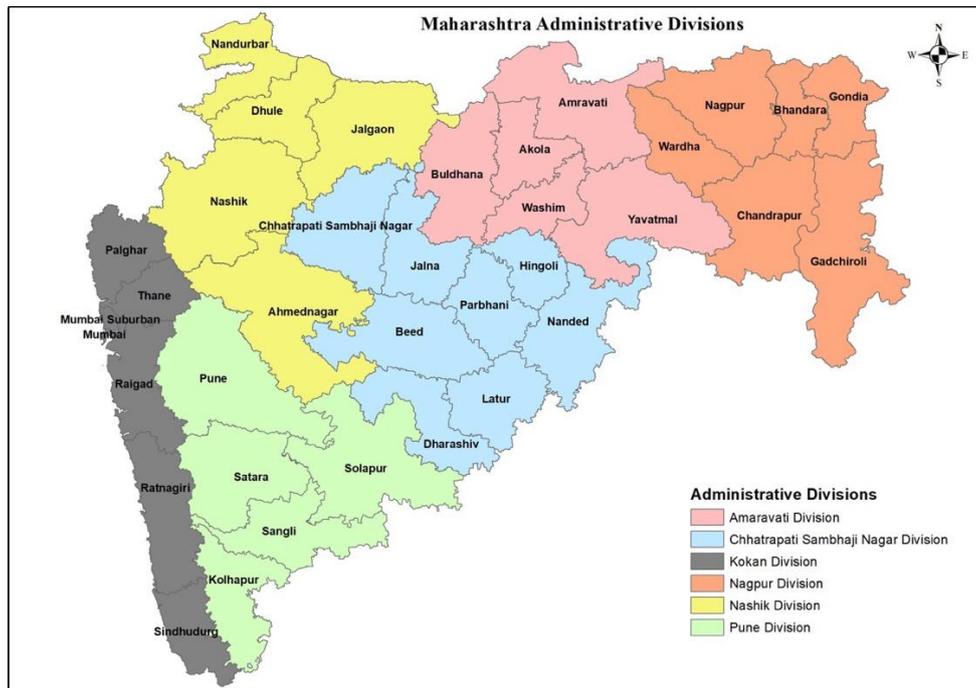
Figure 2: Agro-climatic Zones in Maharashtra



Source: Indian Council of Agricultural Research^{vii}

The state is divided into six administrative divisions, namely Konkan, Pune, Nashik, Aurangabad, Amravati, and Nagpur (Figure 3). The current project focuses on the Konkan division, which falls under the Konkan basin (Figure 4) and comprises seven districts: Ratnagiri, Sindhudurg, Raigad, Palghar, Mumbai City District, Mumbai Suburban, and Thane.

Figure 3: Administrative Division Map of Maharashtra



Source: Government of Maharashtra^{viii}

Figure 4: Maharashtra River Basin Map



Source: Maharashtra Water Resources Regulatory Authority^{ix}

With the highest number of municipal corporations and census towns and 44% urban population, the Konkan division is one of the most urbanised divisions in the state. (Mohanty, et al., 2020). At the district level, the urban population in Raigad, Ratnagiri, Sindhudurg, and Palghar^x districts are 37%, 16%, 13%, and 45% (Mohanty, et al., 2020). Climate change vulnerabilities for the selected towns, located within the Konkan division, are discussed in Section 4.

4. STATE CLIMATE CHANGE VULNERABILITY

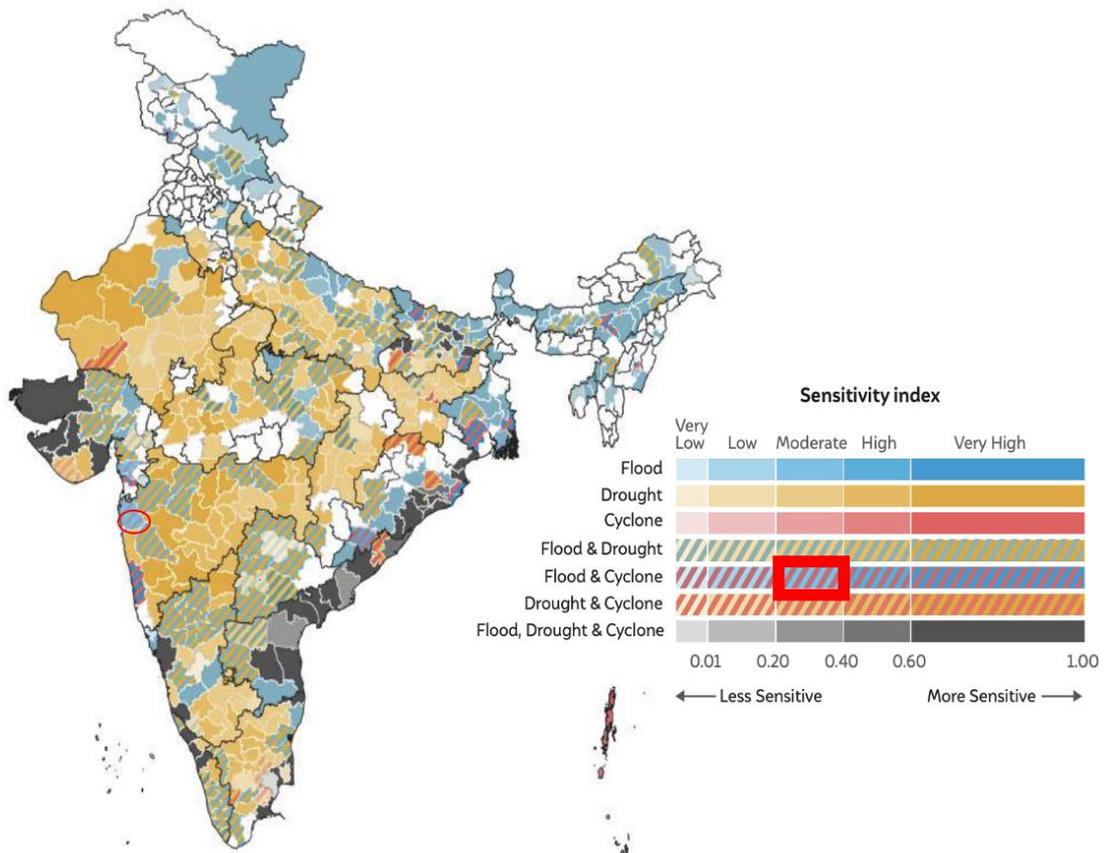
Broadly, vulnerability is a function of exposure (to hazard), sensitivity, adaptive capacity (to adapt to changing circumstances), and resilience (to bounce back to the previous state). The current section highlights the status and projected exposure to climate change events, along with their potential impact on people and WaSH services. The status of WaSH services at the state and division levels, as a function of resilience and adaptive capacity, is also discussed.

4.1 Climate Change Exposure, Vulnerability, and Impact

Maharashtra, situated in Western and Central India, has a coastline of approximately 720 kmⁱⁱⁱ along the Arabian Sea. With a population of 112.4 million (Census 2011) and a geographical area of 0.308 million sq. km, the state ranks second in population and third in area among Indian states. (Water Resources Department, 2019). Maharashtra is the third most urbanised state in India, with 51 million urban population in 2011 (Mohanty, et al., 2020). Maharashtra, along with Assam and Andhra Pradesh, is among the top three climate-vulnerable states in the country (Mohanty & Wadhawan, 2021).

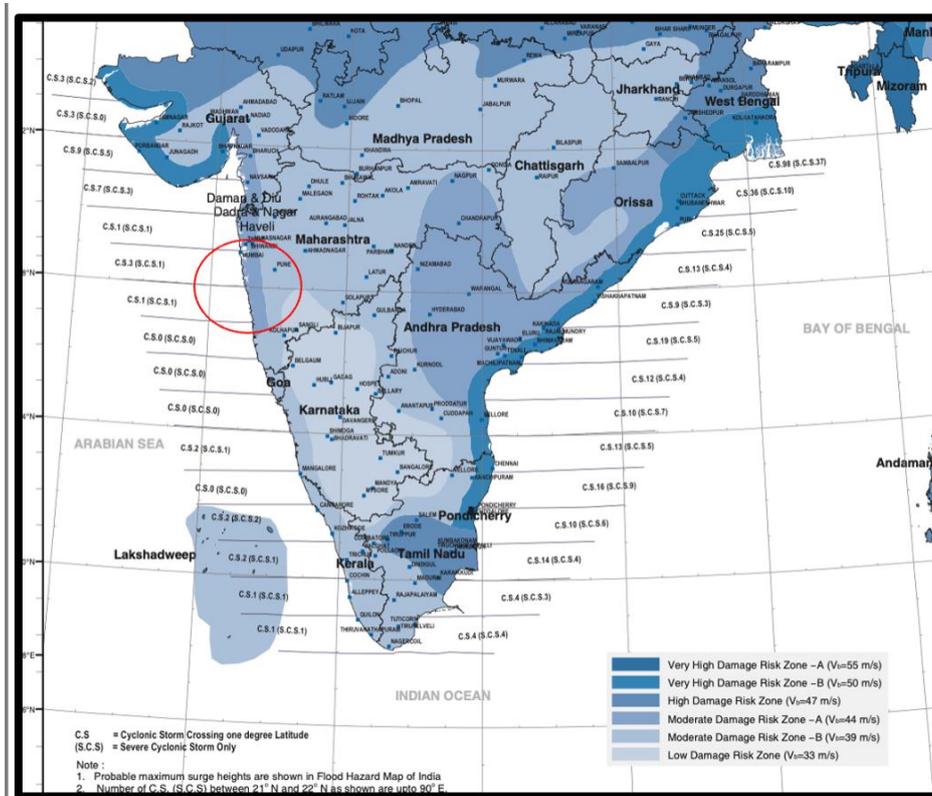
Approximately 12% of the land is susceptible to floods and river erosion, while Maharashtra's 720 kmⁱⁱⁱ long indented coastline is vulnerable to cyclones and tsunamis. (National Centre for Disease Control, 2022). Additionally, 68% of the cultivable land faces drought risks, and hilly regions are exposed to the threat of landslides and avalanches (ibid). Figures 5 and 6 showcase the vulnerability of the state to different disasters and climate-induced extreme events.

Figure 5: Climate Sensitivity Index: India



Source: (Mohanty & Wadhawan, 2021)

Figure 6 Exposure to Cyclones and Wind Speed: Maharashtra



Source: NDMA

The most recent cyclones to hit the State was cyclone Okhi in 2016, cyclone Nisarga in 2022, cyclone Tauktae in 2021 causing loss of life and infrastructural losses in coastal areas (Government of Maharashtra, 2023) (see table 3).

Table 3: Damages during Cyclones in Maharashtra

Sl. No.	Division	District	Humans (in numbers)	Animals (in numbers)
1	Konkan	Thane	0	3
2		Palghar	0	0
3		Raigad	6	41
4		Ratnagiri	0	13
5		Sindhudurg	0	0
6	Pune	Pune	4	26
7	Nashik	Nashik	0	56
8		Dhule	1	3
9		Ahmednagar	1	23
		Total	12	165

Source: (Government of Maharashtra, 2023)

In terms of **future climate change projections**, the state action plan predicts specific changes in the various climatic factors. For example, a rise in temperature and rainfall with regional variations is predicted. (The Energy and Resources Institute, 2014). Among various divisions, the Konkan division is projected to experience a lesser rise (1.1-1.28°C) in mean temperature (26.99°C) and an increase (10-30%) in monsoon rainfall (average at 2578.2 mm) by 2030^{xi}. The projected percentage increase in extreme rainfall in the 2030s relative to the baseline is expected to increase in all divisions, with a rise of 10-14% for the Konkan division (Mumbai, Ratnagiri, Sindhudurg areas).

An increase in temperature means a warmer atmosphere, which may also lead to extreme rainfall events, accompanied by longer dry or low rainfall spells between these events. Among various divisions, the Konkan division (Mumbai, parts of Ratnagiri, Sindhudurg, parts of Raigad) is expected to have the least increase in the number of dry days. (The Energy and Resources Institute, 2014). The study forecasted an increase of 3 to 5 days in the number of dry days in the 2030s relative to the baseline for the Konkan division, compared to 8-9 days for specific parts of south-central Maharashtra. These dry spells are a particular concern for agriculture and water resources. The impact on water resources could pose a threat to access to equitable water services at the ULB level, especially in light of the top-down push for 24/7 and 135 lpcd norms.

Overall, the Konkan division is expected to continue receiving more rainfall in absolute terms than other divisions. (The Energy and Resources Institute, 2014). The study also predicts an increase in surface runoff in specific catchments, such as sub-catchments of the Godavari.

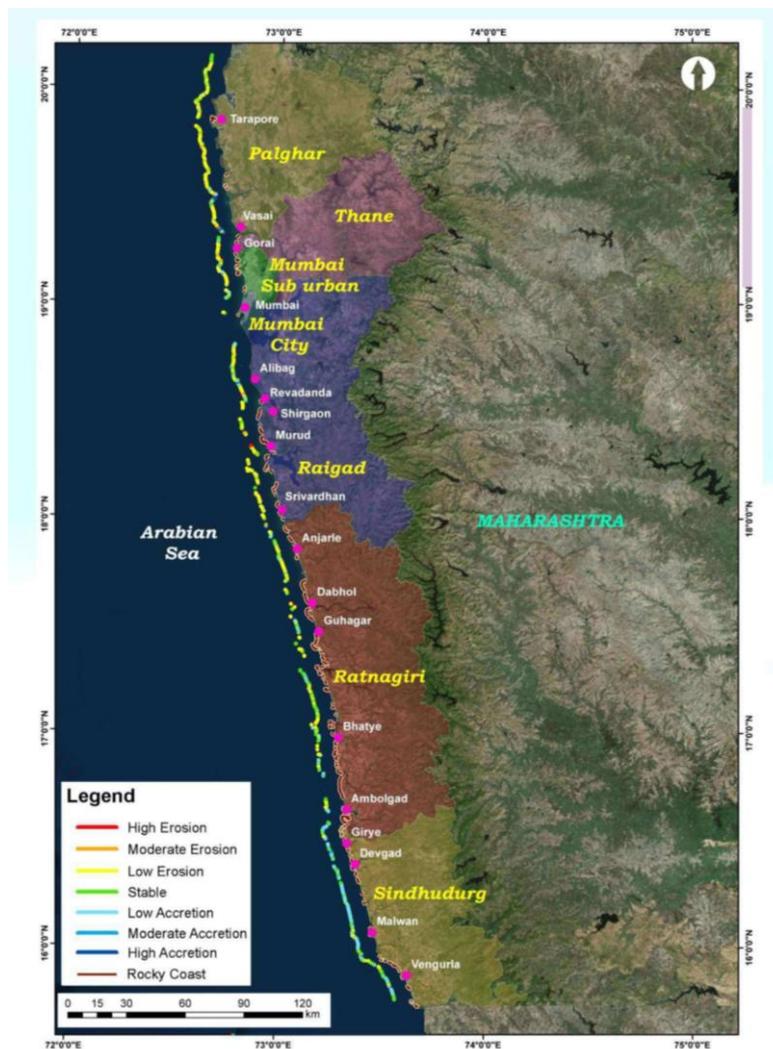
Additionally, the TERI study also predicts a rise in the heat index by the 2030s compared to the baseline for the Konkan and Nashik divisions. **This could increase discomfort from heat stress, increase the likelihood of malaria transmission, and increase energy demand for cooling and water demand in urban areas, thereby exacerbating the urban heat island effect.**

Further, an increase of about **0.24 m to 0.66 m in mean sea level by the end of the 21st century for the Maharashtra coastline^{xiii}** is projected. (The Energy and Resources Institute, 2014). The selected cities in the Konkan division, namely Alibag, Ratnagiri, Vengurla, Dahanu, Malvan, and Guhagar, have average elevations of 0m, 11m, 11m, 8.312m MSL, 10.698m MSL, and 63.49m MSL, respectively. **Furthermore, the sea level rise may coincide with heightened wave heights, intense wind speeds, and increased storm surges (ibid). One of the primary impacts of sea level rise is coastal erosion, inundation (a 1mm rise could lead to inundation of approximately 0.5m per year), and loss of land, as demonstrated** in studies for Tamil Nadu, Orissa, and Andhra Pradesh. (World Bank Group, 2021). Coastal erosion and inundation could lead to saltwater intrusion, especially into groundwater aquifers, thereby reducing the availability of freshwater. (The Energy and Resources Institute, 2014).

This will exacerbate the existing issue of coastal erosion, considering that 33.6% of India's 6907.2 km shoreline is already being affected by erosion. (National Centre for Coastal Research, 2022). Although the west coast, including Karnataka, Goa, Maharashtra, and Gujarat (except Kerala), is primarily in a stable condition, along with isolated pockets of eroding coast and fewer erosion hotspots, it has exhibited an upward trend in coastal erosion between 1990 and 2016 (Kankara, Murthy, & Rajeevan, 2018), (National Centre for Coastal Research, 2022).

In Maharashtra, approximately 25.5% of the coast is eroding, 10% is accreting, and 64.6% remains stable. (National Centre for Coastal Research, 2022) (Figure 7). The Sindhudurg, Ratnagiri and Raigad districts are dominated by a stable coast with a few pockets of low erosion and accretion. While accretion is observed along the Alibag region (attributed to a natural phenomenon), erosion is observed along the Vengurla beach. (Kankara, Murthy, & Rajeevan, 2018), (National Centre for Coastal Research, 2022).

Figure 7: Changes in the shoreline along the Maharashtra Coast (1990-2016)



Source: (Kankara, Murthy, & Rajeevan, 2018)

Table 4 shows the ranking of the district for parameters related to exposure, sensitivity, and adaptive capacity. The drought-prone districts are Sangli, Ahmadnagar, Solapur, Dhule, Buldhana, Hingoli, Jalgaon, Osmanabad, Nandurbar, Nagpur, Satara, Akola, Nanded, Aurangabad, Pune, Amravati, Nashik, Jalna, Garchiroli, Raigad, Chandrapur, Gondia, Wardha, Yavatmal; the flood-prone districts are Mumbai, Jalgaon, Aurangabad, Pune, Nagpur, Amravati, Nashik, Ratnagiri, Wardha, Thane; and the cyclone-prone districts are Mumbai, Ratnagiri, Thane. (National Centre for Disease Control, 2022). **The study research focuses on six towns: Alibag, Ratnagiri, Vengurla, Dahanu, Malvan, and Guhagar, located in Raigad, Ratnagiri, Sindhudurg, and Palghar districts, respectively. Raigad district, which is**

moderately vulnerable to drought, and Ratnagiri district, which is moderately susceptible to floods & cyclones (Table 4).

Table 4: District-level Vulnerabilities in Maharashtra

SR. No	Rank	District	Event	Exposure	Sensitivity	Adaptive Capacity	Vulnerability Index	Vulnerability
1	1	Sangli	Drought	0.82	1	0.47	1	Very High
2	15	Ahmednagar	Drought	0.96	0.65	0.44	0.813	Very High
3	22	Solapur	Drought	0.82	0.75	0.47	0.75	Very High
4	27	Dhule	Drought	0.82	0.75	0.48	0.734	Very High
5	28	Mumbai	Flood & Cyclone	0.94	0.76	0.62	0.733	Very High
6	37	Buldana	Drought	0.82	0.65	0.44	0.694	Very High
7	49	Hingoli	Drought	0.76	0.52	0.37	0.612	Very High
8	49	Jalgaon	Flood & Drought	0.63	0.97	0.42	0.612	Very High
9	52	Osmanabad	Drought	0.96	0.55	0.51	0.593	High
10	61	Nandurbar	Drought	0.76	0.55	0.43	0.557	High
11	61	Nagpur	Drought	0.68	0.8	0.56	0.557	High
12	68	Satara	Drought	0.82	0.65	0.57	0.536	High
13	74	Akola	Drought	0.68	0.7	0.52	0.525	High
14	79	Nanded	Drought	0.76	0.46	0.4	0.501	High
15	87	Aurangabad	Flood & Drought	0.74	0.81	0.52	0.485	High
16	92	Nagaur	Flood & Drought	0.86	0.62	0.47	0.477	High
17	117	Pune	Flood & Drought	0.74	0.79	0.63	0.39	Moderate
18	135	Amravati	Flood & Drought	0.45	0.78	0.42	0.351	Moderate
19	148	Nashik	Flood & Drought	0.72	0.61	0.57	0.324	Moderate
20	150	Jalna	Drought	0.41	0.65	0.48	0.318	Moderate
21	151	Garhchiroli	Drought	0.68	0.39	0.48	0.317	Moderate
22	171	Ratnagiri	Flood & Cyclone	0.17	0.89	0.37	0.26	Moderate
23	187	Raigad	Drought	0.41	0.49	0.49	0.235	Moderate
24	191	Chandrapur	Drought	0.41	0.5	0.52	0.226	Moderate
25	196	Gondiya	Drought	0.41	0.42	0.46	0.215	Moderate
26	213	Wardha	Flood & Drought	0.28	0.72	0.51	0.166	Low
27	231	Yavatmal	Drought	0.41	0.27	0.51	0.124	Low
28	253	Thane	Flood & Cyclone	0.17	0.38	0.62	0.066	Low

Source: (National Centre for Disease Control , 2022)

4.2 Vulnerability with focus on Socio-economic and Water and Sanitation Infrastructure and Services

Access to basic services such as housing, improved sanitation, and safe drinking water forms the first line of defence against the potential impacts of climate change. These services are essential for enhancing people’s resilience and adaptive capacity. The Intergovernmental Panel on Climate Change (IPCC) recognises universal access to water, sanitation, and hygiene (WaSH)—as targeted in SDGs 6.1 and 6.2—as a critical, low-regret adaptation strategy, supported by high confidence. Moreover, ensuring universal access to WaSH not only contributes directly to SDG 11 (sustainable cities and communities) but also promotes social equity and environmental sustainability.

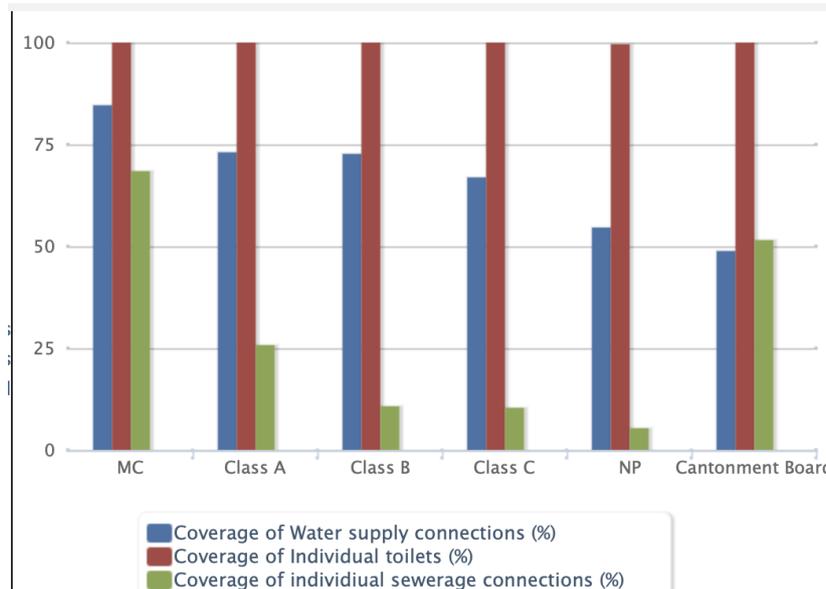
This section thus discusses the status of basic services, with a special focus on water and sanitation services. It also highlights GHG emissions related to water and sanitation and the financial performance of the sector, both of which have significant implications for climate-resilient planning.

Status of Water, Sanitation, and Hygiene Services

The state is facing an unprecedented water crisis, with a record number of water tankers deployed in several regions. Late monsoons and deficient rainfall have exacerbated the situation, leading to depleted groundwater levels in 279 talukas and less than 10% live storage in 13 major reservoirs. (CEPT, 2024). Figure 8 reveals variation in household water supply and sewerage connections across different classes of towns for 2021-2022^{xiii}.

Towns of all sizes fail to meet the Service Level Benchmarks (SLBs) of 100% water supply and sewerage connection. For example, in our six selected towns, while Alibag, Dahanu, and Guhagar have achieved 92.5%, 91%, and 100% water supply connections, Malvan has the potential to improve being at 70%, with Vengurla and Ratnagiri at 24.73% and 46.77% requiring a boost. Moreover, all six study towns appear to rely heavily on on-site sanitation systems, with Dahanu, Malvan, and Guhagar officially reporting 0% sewerage networks, according to the 2024-2025 reported SLBs. **Maharashtra towns, however, seem to meet the 100% SLB criteria for individual toilets, with the Government of Maharashtra reporting that at least three municipalities do not have 100% toilet coverage.** (Government of Maharashtra, 2022b, p. 47). **Overall, smaller towns have lower access to these services, underscoring the importance of prioritising WaSH infrastructure and services in these areas. It also indicates that the indirect and direct emissions from towns of varying sizes differ due to differences in WaSH infrastructure and service footprints.**

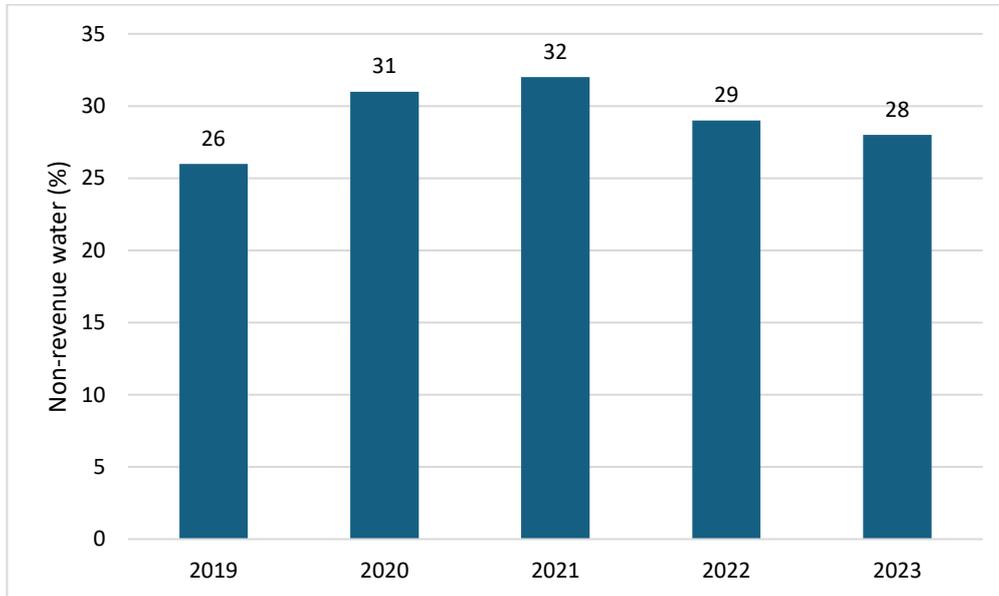
Figure 8: Access and Coverage of Water and Sanitation Services for Different Classes of Towns in Maharashtra



Source: Performance Assessment System^{xiv}

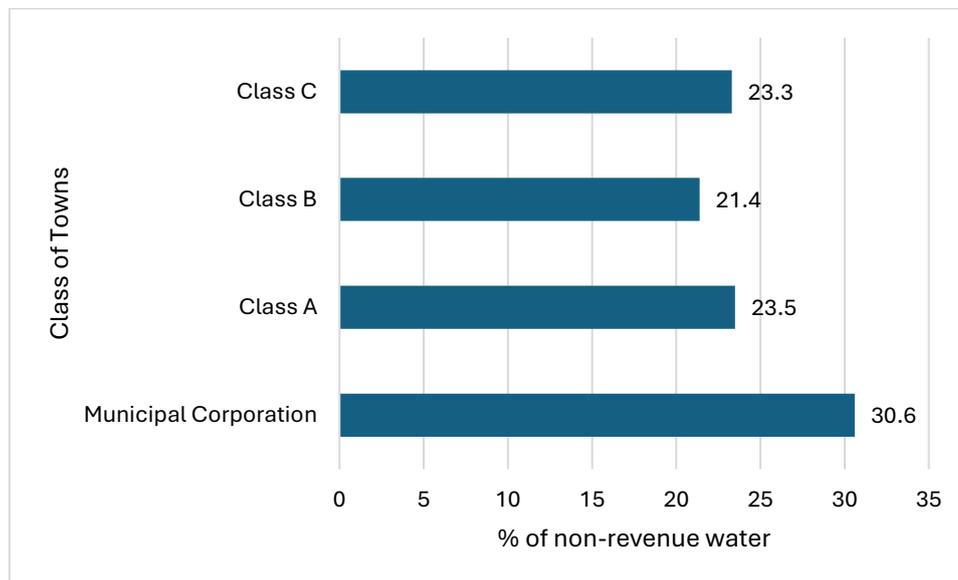
The loss of water, or the extent of Non-Revenue Water (NRW), indicates an inefficient water supply infrastructure, leading to increased water demand and energy demand and consequently higher GHG emissions. (NIUA, 2021). **As shown in Figure 9, NRW is decreasing at the state level, mainly due to an increase in meter connections and has now fallen below the national average of 38%^{xv}. However, town-level variations reveal higher NRW percentages in larger towns (Figure 10).**

Figure 9: Extent of non-revenue water (%) – State Average



Source: Performance Assessment System ^{xvi}

Figure 10: Extent of non-revenue water (%) in different classes of towns of Maharashtra

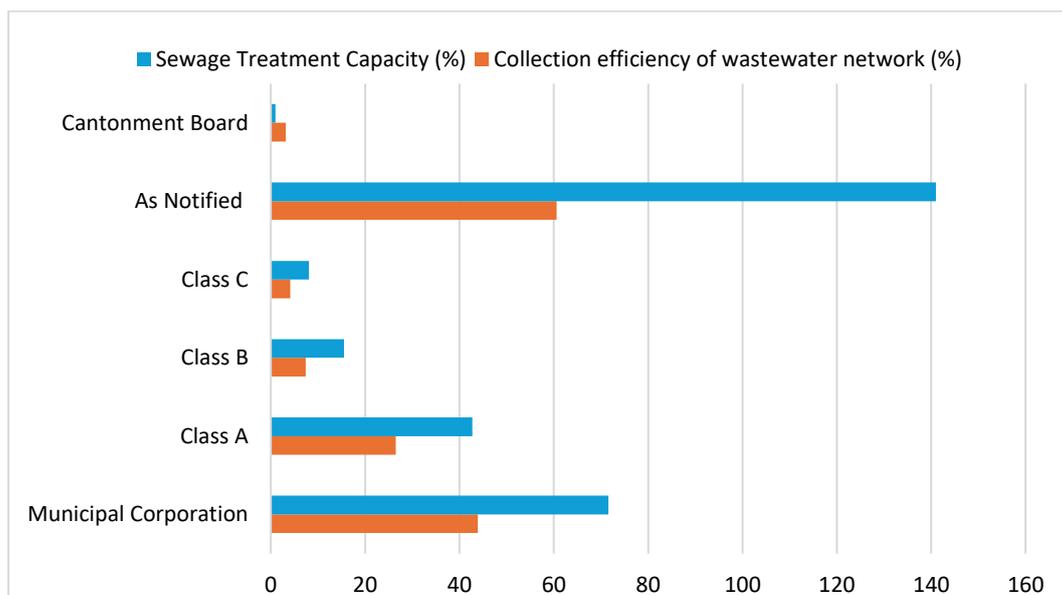


Source: Performance Assessment System ^{xvii}

Furthermore, towns of all sizes fall short of the SLB norms, which require 100% sewage treatment capacity and 100% collection efficiency of wastewater networks (Figure 11). Larger towns tend to perform better on these parameters, underscoring the critical need to focus

on improving infrastructure in smaller cities. Four of the six municipalities (Dahanu, Malvan, Guhagar, and Alibag) are reported to either have no treatment facilities or have defunct plants. In Dahanu, private operators are reportedly managing desludging, often disposing of faecal sludge unsustainably on land areas. While Malvan, Guhagar, and Alibag are reported to have non-operational FSTPs due to significant design flaws and inadequate maintenance. Vengurla, on the other hand, does have an STP but is underutilised due to reduced desludging activities resulting from significant population out-migration. Furthermore, the stormwater drainage systems in these study towns either cover only a portion of the town, such as Dahanu (40%) and Malvan (25.84%), or have relatively adequate coverage, as seen in Vengurla (81%), but unfortunately still face persistent waterlogging and flooding issues.

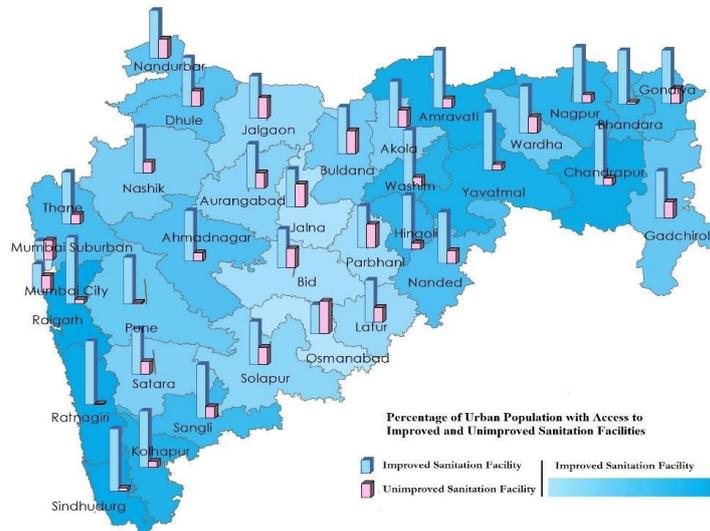
Figure 11: Quality of Water and Wastewater Services



Source: Performance Assessment System ^{xviii}

A district-level assessment corroborates the above findings, highlighting that access to improved sanitation is a significant issue in urban Maharashtra. (Mohanty, et al., 2020). Among different divisions, the Konkan division performs rather well. In the region, Ratnagiri, Sindhudurg, Raigad, and Thane have 96%, 81.1%, 96.8%, and 97.9% of their urban populations, respectively, with access to improved sources of drinking water (Figures 12 and 13).

Figure 13: Maharashtra District Map for Percentage of Urban Population With Access to Improved and Unimproved Sanitation Facilities

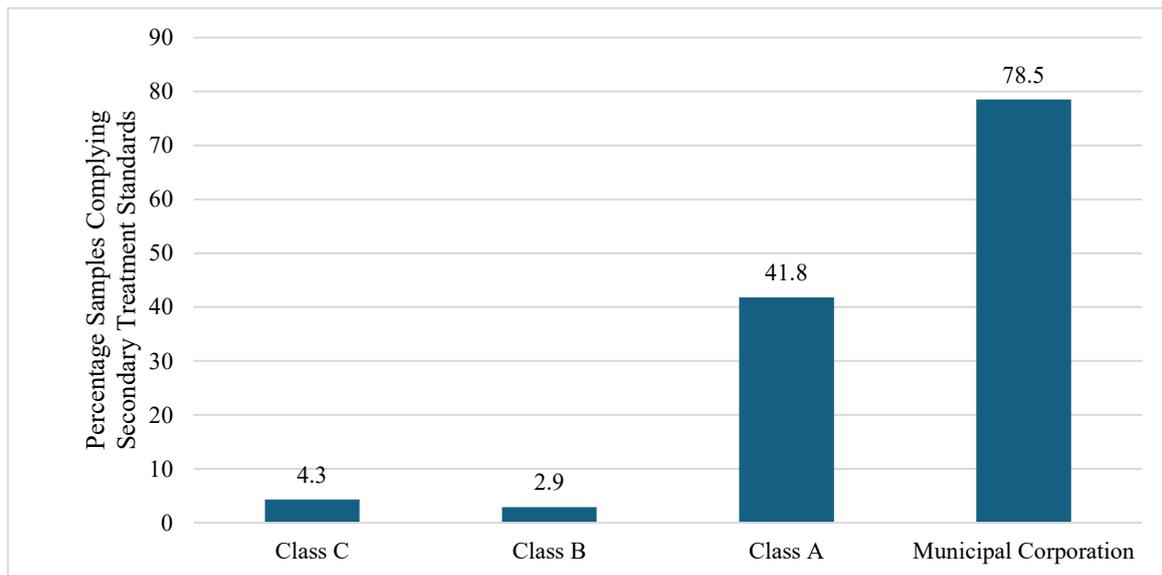


Source: (Mohanty, et al., 2020)

Environmental Performance and GHG Emissions

The state’s subpar performance in provisions of wastewater infrastructure has resulted in a significant proportion of untreated wastewater being released, contributing to GHG emissions. Recent assessment indicates only 47% of the total sewage generated (9107MLD) is treated (Central Pollution Control Board , 2021)^{xix}. **Town level data shows that the compliance to environmental standards is lower for the smaller towns highlighting the need to focus on such areas (Figure 14).**

Figure 14: Compliance to Environmental Standards: Quality of Wastewater Treatment for Different Size Towns



Source: (Central Pollution Control Board , 2021)^{xx}

Both complier and noncomplier systems contribute to GHG emissions. The GHG emissions from domestic wastewater sector of Maharashtra contributed 54% of the state’s total emissions in the waste sector (11.77 MtCO₂) in 2018. The total GHG emissions from domestic wastewater treatment and discharge for urban Maharashtra in 2018 were estimated to be 30,47,989 tCO₂, equating to 0.051 tCO₂ per capita—slightly lower than the national average of 0.053 tCO₂) (GHG platform India).

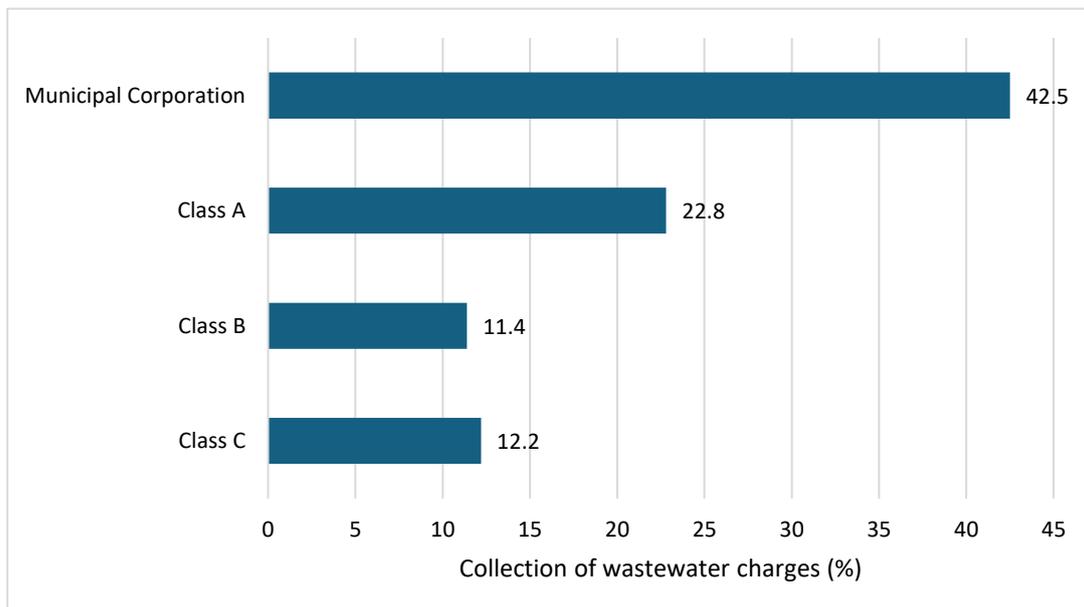
The state is also one of the five states—along with Uttar Pradesh, Tamil Nadu, West Bengal, and Gujarat—that collectively contributed to approximately 47% of the total CH₄ emissions from urban domestic wastewater in 2018. This is largely due to lower sewerage network connections leading to a reliance on OSS systems which are significant source of CH₄ emissions in these states (Shroff, Caleb, Kolsepatil, & Mishra, 2019). Therefore, the promotion of FSTPs (faecal sludge treatment plants) is highly significant. The state is a frontrunner in managing faecal sludge, with 179 operational FSTPs and 60 more in development. Although operation and maintenance of these FSTPs particularly in small towns requires attention, such as in Alibag where a non-working FSTP is leading to disposal of untreated sludge resulting in 254 tons of CO₂ equivalent emissions that is contributing to methane emissions and environmental pollution.

Financial Performance of WaSH Sector

The subpar performance in wastewater management infrastructure and services leads to poor collection of wastewater related charges and cost recovery for smaller towns, except for municipal corporations (Figure 15 and 16). Despite receiving capital from central and state governments through various programs and schemes, towns, especially smaller ones, struggle to recover the costs of operations and maintenance.

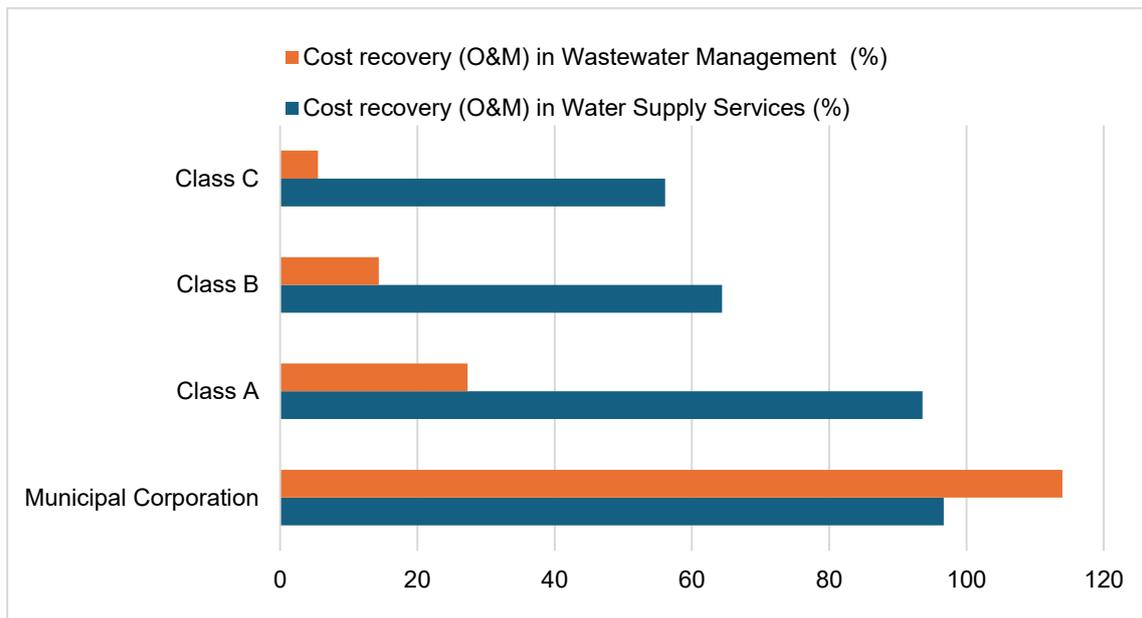
One of the primary reasons for this is the reliance on ‘one-size-fit-all’ centralised wastewater management systems, whose financial sustainability within the context of ULBs’ financial health was questioned in the National Urban Sanitation Policy-2008. **Further, there is a notable disparity between municipal corporations (population over 300,000) and municipalities (population between 25,000 and 300,000), with the former being significantly more self-reliant, generating 86% of their financial resources from own revenues, compared to just 51% for the latter** (Centre for Water and Sanitation, 2019).

Figure 15: Efficiency in Collection of Wastewater Related Charges (%)



Source: data from PAS^{xxi}

Figure 16: Financial Sustainability in WaSH Sector



Source: data from PAS^{xxii}

The section highlighted the climate change vulnerability of Maharashtra and its Konkan division with respect to disaster exposure and access to WaSH infrastructure and services. While the entire state is one of the three most vulnerable states to climate change exposure, the Konkan division falls under the low to moderate risk category. However, this low to moderate risk may translate to high vulnerability for people due to the high MPI caused by poor performance in the health (housing and WaSH infrastructure and services) dimension, particularly in smaller towns.

The key takeaway is that smaller towns struggle with inadequate WaSH infrastructure, poor quality of services, and poor financial health. This undermines their ability to cope with current and future climate change impacts. Tardy environmental compliance and poor services provisions in both small and bigger towns indicate GHG emissions. This situation presents an opportunity to explore alternatives to conventional centralized wastewater solutions that are resilient and address both mitigation and adaptation requirements in the face of looming climate change. Nature-based solutions are more suitable in this context—environmentally sustainable, equitable, affordable, and attuned to the city's demand and capacity.

5. PROGRAMMES / SCHEMES IN URBAN WATER AND SANITATION

For the development of water and sanitation infrastructure and services in urban areas, the state depends upon both the centrally sponsored schemes such as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and the Swachh Bharat Mission (SBM) and its own funds. The section highlights key sources of funding for the water and sanitation sector in Maharashtra state.

Centrally Sponsored schemes

The major centrally sponsored schemes concerning urban water and sanitation are AMRUT and SBM- Urban. Under such schemes the central government provides part of the funds to the states. While AMRUT aims to enhance basic infrastructure in water supply and sewerage systems in selected urban areas, SBM focussed on making cities open defecation free and focussing on the entire sanitation process including septage and faecal management.

The recently launched SBM-U 2.0., with the aim to achieve a “Garbage Free” nation, has taken a more holistic understanding of what encompasses a clean and hygienic environment. This includes both Sustainable Solid Waste Management and Sustainable Sanitation and treatment of used water.

The AMURT mission covers 44 cities in the State and covers 76 per cent of urban population Under this mission, the Government of India sanctioned grants amounting to ₹7,759 crore for the State. Of this, ₹4,313 crore was allocated for 38 water supply projects across 34 cities, of which 14 projects worth ₹931 crore in 13 cities had been completed by January 2022, while the rest remain under implementation. Similarly, ₹3,267 crore was approved for 30 sewerage projects, with 3 projects worth ₹150 crore in 2 cities completed by the same period. In addition, the State sanctioned 128 Green Space (Amrutvan) projects worth ₹179 crore, of which 122 projects amounting to ₹171 crore were commissioned, and the remaining are in progress (Government of Maharashtra, 2022a).

However, under AMURT programme, as Table 5 shows, **priority has been given to the water supply projects over sanitation projects** in terms of total projects, approved funds per project, and expenditure incurred.

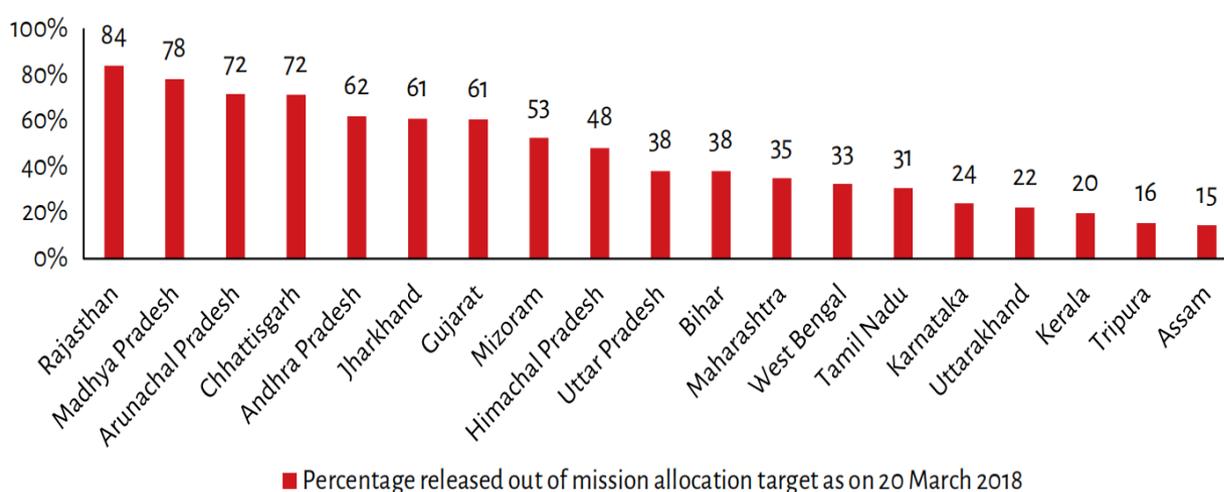
Table 5: Maharashtra State Progress under AMRUT (as of Jan, 2022)

Sector	No. of total Projects	Approved amount in INR Crore	No. of Completed projects	Expenditure In INR Crore
Water Supply	38	4313	14	931
Sewerage	30	3267	3	150
Total	68	7580	17	1081

Source: data from (Government of Maharashtra, 2022a)

Under the SBM-U, the government of Maharashtra declared all its cities as open defecation free (ODF) on 1st October 2017 (Centre for Policy Research, 2019). **As of March 2018, Maharashtra has released only 35% of the allocated amount, which is considerably low (Figure 17). This shortfall indicates challenges in the effective utilisation and disbursement of funds within the state, potentially impacting the progress and success of the mission objectives in water and sanitation projects.**

Figure 17: Percentage of Funds Disbursed Relative to Mission Allocation to Different States

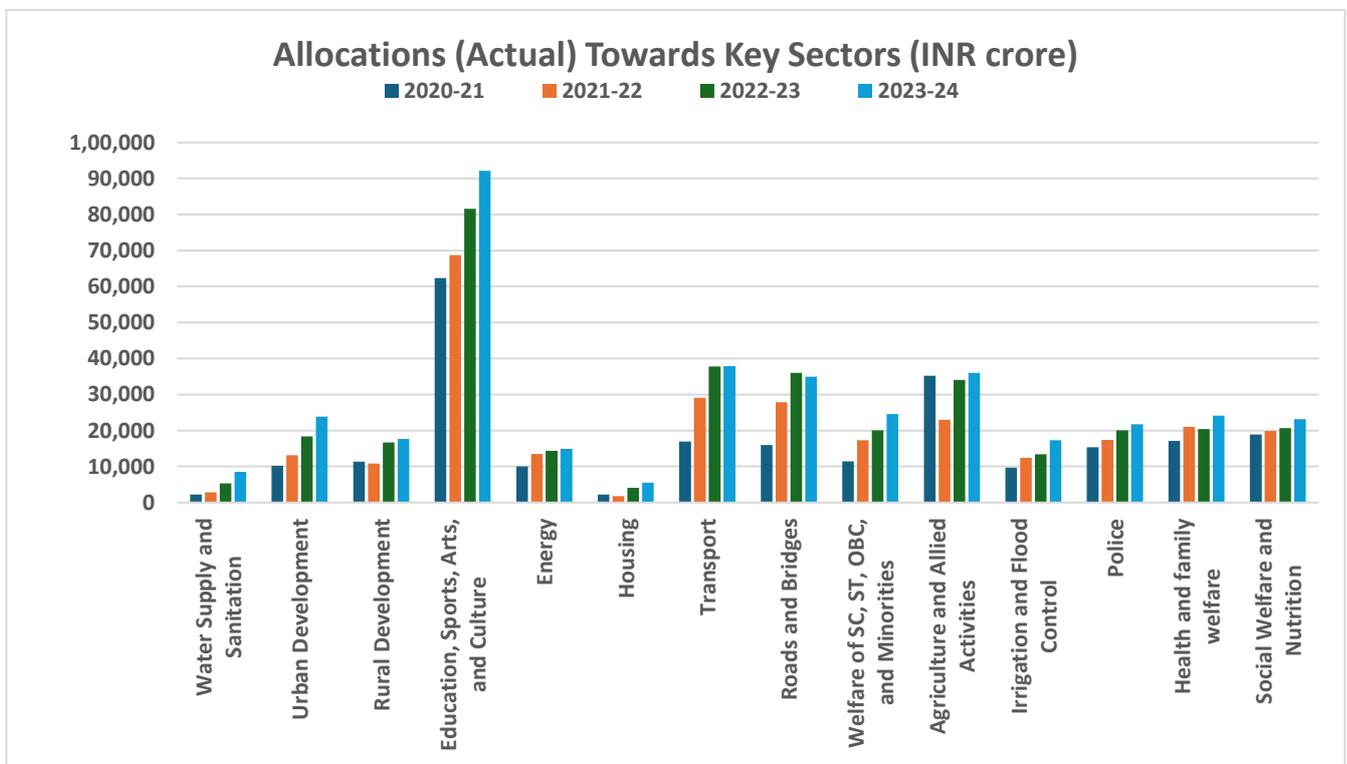


Source: (Centre for Policy Research, 2019)

State Funds and Schemes

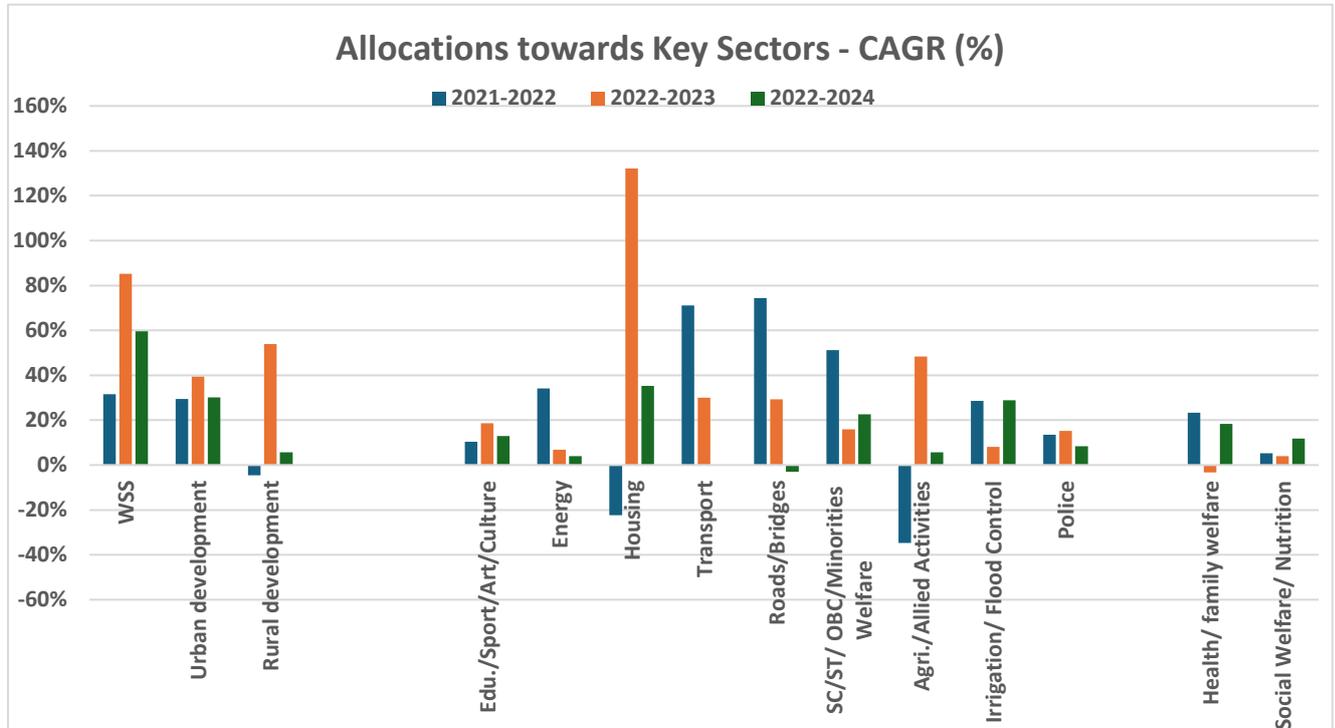
Figure 18 illustrates the actual budgetary allocations across major sectors in the state. All sectors have witnessed increases in allocations over the period 2019–2024. Within this, allocations to urban development, as a share of total allocations, rank among the bottom five sectors. Specifically, water supply and sanitation consistently record some of the lowest allocations, positioned just above housing during the reference period. This reflects the fact that, despite growing recognition of water and sanitation as critical components of urban resilience and human well-being, the sector has not received commensurate priority in the state’s expenditure framework. However, the CAGR analysis in Figure 19 presents a different picture, with urban development, water supply, and sanitation emerging among the top three sectors, registering sharp growth rates of 33% and 57%, respectively. This indicates a gradual shift in state priorities, with these sectors beginning to gain momentum in terms of financial commitment, even though their overall share in the expenditure profile remains relatively modest.

Figure 18: Allocation (actual) towards Key Sectors including Water and Sanitation



Source: data from (Government of Maharashtra, 2022a)

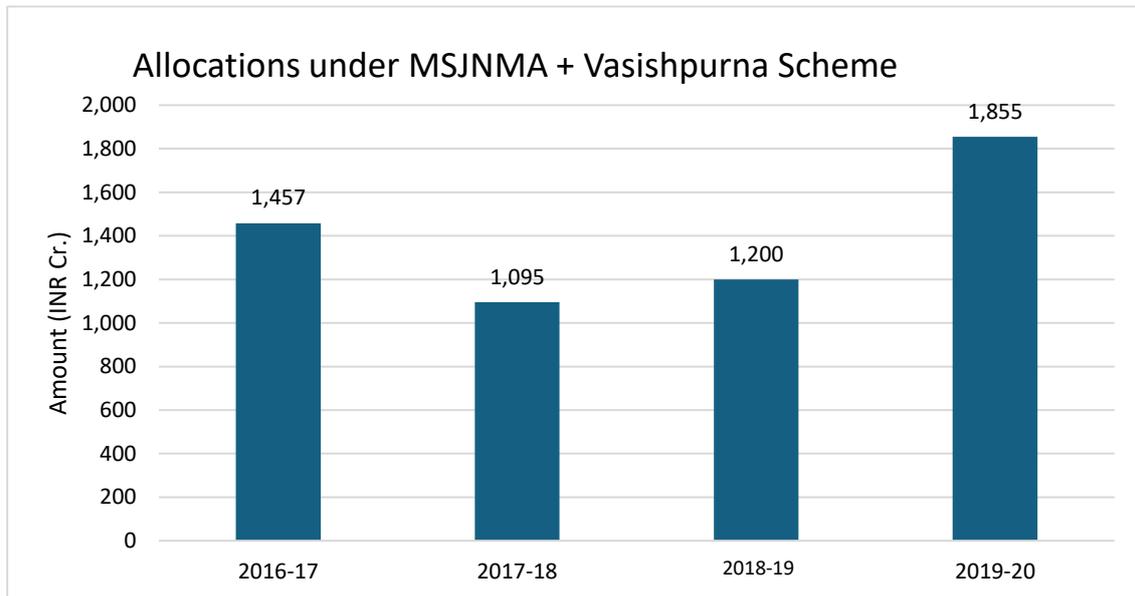
Figure 19: Allocation (actual) towards Key Sectors – CAGR (%)



Source: data from (Government of Maharashtra, 2022a)

Catering to the small towns and cities (municipal corporations (D class), municipal councils, and nagar panchayats) is the **Maharashtra Suvarna Jayanti Nagarotthan Maha Abhiyan (MSJNMA)** and **Vasishpurna Scheme**. The budget allocations for the schemes have increased by 27.3% between 2016 and 2020, as shown in Figure 18 (Centre for Water and Sanitation, 2019).

Figure 20: State Allocations under Maharashtra Suvarna Jayanti Nagarotthan Maha Abhiyan (MSJNMA) and Vasishpurna Scheme



Source: (Centre for Water and Sanitation, 2019)

As of January 2022, a total of 224 projects, amounting to INR 12,801 crore, have been approved under the MSJNMA. Out of these, 64 projects worth Rs. 3,856 crores have been completed (Government of Maharashtra, 2022a).

As Table 6 indicates, **the sewerage sector has been given a lower priority in terms of the number of approved projects. However, the per-project sanctioned amount is higher for this sector, and its performance—measured by the completion of works and expenditure incurred—is also better than the water supply sector.**

Table 6: Progress of Maharashtra Suvarna Jayanti Nagarotthan Maha Abhiyaan

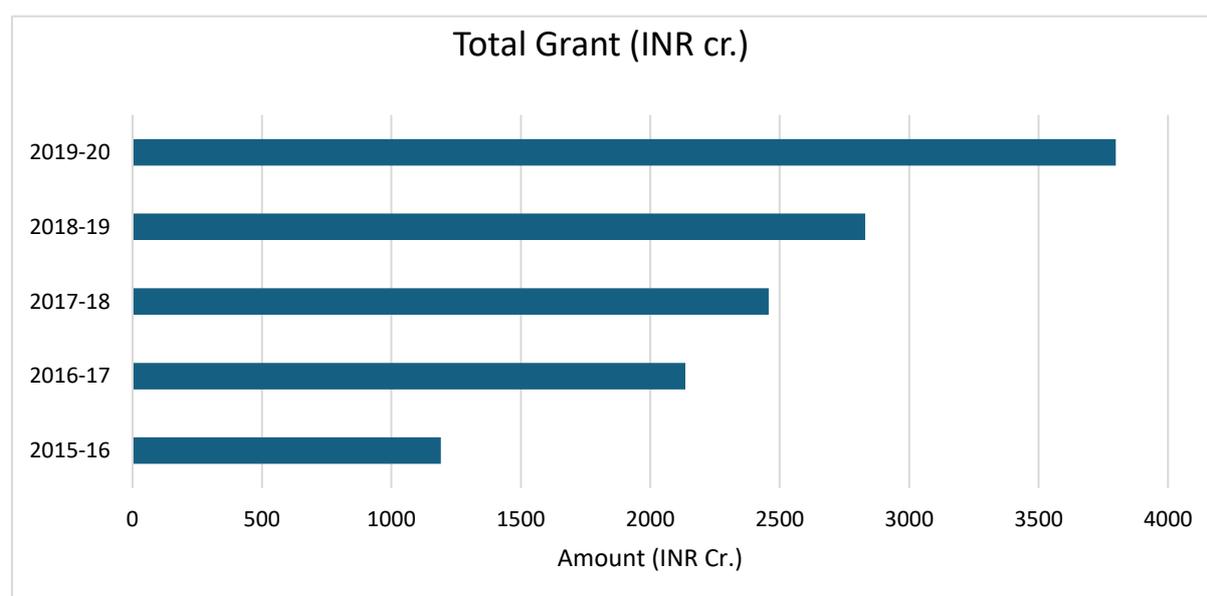
Nature of Works	Works approved (no.)	Sanctioned amount (INR Cr)	Works completed (no.)	Expenditure incurred (INR Cr)
Water Supply	124	5887	26	1208
Sewerage	39	2809	8	819
Other (Road, storm water drain, flyover, solid waste management, etc.)	61	4105	30	1829
Total	224	12801	64	3856

Source: (Government of Maharashtra, 2022a)

Finance Commission

The grants from the Finance Commission to the state government have steadily increased, rising by 218% between 2015 and 2020 (Figure 21). However, the state government devolves 16-20% of its state Finance Commission transfers to ULBs (Centre for Water and Sanitation, 2019), raising concerns over the effective functioning of ULBs.

Figure 21: Finance Commission Grant for Maharashtra (INR Crores)



Source: (Centre for Water and Sanitation, 2019)

Incentive Funding for ULBs

The sources of funds of ULBs are typically (i) Central and State Government grants and (ii) their own sources of revenue. **The recent CAG report highlights a steady downward trend in the percentage contribution from the Urban Local Bodies' (ULBs) own resources to their total financial resources between 2015 and 2020, as evidenced in Table 7. This decline highlights the growing dependence of ULBs on central and state grants (Government of Maharashtra, 2022b), which in turn may affect their decision-making powers.**

Table 7: Funding Sources to ULBs in Maharashtra

Sl.no	Year	Grants	Own Resources	Total Revenue	% of own revenue to total financial resources
1	2015-16	6286.77	53795.62	60082.39	90%
2	2016-17	10812.88	47739.34	58552.22	82%
3	2017-18	11365.64	52413.83	63779.47	82%
4	2018-19	15791.95	51399.25	67191.2	76%
5	2019-20	15996.72	56942.42	72939.14	78%

Source: (Government of Maharashtra, 2022b)

To help ULBs and encourage them to achieve various Service Level Benchmarks, including ODF status, the state government has announced incentive funds. ODF cities can use the SBM Incentive Fund and 50% of the 14th Finance Commission funds to obtain ODF+ and ODF++ status. The overall eligibility under the SBM Incentive Fund is Rs. 408 crores, and the total budget allocation as a state share in SBM is Rs. 1,675 crores for 2015-20 (Centre for Water and Sanitation, 2019).

Six Town Examples

Alibag

The financial health of Alibag Municipal Council (AMC) for Water, Sanitation, and Hygiene (WaSH) services highlights a growing dependence on external funding due to a decline in self-generated revenue from 2015 to 2020. While central government grants have improved water infrastructure, inconsistent disbursements raise concerns about long-term sustainability. AMC's reliance on fluctuating state and central funds complicates budget planning, while challenges in tax collection further strain revenue generation. The low-cost recovery ratio (46.88%) and deficits from bulk water purchases emphasise the need for

financial reforms. Strengthening local revenue streams and improving operational efficiency are crucial for AMC to ensure a sustainable water supply service and financial independence.

Ratnagiri

Ratnagiri Municipal Council (RMC) faces significant financial challenges in both its water supply and sewerage & sanitation systems, primarily due to inconsistent cost recovery, declining collection efficiency, and increasing fiscal deficits. The water supply system has struggled with fluctuating cost recovery rates, dropping from 107.62% in 2009-10 to just 36.71% by 2023-24, alongside deteriorating collection efficiency. Similarly, the sewerage & sanitation systems have faced very low-cost recovery, with the rate dropping to as low as 2.19% in 2022-23. Both sectors have been heavily reliant on external funding, leading to widening fiscal deficits. Despite significant investments in infrastructure, RMC has struggled to achieve financial sustainability. The growing dependency on grants and loans, combined with inadequate local revenue generation, underscores the need for substantial reforms in revenue collection and financial management.

Vengurla

The most prominent issue for the Vengurla Municipal Council (VMC) is the significant gap between rising operational costs and stagnant revenue, which have led to a drastic decline in cost recovery, especially in sewerage and sanitation services, where cost recovery plummeted from 85.71% in 2014-15 to just 1.76% in 2022-23. This financial strain is exacerbated by inefficient billing systems, poor collection efficiency, and a heavy reliance on external grants and subsidies to cover the mounting expenses. In water supply services, VMC has experienced fluctuating performance in cost recovery and collection efficiency, with a fiscal deficit of INR 74.25 crore from 2011-12 to 2022-23, indicating a reliance on external funding. The municipality's growing capital and revenue expenditures, combined with persistent revenue and fiscal deficits, signal an urgent need for financial reforms to ensure long-term sustainability.

Malvan

Malvan Municipal Council faces distinct challenges in ensuring comprehensive service coverage and financial viability across these sectors. In water supply, the municipality demonstrates robust financial health and management, achieving near-total cost recovery (97.45%) and a high collection efficiency of 97%, supported by 100% metering of connections. However, this financial success contrasts sharply with physical service constraints; residents receive water for only 2 hours daily against the 24-hour benchmark, and per capita supply is limited to 80 lpcd, significantly below the 135 lpcd standard. While Non-Revenue Water (NRW) is efficiently managed at 13.57%, the sanitation sector faces systemic voids. Despite achieving 100% toilet coverage, centralized infrastructure is virtually non-existent, with 0% coverage for sewage networks, treatment capacity, and reuse. Consequently, the sanitation sector generates no revenue, reflecting 0% cost recovery and collection efficiency. Similarly, Solid Waste Management (SWM) struggles with financial sustainability; while household coverage (90%) and

segregation (70%) are progressing, the system fails to recover costs or collect charges (0% efficiency). Furthermore, the absence of waste recovery mechanisms and low scientific disposal rates (50%) indicate an incomplete value chain. Across the board, while complaint redressal mechanisms are highly effective (100%), the total absence of revenue mobilization in sanitation and SWM, coupled with intermittent water supply, underscores a heavy reliance on grants and limits the Councils capacity to finance necessary infrastructural upgrades.

Guhagar

Guhagar Nagar Panchayat highlights a successful operational model in solid waste management, contrasting sharply with critical financial and infrastructural weaknesses in water supply and sanitation. Solid Waste Management (SWM) has achieved 100% operational success—meeting benchmarks for household coverage, collection efficiency, segregation, recovery, and scientific disposal. However, cost recovery remains only 6%, significantly undermining the long-term viability of the SWM services and indicating a heavy reliance on grants to cover operational costs. Water supply shows a similar imbalance. While the town meets benchmarks for coverage (100%), quality (100%), and per capita supply (135 lpcd) is offset by profound issues in service continuity and financial management. Specifically, the system offers water for only 1 hour per day against the 24-hour benchmark. Financially, the sector is vulnerable, with cost recovery at only 50% and collection efficiency at 80%. Crucially, the extent of metering is 0%, severely constraining efforts to implement efficient billing systems, control consumption, and improve revenue generation. Sanitation faces the most severe infrastructural deficit. Despite 100% toilet coverage, there is no core infrastructure—0% sewage network coverage, treatment capacity, and reuse—resulting in no sewage charges and no measurable cost recovery or collection efficiency.

Overall, low revenue mobilization in SWM and water supply, combined with the complete absence of revenue mechanisms in sanitation, leaves Guhagar heavily dependent on external funding. Strengthening metering, improving tariff structures, and prioritizing investments in sewage infrastructure are essential for ensuring long-term financial viability.

Dahanu

Dahanu Municipal Council reveals a critical vulnerability in the financial sustainability and continuity of its urban services, despite notable success in certain operational areas. The Solid Waste Management (SWM) sector shows the strongest operational performance, meeting or exceeding benchmarks for household coverage, collection efficiency, segregation, and municipal solid waste recovered (achieving 100% or more). However, this success is not reflected financially, with cost recovery at just 17% and collection efficiency at 63%, indicating heavy dependence on external funding. The Water Supply sector faces similar financial challenges alongside severe continuity issues. While Dahanu maintains excellent water quality (100%) and low Non-Revenue Water (NRW) (15.10%), it provides water for only 1.5 hours per day, far below the 24-hour benchmark. Financial sustainability is weak, with cost recovery at 43.50% and collection efficiency at 73.90%, and the lack of metering data further constrains revenue mobilization. The Sanitation sector is marked by infrastructural gaps and financial ambiguity. Although toilet coverage is 100%, sewage network coverage remains 0%. Reported cost recovery stands at 60%, but the absence of data for collection efficiency, treatment

capacity, and reuse suggests this figure may stem from partial systems or tariff structures that do not reflect actual service requirements.

Across all sectors, persistent weaknesses in cost recovery—especially heavy grant dependence in SWM and water supply—limit the Corporation’s capacity to maintain assets and finance essential infrastructure for continuous service delivery and network expansion.

To summarise, the state has benefited from increased funding through the AMRUT and SBM programs, and the government has several resources and initiatives for WaSH in urban sectors. While all sectors have seen rising allocations over the period, urban development and water supply and sanitation remain among the least funded. However, recent trends show these sectors growing faster than many others, suggesting a gradual shift in state priorities, even though their overall share in expenditure continues to be modest. Additionally, water supply projects continue to be prioritized over sewerage projects, a trend also observed in the Jawaharlal Nehru Urban Renewal Programme (Rana, 2021). Also, while state allocations are increasing for smaller and medium towns, which is a positive development, the growing reliance of ULBs on central and state grants and the decline in their own revenue sources is a worrying sign for their financial health, as it reduces their decision-making authority and the long term sustainability of the services offered.

6. POLICY AND INSTITUTIONAL LANDSCAPE IN CLIMATE CHANGE AND WATER AND SANITATION

The climate change and water and sanitation sectors are governed by multiple institutions, each with distinct mandates and policy frameworks. Understanding these institutions is essential for identifying key stakeholders — including those responsible for financing, technology selection, infrastructure development, and policy implementation — as well as for assessing overlaps, and coordination challenges. This understanding is critical to enhancing resilience in the water and sanitation sectors. **This section is organized into two parts.** The first part provides a comprehensive review of the current institutional landscape at both the national and state levels, highlighting the role of Urban Local Bodies (ULBs) in delivering water and sanitation services. It also identifies key institutional overlaps and challenges. The second part examines relevant policies related to water and sanitation, climate change, and disaster management, with a focus on implementation challenges observed at the town level.

6.1 Institutional Landscape

6.1.1 State Level

At the national and state level, various departments, agencies, and organizations are involved not only in the provision of water and sanitation infrastructure and services but also in broader climate change governance and disaster management (refer to Table 8 and 9).

According to the 7th Schedule of the Constitution of India, water is a state subject, and the state has the prerogative to take decisions about the available water resources within the state jurisdiction. The central ministry of housing and urban affairs (MoHUA) formulates the policies, rules or laws and the states have the authority to adopt the policies in their respective states. The Central Public Health Environment and Engineering Organisation (CPHEEO) is the technical arm of the Ministry of Housing and Urban Affairs (MoHUA), which formulates and defines the service level benchmarks (SLBs) for water supply and sewerage. CPHEEO also drafts the manuals, guidelines, and policies that are applicable to all municipalities in the country. However, the state can formulate their policies within the national policy framework.

The Central Pollution Control Board (CPCB), under the Ministry of Environment, Forests, and Climate Change, sets environmental pollution standards that State Pollution Control Boards (SPCBs) enforce. Urban local bodies and state water and sewerage boards must comply with these standards. According to the three-tier structure of governance in India, the state approves central policies or centrally sponsored schemes, and the ULB implements action plans based on these policies and guidelines, such as the Atal Mission for Rural and Urban Transformation (AMRUT). The state-sponsored schemes are driven by the state urban development department (UDD). Thus, the source of grants for AMC is mainly the central and state schemes. The design and construction of sanitation facilities involve a network of institutions: ULBs are responsible for operation and maintenance (O&M) and construction at the city level, while in smaller towns, ULBs handle only O&M, with the Public Health Engineering Department (PHED) taking charge of construction. Additionally, the standards for the design and construction of onsite sanitation systems (OSS) and sewerage/water supply infrastructure are governed by distinct organisations: the CPHEEO and the Bureau of Indian Standards (BIS), respectively. Furthermore, energy-related aspects of the water and sanitation sector fall under the purview of the Ministry of Power and the Maharashtra Energy Development Agency (MEDA), with programs such as MEEP. Meanwhile, renewable energy generation from sanitation facilities is overseen by the Ministry of New and Renewable Energy (MNRE) through various central bioenergy programs.

Table 8: Key National and State Government Agencies in Urban Water and Sanitation and Climate Change

Sl. No.	Name of Agency	Roles and Responsibilities
1.	Ministry of Housing and Urban Affairs	Formulates policies, rules, and laws for urban development in India
2	Central Public Health Engineering and Environmental Organisation	The technical wing of MoHUA serves as an advisory body to the Ministry for WASH
3	Ministry of Jal Shakti	Responsible for the development of water resources, and providing quality drinking water and sanitation facilities
4	Department of Water Resources, River Development, and Ganga Rejuvenation	Formulates policy guidelines and programmes for the development, conservation, and management of water resources.
5	Central Groundwater Board	The scientific organisation under DWR RGDR develops and disseminates technologies for sustainable groundwater management.
6	Ministry of Environment, Forest and Climate Change	Plans, promotes, coordinates, and oversees the implementation of environmental and forestry conservation programmes.
7	Central Pollution Control Board	A statutory board established to control water and air pollution in India
8	Ministry of Consumer Affairs and Food and Public Distribution	Formulates plans, policies and programs for consumer protection, welfare, and food security.
9	Bureau of Indian Standards	Formulates standards, markings, and certifications for goods to ensure quality and safety.
10.	Ministry of Finance	Entrusted with the formulation of the budget, offering policy advice, and reviewing government programs. Accountable for finance,

Sl. No.	Name of Agency	Roles and Responsibilities
		governance and financial management through funds, grants, and procurements.
11	Central Finance Commission	Recommends the distribution of tax revenues between the Union and the States and amongst the States themselves.
12	Ministry of New and Renewable Energy	Policies and schemes on renewable Energy from urban Waste, solar power
13	Ministry of Power	Bureau of Energy Efficiency (BEE), Energy Conservation Act

In Maharashtra, several state-level agencies exhibit overlapping functions, roles, and responsibilities across various sectors, including water supply, sanitation, environmental protection, energy, climate change, and disaster management, resulting in coordination challenges. For instance, both the Water Resources Department (WRD) and the Maharashtra Jeevan Pradhikaran (MJP) are engaged in rural water infrastructure projects - WRD manages surface and groundwater, while MJP implements drinking water schemes - resulting in duplication, particularly in areas such as watershed development and groundwater recharge.

Similarly, overlaps exist between the Public Works Department (PWD), Urban Local Bodies (ULBs), and the Urban Development Department (UDD) in urban water and sanitation infrastructure. PWD continues to manage and construct pipelines and sewerage systems even as ULBs are responsible for service delivery and operation, often creating ambiguity in maintenance and accountability. In the energy sector, the Maharashtra Energy Development Agency (MEDA) promotes renewable energy and energy efficiency. Still, implementation often requires coordination with departments like WRD or MSEDCL (not listed), which can cause delays, such as in solar rooftop integration projects. Climate change governance also shows functional overlaps among the State Climate Change Cell (SCCC), Maharashtra Pollution Control Board (MPCB), the Environment and Climate Change Department, and the Maharashtra Coastal Zone Management Authority (CZMA).

These bodies independently handle aspects of environmental regulation, ecosystem protection, and climate adaptation, often without integrated planning and coordination. Additionally, the Maharashtra State Disaster Management Authority (MSDMA) is responsible for overall disaster response and planning; however, implementation involves sectoral departments, such as WRD and UDD, particularly in flood mitigation and emergency water supply. This fragmented landscape necessitates more explicit institutional mandates, integrated planning, and robust inter-agency coordination mechanisms to avoid redundancy and enhance service delivery resilience.

Overall, these institutional overlaps lead to inefficiencies, including duplicated infrastructure investments, fragmented environmental enforcement, and delayed project implementation. Addressing these challenges requires more explicit mandates, improved inter-agency

coordination, unified data management, and harmonised policies to enhance service delivery and governance in Maharashtra’s water, sanitation, environment, energy, and disaster sectors.

Table 9: Key State Government Agencies in Urban Water and Sanitation and Climate Change

Sl. No.	Sector	Organization	Key Roles & Responsibilities
1	Water and Sanitation	Water Resources Department (WRD)	Manages surface water resources, irrigation, dams, watershed development; regulates groundwater extraction
		Maharashtra Jeevan Pradhikaran (MJP) under the Water Supply and Sanitation Department	Planning, implementation, and management of rural and urban drinking water supply schemes
2	Urban Development	Urban Development Department, Maharashtra	Oversight of Urban Local Bodies (ULBs); urban water supply, sanitation, and infrastructure development
		Public Works Department (PWD)	Design, construction, and maintenance of water supply pipelines, drainage, and sanitation infrastructure
3	Energy & Renewable Energy	Maharashtra Energy Development Agency (MEDA)	Promotion and development of renewable energy and energy efficiency projects
4	Climate Change	State Climate Change Cell (SCCC)	Coordination of climate change mitigation and adaptation efforts; implements Maharashtra State Action Plan on Climate Change (MSAAPCC)
		Maharashtra Pollution Control Board (MPCB)	Enforcement of environmental regulations and pollution control relevant to climate policies
		Maharashtra Environment and Climate Change Department	Formulation and enforcement of environmental policies, ecosystem protection, pollution control and climate change
		Maharashtra Coastal Zone Management Authority	Regulation and monitoring of coastal zones under CRZ Notifications
5	Disaster Management	Maharashtra State Disaster Management Authority (MSDMA)	State-level disaster management planning, preparedness, risk reduction, and response coordination

6.1.2 Town Level

While schemes and projects are implemented at the urban local level, their planning, funding, and oversight often involve coordination across multiple tiers of government. **The roles and responsibilities of stakeholders—from households to central-level institutions—are illustrated through the case of Vengurla (refer to Table 10).**

Although Urban Local Bodies (ULBs) are designated as the nodal agencies for sanitation services, the current institutional setup reveals their limited role in long-term climate and

disaster resilience planning, particularly concerning large-scale sanitation infrastructure, such as Sewage Treatment Plants (STPs) and Faecal Sludge Treatment Plants (FSTPs). As shown in the table below, capital investments for such infrastructure are primarily driven by central schemes such as SBM-Urban. At the same time, decisions around technology selection, approval, and implementation are made at the state level under the Maharashtra Jeevan Pradhikaran (MJP). Despite having limited say in the planning and design phases, the responsibility for operations and maintenance (O&M) is devolved to the Vengurla Municipal Council (VMC), highlighting a misalignment between institutional responsibility and capacity.

This disconnect becomes even more critical in the context of increasing climate-related risks such as extreme rainfall, flooding, and sea-level rise. As ULBs are expected to maintain essential infrastructure and ensure service continuity during climate-induced disruptions, their financial capacity becomes a key determinant of resilience. Our analysis of VMC's finances, consistent with broader trends among ULBs in India, reveals vulnerabilities—particularly in cost recovery, operating ratios, and revenue deficits across both water supply and sanitation services. Although there has been a gradual rise in per capita revenue expenditure in recent years, indicating efforts to address growing operational demands, sustaining such expenditure without proportional revenue growth may pose long-term challenges to both financial and climate resilience.

For smaller-scale community and public sanitation infrastructure, the ULB relies on a mix of its own resources and SBM-Urban funds. VMC has also leveraged performance-based awards from the state government to improve sanitation access through the installation of public toilets. While such efforts reflect a commitment to service delivery, they remain disconnected from a broader strategic framework that aligns sanitation with climate adaptation and disaster preparedness.

At the household level, institutional engagement in regulating on-site sanitation systems (OSS) is minimal. The ULB does not participate in the design, construction, or enforcement of standards for toilets or OSS for households. Regulatory oversight exists only for larger establishments through MJP's building plan approval mechanism, underscoring gaps in ensuring climate- and disaster-resilient sanitation at the individual and community scale.

Interviews with ULB officials further highlight limited engagement in formal disaster governance structures. Vengurla's disaster management framework is anchored at the taluka level, with the local cell focusing mainly on recording events and forwarding damage reports to the District Disaster Management Authority (DDMA). The role of the ULB remains largely reactive, restricted to post-disaster relief efforts, such as providing drinking water, sanitation facilities, temporary shelters, and restoring essential services. In instances of structural

damage to homes, ULBs are tasked with reporting to higher authorities, reinforcing their peripheral role in proactive disaster preparedness and risk reduction.

In summary, while ULBs like VMC play a central role in the delivery and maintenance of WaSH infrastructure, their constrained role in strategic planning, limited financial capacity, and reactive posture in disaster governance highlight institutional bottlenecks that undermine local climate resilience. Strengthening the mandate, capacity, and coordination of ULBs is essential to bridge the gap between day-to-day service delivery and long-term climate and disaster preparedness.

Table 10: Town Level Institutional Arrangement in Sanitation Services: A Case of Vengurla Town

Intervention	Technology Selection	Land	Capital	Technology Provision	Technology implementation	O&M	O&M Funding	
Toilets	HH	HH	HH	Local masons/private vendors	Local masons/private vendors	HH	HH	
On-site Sanitation Systems	HH	HH	HH			HH	Septage removal by vehicles of the ULB	HH
Public Toilets	ULB	ULB	ULB	ULB	ULB	ULB	ULB	
		Bus Stand	Central Government [SBM 1.0]					
			State Government [Award Funds]					
Faecal Sludge and Septage Treatment Plant	State [MJP]	ULB	Central Government [SBM 1.0]	State [MJP]	State [MJP]	ULB	ULB	
Sewage Treatment Plant	State [MJP]	ULB	Central Government [SBM 1.0]	State [MJP]	State [MJP]	ULB	ULB	

Source: IIT-Bombay – based on Interviews with Vengurla Municipal Council Officials

6.2 Policy Landscape

This section presents the findings from a comprehensive review of policies within the climate change, urban water supply, and sanitation (UWSS) sectors, along with related areas such as energy, disaster governance and environmental governance. It examines how adaptation, mitigation, and the resilience of UWSS infrastructure and services are addressed across these sectoral policies. Additionally, this section incorporates field findings from research conducted in the selected towns in Maharashtra—Vengurla, Ratnagiri, Alibag, Dahanu, Malvan, and Guhagar—to assess the adoption and effectiveness of state-level policies and measures at the local level.

Aligning with the national commitment to a ‘Net Zero target by 2070’ as outlined in COP26 in 2021, the Government of Maharashtra has taken various measures. The key state policies, programmes and regulations that promote CC adaptation and mitigation in WaSH are listed in **Annexure I**. Additionally, the state implements national programmes and schemes, such as the Swachh Bharat Mission (urban and rural), AMRUT, and the Municipal Energy Efficiency programme (MEEP). A review of policies and programmes was conducted to examine whether the current policy and institutional framework enables the linkages between climate change and the water and sanitation sector.

6.2.1 Policies and Programmes with Mitigation Focus

Addressing mitigation directly includes suggestions for pump efficiency, septage management, proper septic tank and non-network and decentralised sanitation solutions under the MEEP, Septage Management Guidelines 2016, and the Integrated State Water Plan for the west-flowing rivers – 2018, respectively. Measures such as the implementation of well-designed septic tanks facilitate effective treatment, thereby reducing direct greenhouse gas emissions. Similarly, the adoption of non-network solutions diminishes operational greenhouse gas emissions by lowering the energy required for transporting water and wastewater over shorter distances. The state is also a frontrunner when it comes to managing faecal sludge with 179 operational FSSTPs (faecal sludge and septage treatment plants) and 60 upcoming FSTPs (National Faecal Sludge and Septage Management Alliance, 2024), which further helps in managing the methane emissions from septic tanks. However, **our town-level assessment reveals the absence of an FSSTP in Ratnagiri, raising concerns about the operational efficacy of the FSSTP in Alibag. Furthermore, as mentioned earlier in the report, the field research for Dahanu, Malvan, and Guhagar suggests that these towns either have no sewage treatment facilities or have defunct plants. In the absence of facilities in Dahanu, private operators are reportedly managing desludging, often disposing of faecal sludge**

unsustainably in fields. At the same time, Malvan and Guhagar are reported to have non-operational FSTPs due to significant design flaws and inadequate maintenance.

Under MEEP (Figure 22), out of 44 AMRUT cities in Maharashtra, 12 cities are currently undergoing the tendering process for the installation of 425 water-efficient pumps. (Energy Efficiency Services Limited, 2024).

Figure 22: Energy-efficient pumps installed under MEEP in Maharashtra (as of 24 August 2024)



Source: (Energy Efficiency Services Limited, 2024)

At the town level, the Vengurla Municipal Council has undertaken energy and water audits for its water and sanitation services, demonstrating a proactive approach to sustainability. The council actively promotes the use of renewable energy and contributes to reducing greenhouse gas (GHG) emissions. As part of these efforts, all municipal buildings have been equipped with rooftop solar systems. Moreover, the city has introduced an incentive-based policy that offers property tax concessions to households adopting rooftop solar panels and rainwater harvesting systems. These measures reflect the council’s commitment to mitigating climate change by reducing its dependence on conventional energy sources and lowering the town’s overall carbon footprint.

6.2.2 Policies and Programmes with Adaptation Focus

Most policies at the intersection of climate change, water, and sanitation are focused on adaptation strategies. This is evident in the State Action Plan, which emphasises inclusive, sustainable development through climate-resilient, low-carbon pathways. The plan primarily focuses on adaptation, a priority that is reflected in the budget allocation, with a significant portion dedicated to adaptation projects and sectors.

Most policies either intentionally or unintentionally focus on interlinked issues of: (i) water scarcity and water security, (ii) improved and equitable access to improved drinking water and improved sanitation services, and (iii) human and environmental health.

The policies addressing water scarcity and security primarily suggest adaptive measures such as rainwater harvesting, groundwater recharge, improving water use efficiency across sectors, regulating groundwater withdrawal, and promoting the recycling and reuse of treated wastewater. **The overarching guidance is provided by the State Adaptation Action Plan on Climate Change (2014). As the name suggests, the plan is focused on advancing climate change adaptation. Consequently, the recommendations prioritise adaptation across various sectors, including WaSH, with mitigation co-benefits.** From the standpoint of adaptation to water scarcity and security, the plan outlines key measures, including creating WaSH infrastructure and services, enhancing water use efficiency across all sectors, recycling and reusing treated wastewater, and implementing rainwater harvesting. (The Energy and Resources Institute, 2014).

Similarly, key sectoral policies, programmes and regulations in the water and sanitation sector are primarily adapted forward with mitigation as a co-benefit. The latest State Water Policy (2019) addresses water scarcity and security, directly linking these challenges to climate change. It emphasises the importance of ensuring clean water and sanitation through adaptation-focused measures, such as improving water use efficiency across all sectors, promoting the recycling and reuse of treated wastewater, encouraging rainwater harvesting, and regulating groundwater. Similar suggestions are made under the Integrated State Water Plan for the west-flowing rivers – 2018, but from the perspective of maintaining E-flows (adaptation).

Going one step forward, the **State Water Policy – 2019** suggests 30% minimum wastewater usage, and Service Level Benchmarks (SLBs) mandate the ULBs to ensure 80% of domestic water is available for reuse (Water Resources Department, 2019). The status of recycling and reusing wastewater in the state remains less than encouraging when compared to national and global averages. **Although the state treats 18% more of its wastewater than the national average, its reuse rate is only 4%, which is 1% lower than the national figure and 7% below the global average** (Center for Water and Sanitation, 2024). The towns of Ratnagiri and Alibag

exhibit minimal recycling of treated wastewater, primarily due to the lack of sewage treatment plants (STPs).

In contrast, Vengurla has taken proactive steps to address wastewater pollution and promote recycling, thereby reducing the demand for freshwater. In line with Maharashtra’s building bylaws, the municipal council has mandated that all existing and new buildings install standalone, decentralised wastewater treatment plants. Several buildings in Vengurla have already implemented these decentralised systems to treat and recycle wastewater. The treated water is mainly reused for non-potable purposes such as gardening and landscaping. The municipal council actively monitors and supervises the quality of treated wastewater to ensure proper system maintenance and compliance with environmental standards.

The key policy governing groundwater regulation in Maharashtra is the **Maharashtra Groundwater (Development and Management) Act, 2009**. It mandates registration of all well owners and drilling agencies, prohibits deep well drilling, and imposes user charges on groundwater users. **At the town level, both Ratnagiri and Vengurla actively implement these regulations**, including the requirement for obtaining a No Objection Certificate (NOC) before groundwater extraction. Interviews with officials from the Ratnagiri Urban Local Body (ULB) reveal that groundwater management is a priority area with robust regulatory enforcement. The Groundwater Department plays a crucial role in monitoring groundwater levels and quality through regular assessments and data collection from observation wells. This enables early detection of over-extraction or water quality deterioration, which is vital for sustainable management in a coastal region like Ratnagiri. The NOC system helps regulate extraction, preventing unsustainable use and ensuring equitable access for all users. These measures enhance climate resilience by safeguarding water security and maintaining aquifer health, which are critical in the face of growing climate variability and increasing demand. Developing an integrated, climate-informed water resource management framework could further strengthen these efforts and align Ratnagiri’s water governance with broader sustainability and adaptation objectives.

The rainwater harvesting policies provide both adaptation and mitigation co-benefits, including freshwater savings and improved energy efficiency. As decentralised systems, they are less energy-intensive compared to traditional water distribution networks – a fact also recognised in the State Climate Change Action Plan. Additionally, the costs are shared by users, reducing the financial burden on utilities. At the national level, programmes such as the Jal Shakti Abhiyan and its *Catch the Rain* campaign focus on 148 districts identified by the Central Ground Water Board (CGWB). As in previous years, the initiative includes five key interventions, including Water conservation and rainwater harvesting (Government of India, 2009). Maharashtra ranked ninth in terms of rainwater harvesting structures (status from March 22, 2025, to July 28, 2025) (Ministry of Jal Shakti, 2025). **Our study across three**

selected coastal towns (Alibag, Ratnagiri, and Vengurla) reveals that rainwater harvesting (RWH) is not yet a widely adopted practice. However, the city of Vengurla stands out as a positive exception. The Vengurla Municipal Council has proactively implemented rainwater harvesting regulations, **resulting in the installation of RWH systems in approximately 60% to 70% of municipal buildings.** The remaining 30% to 40% are expected to complete installations by the next financial year. **This initiative is supported by the *Majhi Vasundhara Abhiyan*,** a state-led mission that provides funding for environmental conservation efforts, with a specific emphasis on rainwater harvesting. Additionally, under the AMRUT 2.0 scheme (Atal Mission for Rejuvenation and Urban Transformation), funds have been allocated for the rejuvenation of Narayan Lake, which serves as the town’s secondary freshwater source. Further, to **encourage sustainable practices such as the adoption of solar energy and RWH at the household level—thereby reducing dependence on grid electricity and piped water—the Vengurla Municipal Council has introduced property tax concessions.**

If implemented, such measures can lead to reduced reliance on freshwater, which can ease the burden on water supply systems, reducing the need for water abstraction and transportation, which in turn lowers energy consumption and mitigates operational GHG emissions.

While all these are policy directives, the state government has also made specific provisions to create a supporting environment for their execution. For example, under the Maharashtra Water Resources Regulatory Act of 2005, the state established the Maharashtra Water Resources Regulatory Authority (MWRRA). The institution is entrusted with the responsibility to “promote efficient use of water and to minimise the wastage of water and to fix reasonable use criteria for each Category of Use” (including domestic users) (Government of Maharashtra, 2005, p. 25). The MWRRA also released a (draft) “Water Entitlement Transfer (WET) and Wastewater Reuse Certificates (WRC) Platform Regulations-2019” with the intent to incentivise water use entities to use water efficiently and adopt the recycle and reuse of treated domestic wastewater. The implications of such a framework remain uncertain, as it is still in the draft stage. The plan suggests standard fiscal instruments to enable the adoption of water use efficiency and recycling and reuse policies, such as **tax concessions, raising the price of freshwater, and incentivising domestic wastewater treatment equipment manufacturers.** (The Energy and Resources Institute, 2014). It also mandates regular water and energy audits. **The practices of conducting ‘water audits’ and ‘energy audits’ were observed only in Vengurla, in line with the recommendations of the State Climate Change Adaptation Action Plan (2014) and the State Water Policy (2019).** Insights gained from these audits have enabled the council to develop targeted policies and implement technological solutions that effectively reduce water losses, enhance the energy efficiency of the water cycle, and address both current and projected demand-supply gaps.

Furthermore, the Ministry of Health and Family Welfare, Government of India, launched the National Programme on Climate Change and Human Health in line with India's commitment to the Paris Agreement. Under this initiative, several states, including Maharashtra, have developed state-level climate action plans that incorporate health concerns related to climate resilience. The declaration calls for essential services, including water, sanitation, waste management, and electricity, to remain functional during such events. Moreover, for the health sector to be truly climate-resilient, it must adopt eco-friendly technologies and energy-efficient practices, contributing to a "greener" health system. The plans emphasise the need for the health department to embrace sustainable practices through environmentally conscious technologies and energy-efficient solutions.

It is evident that while state policies are primarily geared towards adaptation, they also indirectly contribute to the broader goal of mitigating challenges in water and sanitation services. This is also evident from the higher allocations towards adaptation (5% of the total state budget for 2023-24) vs 2% each towards mitigation and resilient efforts. (Agarwal, Solanki, & Garimella, 2024). This adaptation focus is understandable, given that none of the towns in the state currently meet the Service Level Benchmarks (SLBs) for water supply and sewerage connections, as discussed in the previous section. Our interactions with the Ministry of Housing and Urban Affairs (MoHUA) and various think tanks reinforced these insights, highlighting the lack of robust policy evidence to support the development of mitigation-focused strategies in water and sanitation services.

While most policies primarily focus on adaptation efforts and establishing an enabling environment through economic instruments, such as funding (through programmes like SBM, AMRUT, MSJNMA, and Vasishpurna Scheme), there is only one dedicated program (MEEP) that explicitly addresses mitigation within the water and sanitation sector.

6.2.3 Policies and Programmes with Infrastructure Resilience Focus

The state's primary guidance document for climate action, the State Climate Change Action Plan, addresses the physical resilience of water and sanitation infrastructure and services by highlighting the vulnerabilities these systems face from climate impacts such as floods, droughts, and sea-level rise. It frames the problem in terms of the increasing risks to the functionality and sustainability of critical water supply and sanitation facilities, especially in flood-prone urban areas, drought-affected regions, and vulnerable coastal zones. To enhance resilience, the plan proposes several solutions, including integrating climate projections and risk assessments into the design and construction of water and sanitation infrastructure to withstand extreme weather events. It emphasises improved drainage and flood management through flood mitigation projects and enhanced stormwater infrastructure, protecting

sanitation facilities from flood damage and contamination. Additionally, the plan advocates for the conservation and restoration of coastal ecosystems, such as mangroves and wetlands, which serve as natural barriers against sea-level rise and storm surges. Decentralised and community-based management approaches are promoted to ensure adequate maintenance and adaptation of water and sanitation services under climate stress. Finally, the plan supports integrated water resource management with a watershed-based approach to ensure sustainable water availability and sanitation services through conservation and efficient use. These strategies are implemented within a multi-tiered governance framework, which includes sector-specific action plans and coordination mechanisms, to strengthen adaptive capacity and ensure effective execution.

The Maharashtra State Disaster Management Plan - 2023 recognises that water and sanitation systems are both critical lifelines and highly vulnerable to disasters such as floods, droughts, and landslides. (Government of Maharashtra, 2023). It frames the issue by identifying key risks to physical infrastructure—from inundation and contamination during floods to supply disruptions during prolonged dry spells. Ensuring continuity of water services and safe sanitation under emergency conditions is therefore a central concern of the resilience strategy. **The plan outlines both structural and non-structural measures to enhance the physical resilience of water and sanitation infrastructure** in the face of climate-induced disasters. **Structural resilience measures** include the construction of embankments, retention basins, and improved drainage systems to protect water treatment plants and sanitation facilities from flooding. It also promotes the development of check dams, percolation tanks, and watershed structures to store floodwater and recharge aquifers, thereby stabilising water availability during droughts. **In high-risk zones**, water and sanitation infrastructure is elevated or retrofitted to reduce vulnerability. In hilly regions, landslide mitigation strategies, such as retention walls, surface drainage, and slope stabilisation, are used to protect pipelines and service networks. Complementing these are **non-structural resilience strategies**. These include enforcing hazard zoning and land-use regulations to prevent the construction of infrastructure in floodplains and areas prone to landslides. Early warning systems and GIS-based risk mapping, like the Nagpur Digital Risk Atlas, are used to anticipate and manage threats to water systems. The plan also supports ecosystem-based disaster risk reduction (Eco-DRR), including vegetation restoration efforts such as Miyawaki forests, which help recharge groundwater and reduce runoff. Community-led management is emphasised through training programs focused on water storage, sanitation and hygiene, and emergency preparedness. Additionally, data-driven water management, utilising IoT sensors and climate-informed forecasting, enables proactive responses to risk, particularly in cities like Kolhapur and Sangli, under the Maharashtra Resilient Cities Development Programme (MRCDP). Finally, the plan integrates resilience into policy frameworks by mandating flood- and drought-resistant design standards in building codes and urban sanitation planning.

At the city level, the Smart Cities Mission encourages cities to incorporate risk resilience into their proposals by assessing the environmental impact of each project and its ability to withstand disasters. However, our field studies in Vengurla, Ratnagiri, and Alibag suggest that much of the water and wastewater infrastructure developed in earlier times did not incorporate disaster-related concerns or prioritise climate-proofing. In fact, the upcoming infrastructure reports also fail to integrate disaster risk and climate change considerations into their infrastructure and service proposals.

6.2.4 Policies and Programmes Focussing on Coastal Areas

There is no dedicated national mission for coastal areas and climate change under the National Action Plan on Climate Change (NAPCC). However, the National Water Mission addresses the impacts of climate change on coastal regions as part of its broader mandate.

“A National Water Mission will be mounted to ensure integrated water resource management, helping to conserve water, minimise wastage and ensure more equitable distribution both across and within states. The Mission will consider the provisions of the National Water Policy and develop a framework to optimise water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing. It will seek to ensure that a considerable share of the water needs of urban areas are met through recycling of wastewater, **and ensuring that the water requirements of coastal cities with inadequate alternative sources of water are met through adoption of new and appropriate technologies such as low-temperature desalination technologies that allow for the use of ocean water**” (Ministry of Jal Shakti , 2021, p. 8). Key concerns include saltwater intrusion due to sea level rise, which significantly impacts groundwater quality and access to drinking water. **Coastal regions, along with drought-prone areas, flood-prone areas, regions with deficient rainfall, and areas classified as over-exploited, critical, or semi-critical in terms of groundwater development and water quality, have been prioritised under the mission. Strategies for these priority areas include** improving water use efficiency by 20%, for which the Ministry has established the Bureau of Water Efficiency (BWE); Assessing the impacts of climate change on water resources; Maintaining a comprehensive water database in the public domain; **and publishing the Composite Water Management Index (CWMI) to track and promote effective water management practices.**

In 2011, the Ministry of Environment, Forests, and Climate Change (MoEF&CC) established the **National Centre for Sustainable Coastal Management (NCSCM)** as an autonomous institution to support coastal protection, conservation, rehabilitation, and policy guidance. NCSCM promotes the **Integrated Coastal Zone Management (ICZM)** approach by utilising science-based decision support systems and facilitating collaboration among communities,

government bodies, and national and international institutions. To implement this integrated approach, the Government of India launched the **Integrated Coastal Zone Management Project (ICZMP)** under the **CRZ and IPZ Notifications (2011)**. The project has enabled key activities, including **hazard line mapping, identification of eco-sensitive areas, and delineation of sediment cells** along the entire Indian coastline, laying the groundwork for climate-resilient coastal planning and governance. For implementing the provisions of the **CRZ Notification, 2011**, the **Maharashtra State Coastal Zone Management Authority** was constituted. Its mandate includes protecting and improving the coastal environment, controlling pollution, and examining proposals for changes in CRZ classifications. The Authority is also empowered to investigate and review violations under the **Environment Protection Act** and **CRZ regulations** within Maharashtra. **The state has a development CRZ master plan for various districts, including Sindhudurg, Ratnagiri, Raigad, Palghar, Thane, and the Mumbai suburban area.**

The key document in climate change, namely the Maharashtra State Adaptation Action Plan on Climate Change (MSAAPC), acknowledges the heightened vulnerability of the state's coastal regions to climate impacts, including **sea-level rise, saline intrusion, and extreme weather events, which threaten freshwater availability and sanitation infrastructure**. To address these challenges, the plan emphasises the protection of groundwater from saltwater contamination and advocates for climate-resilient water supply and sanitation systems capable of withstanding floods and saline intrusion. It promotes integrated water resource management strategies, including rainwater harvesting and wastewater treatment, to ensure sustainable access to safe water and sanitation. Additionally, MSAAPC calls for strengthening monitoring systems, enhancing community participation, and building institutional capacity to enable effective climate adaptation in coastal water and sanitation services, thereby safeguarding public health and ecosystem integrity in vulnerable coastal zones.

At the town level, the study found that the **Vengurla Municipal Council has implemented stringent measures to prevent waste dumping and landfilling along the coastal belt, thereby protecting the local environment and advancing its sustainability goals**. The council operates a fully functional **Construction and Demolition (C&D) waste management facility**, providing residents with an eco-friendly waste disposal option. This initiative underscores the town's commitment to sustainable waste management by reducing environmental degradation, conserving aquatic ecosystems, and mitigating risks of surface and groundwater contamination. The **municipal council prioritises mangrove conservation, including plantation efforts and mangrove safaris, recognising mangroves as the first line of defence against high tides and storm surges**. To support this, the **ULB collaborates with local all-women self-help groups (SHGs)** to organise large-scale monthly cleanliness drives in mangrove areas. Widely recognised and covered by environmental media, these efforts preserve mangrove health and raise awareness among National Cadet Corps (NCC) groups,

college students, and local fishing communities about the critical role of mangroves in coastal protection^{xxiii}. **To address saltwater intrusion** in public and private wells, the council has constructed—and continues to build—**additional ‘Bandharas,’** a traditional rainwater harvesting technique involving earthen embankments across shallow valleys or stream beds to retain rainwater and recharge groundwater. This intervention helps prevent further saltwater intrusion and supports groundwater replenishment. **As part of its pre-disaster preparedness, the council prioritises Bandhara construction. The Maharashtra Maritime Board, responsible for coastal infrastructure such as breakwaters and embankments, oversees related projects, and the council actively coordinates with them to strengthen coastal protection measures.**

7. RECOMMENDATIONS

Maharashtra's policy and institutional landscape was examined through a grounded assessment in the towns of Vengurla, Alibag, Ratnagiri, Dahanu, Malvan, and Guhagar to understand how water, sanitation, and climate change policies interact, and to identify key policy, institutional, and implementation challenges. **This section presents an analysis of these challenges and offers targeted recommendations under key themes: financial programmes and schemes, institutional frameworks, and the broader policy landscape.**

Maharashtra, one of India's most urbanised and climate-vulnerable states, faces increasing risks from extreme weather events such as floods, droughts, and cyclones. The state has acknowledged the need for climate-resilient water, sanitation, and hygiene (WaSH) services, especially given its diverse geography and growing urban population. However, its adaptive capacity remains constrained by inadequate basic services, particularly in smaller towns that struggle with weak WaSH infrastructure, poor service quality, and financial fragility. Environmental compliance is low, and poor service delivery contributes to greenhouse gas (GHG) emissions, with untreated wastewater being a significant source of these emissions. While Maharashtra receives funding under central schemes, its urban development budget has declined, and Urban Local Bodies (ULBs) increasingly depend on external grants, eroding their financial autonomy. Sewerage projects remain underfunded compared to water supply. This underscores the potential of exploring decentralised, nature-based wastewater solutions that are more sustainable and context-appropriate. Institutional fragmentation and weak policy coherence between state and national levels hinder effective climate action, with WaSH-related disaster risk management often overlooked. Although adaptation receives greater policy and funding attention, there is a lack of explicit mitigation strategies in the WaSH sector. None of the state's towns meet Service Level Benchmarks (SLBs), justifying the adaptation focus. However, consultations with MoHUA and think tanks point to the need for evidence-based mitigation strategies. Field studies also reveal a limited understanding of climate-WaSH linkages at the ULB level, highlighting the urgency of capacity building.

7.1 Financial Programmes and Schemes

Key Challenges

1. **Weak Financial Health of ULBs:** The proportion of own-source revenue to total ULB revenue declined from 90% in 2015–16 to 78% in 2019–20. This undermines their autonomy in decision-making and their capacity to plan independently.

2. **Inadequate Devolution of Finance Commission Grants:** Only 16–20% of state-level grants are devolved to ULBs, limiting their ability to meet service delivery expectations.

Recommendations

1. **Prioritise Investments Across Sectors:** Prioritise sewerage and wastewater treatment infrastructure, especially in vulnerable and rapidly urbanising areas, to ensure environmental sustainability.
2. **Strengthen Financial Autonomy of ULBs:** Encourage local revenue generation (property tax reform, user fees) and provide capacity-building support to enhance financial planning and service delivery.
3. **Ensure Equitable Devolution of Finance Commission Grants:** Institutionalise mechanisms to devolve a larger share of intergovernmental transfers to ULBs based on performance and need.

7.2 Policy and Institutional Landscape

7.2.1 Institutional Landscape

Key Challenges

1. **Overlapping Institutional Roles and Ambiguity in Accountability:** Multiple agencies (WRD, MJP, PWD, UDD, etc.) operate with unclear mandates, leading to duplication, inefficiencies, and confusion over roles in infrastructure planning, execution, and maintenance.
2. **Misalignment of Roles and Responsibilities in ULBs:** ULBs are responsible for operations and maintenance but are excluded from the planning, design, and investment decisions for major infrastructure projects, weakening accountability and performance.
3. **Limited ULB Involvement in Strategic Planning:** ULBs have minimal engagement in long-term climate resilience and disaster preparedness planning, despite being frontline service providers.
4. **Financial Vulnerability of ULBs:** Low-cost recovery, operational deficits, and high reliance on external grants undermine the financial sustainability and adaptive capacity of ULBs.

5. **Lack of Integration Between Sanitation and Climate/Disaster Strategies:** Sanitation infrastructure and investments are not systematically linked to climate adaptation or disaster risk reduction frameworks.
6. **Gaps in Household-Level Sanitation Regulation:** On-site sanitation systems (OSS) at the household level remain unregulated, especially in vulnerable, flood-prone areas, posing public health and environmental risks.
7. **Reactive and Peripheral Disaster Governance Role for ULBs:** ULBs are largely sidelined from formal disaster governance structures and act mainly in a post-disaster relief capacity, rather than engaging in proactive risk mitigation or preparedness.

Recommendations

1. **Clarify and Streamline Institutional Mandates:** Clearly delineate roles across WRD, MJP, UDD, and other departments to reduce duplication and strengthen accountability.
2. **Enhance ULB Involvement in Infrastructure Planning:** Empower ULBs in technology selection, infrastructure design, and capital investment planning for WaSH projects.
3. **Strengthen ULB Financial Capacity:** i) Enhance local revenue generation and establish sustainable cost recovery models to support resilient operations. ii) Support ULBs in improving cost recovery mechanisms and diversifying revenue sources to sustain infrastructure and service resilience.
4. **Integrate Water and Sanitation with Climate and Disaster Planning:** Link community and city-level water and sanitation infrastructure development with climate risk assessments and disaster preparedness frameworks.
5. **Institutionalise ULBs in Disaster Governance:** i) Include ULBs in formal disaster management planning at district and state levels, enabling proactive and locally relevant risk reduction strategies. ii) Formalise the role of ULBs in disaster preparedness, early warning, and risk reduction strategies at the district and state levels.

Expand Regulatory Oversight to Household OSS: i) Extend technical support and regulatory oversight to household OSS systems, particularly in new constructions. ii) Develop local mechanisms to monitor and regulate household-level sanitation systems, particularly in vulnerable areas.

7.2.2 Policy Landscape

It is clear that while state policies primarily focus on adaptation, they also indirectly support broader mitigation goals in water and sanitation services. This is reflected in the budget

allocations for 2023-24, where 5% is dedicated to adaptation compared to just 2% each for mitigation and resilience efforts. This prioritization is understandable—like many other Indian states—since none of the towns currently meet the Service Level Benchmarks (SLBs) for water supply and sewerage connections. Therefore, the immediate focus must be on strengthening adaptive capacity and enhancing community resilience before advancing long-term mitigation objectives. Consultations with the Ministry of Housing and Urban Affairs (MoHUA) and several think tanks have reinforced these findings, underscoring the current lack of robust policy evidence to develop effective mitigation-focused strategies within the water and sanitation sector.

Policies and Programmes with Mitigation Focus

Maharashtra's WaSH sector has made notable strides in climate change mitigation through leadership in faecal sludge management, with 179 operational and 60 upcoming treatment plants, and the promotion of non-networked sanitation systems that reduce operational emissions. The state also plans to install 425 energy-efficient water pumps in AMRUT cities under the Municipal Energy Efficiency Programme (MEEP), supported by key policy instruments like the Septage Management Guidelines (2016) and the Integrated State Water Plan (2018). **However, significant challenges persist, including limited integration of climate and WaSH policies, slow progress in implementing energy-efficient technologies—with only 12 of 44 AMRUT cities advancing in pump installations—and a heavy reliance on centrally driven programmes with minimal local innovation. Additionally, MEEP's focus has primarily been on street lighting rather than water pump efficiency.** At the regional level, encouraging efforts are evident, exemplified by Vengurla Municipal Council's energy and water audits, as well as its proactive promotion of renewable energy. The council has equipped all municipal buildings with rooftop solar systems and introduced property tax incentives for households adopting rooftop solar panels and rainwater harvesting, reflecting a strong commitment to reducing carbon footprints.

Recommendations include strengthening policy integration across the climate and WaSH sectors, accelerating the implementation of energy efficiency projects beyond street lighting, encouraging localised innovation and planning, and scaling up renewable energy and water-saving initiatives at the municipal and household levels to enhance climate resilience. Furthermore, strengthen and expand mitigation-focused initiatives within WaSH, in conjunction with existing adaptation efforts.

Policies and Programmes with Adaptation Focus

Maharashtra's climate and WaSH policies primarily focus on adaptation, emphasising climate-resilient development through strategies such as rainwater harvesting, groundwater

recharge, water-use efficiency, wastewater recycling, and groundwater regulation. The State Water Policy (2019) and the Integrated State Water Plan (2018) reinforce these priorities; however, wastewater reuse remains low nationally and locally, with Vengurla leading in decentralised treatment and monitoring. Groundwater management under the 2009 Act is effectively enforced in Ratnagiri and Vengurla, including the issuance of mandatory extraction permits. Rainwater harvesting, which offers both adaptation and mitigation benefits, is underutilised, except in Vengurla, where 60–70% of municipal buildings have systems supported by state incentives. The Maharashtra Water Resources Regulatory Authority promotes efficient water use, although key initiatives are still in draft form. Water and energy audits, encouraged by state policies, are mainly practised in Vengurla, enabling targeted improvements. Health sector plans focus on maintaining essential WaSH services during climate events and adopting eco-friendly, energy-efficient technologies.

Key Challenges:

- Strong policy emphasis on adaptation with limited focus on mitigation strategies in WaSH.
- Low wastewater recycling rates and inadequate sewage treatment infrastructure in several towns.
- Limited adoption of rainwater harvesting beyond a few proactive municipalities.
- Draft regulatory frameworks and economic instruments for water reuse and efficiency are not yet fully operational.
- Uneven implementation of water and energy audits and weak integration of health and WaSH climate resilience planning.
- Incomplete achievement of Service Level Benchmarks for water supply and sanitation infrastructure.

Recommendations:

- Strengthen and expand mitigation-focused initiatives within WaSH, alongside existing adaptation efforts.
- Accelerate the development and operation of sewage treatment infrastructure and improve wastewater recycling across towns.
- Promote widespread adoption of rainwater harvesting through incentives and regulatory mandates.
- Finalise and implement regulatory frameworks like water entitlement transfer and wastewater reuse certificates to encourage efficient water use.
- Scale up water and energy audits across urban local bodies to enhance resource efficiency.

- Integrate health-sector climate resilience with WaSH planning to ensure uninterrupted essential services during climate events.
- Increase budgetary allocations and policy support for mitigation and resilience to complement adaptation measures and meet service level goals.

Policies and Programmes with WaSH infrastructure Resilience Focus

Maharashtra's State Climate Change Action Plan and Disaster Management Plan 2023 acknowledge the vulnerability of water, sanitation, and hygiene (WaSH) infrastructure to climate-related impacts, including floods, droughts, sea-level rise, and landslides. Both plans emphasise enhancing physical resilience through climate-informed design, improved drainage, flood mitigation, ecosystem restoration (e.g., mangroves, wetlands, Miyawaki forests), and decentralised community management. Structural measures include embankments, retention basins, check dams, watershed recharge, and infrastructure retrofitting. Non-structural strategies involve hazard zoning, early warning systems, GIS risk mapping, and policy integration with resilient building codes. Innovative data-driven water management, utilising IoT and climate forecasting, supports proactive risk response, particularly in cities participating in the Maharashtra Resilient Cities Development Programme. The Smart Cities Mission promotes the integration of disaster resilience in urban projects. However, field studies in Vengurla, Ratnagiri, and Alibag reveal that much existing and planned WaSH infrastructure lacks disaster and climate-proofing considerations.

Key Challenges:

- Existing water and sanitation infrastructure often lacks climate resilience and disaster risk integration.
- New infrastructure plans do not consider climate and disaster risk assessments.
- Coordination across multiple governance levels and sectors can be complex, hindering effective implementation.
- Vulnerability remains high in flood-prone, drought-affected, coastal, and hilly areas due to inadequate protective measures.
- Limited role of ULBs in disaster risk and climate planning.

Key Recommendations:

- Integrate climate-resilient design and planning into all water and sanitation infrastructure projects.
- Incorporate flood forecasting, early warning systems, and retention basins to manage overflow safely.
- Design stormwater infrastructure to accommodate future climate variability.

- Strengthen enforcement of land-use and building codes based on hazard and vulnerability assessments.
- Ensure effective coordination among the Gujarat State Disaster Management Authority, ULBs, and relevant departments.
- Develop and embed climate-resilient design standards into engineering manuals.
- Provide targeted training to ULBs on assessing Detailed Project Reports (DPRs) using climate-resilient standards.
- Explicitly integrate climate projections and risk assessments into future WaSH infrastructure planning.
- Conduct comprehensive climate and disaster risk assessments of existing WaSH infrastructure.
- Prioritise the upgrade and retrofitting of vulnerable infrastructure to withstand climate extremes.
- Institutionalise the use of advanced data-driven tools (e.g., IoT sensors, GIS mapping) for proactive risk monitoring and adaptive water system management.

Coastal Areas Policies

Despite the vulnerability of Maharashtra’s coastal regions to climate change impacts—such as sea-level rise, saltwater intrusion, cyclones, and flooding—there is no dedicated national mission under the National Action Plan on Climate Change (NAPCC) focused on coastal adaptation. Institutions such as the National Centre for Sustainable Coastal Management (NCSCM) and frameworks like the Integrated Coastal Zone Management Plan (ICZMP) have enhanced hazard mapping and coastal planning; however, coordination and enforcement remain fragmented. In Maharashtra, the State Adaptation Action Plan (MSAAPC) acknowledges coastal vulnerabilities and promotes climate-resilient water and sanitation systems, groundwater protection, and integrated water resource management. Town-level efforts, such as those by the Vengurla Municipal Council, demonstrate localised best practices—including mangrove protection, solid waste management, and traditional rainwater harvesting (Bandharas)—to mitigate saltwater intrusion and enhance resilience.

Key Challenges:

- **Lack of Dedicated Coastal Climate Mission:** No specific national mission addresses the comprehensive adaptation needs of coastal areas.
- **Saltwater Intrusion and Groundwater Degradation:** Sea-level rise and over-extraction have reduced freshwater access in many coastal zones.
- **Weak Integration and Enforcement:** Coastal climate and disaster plans exist, but their implementation and inter-departmental coordination remain limited.

- **Inadequate Infrastructure Resilience:** Many water and sanitation systems are not designed to withstand extreme weather or saline intrusion.
- **Low Adoption of Alternative Water Technologies:** Limited uptake of desalination, rainwater harvesting, and wastewater reuse, especially in smaller coastal towns.

Recommendations:

- **Establish a National Mission for Coastal Climate Adaptation and Resilience** that specifically addresses water, sanitation, and ecosystem resilience in vulnerable coastal zones.
- **Strengthen Enforcement of Coastal Zone Regulations** and ensure integration of CRZ and climate adaptation plans into town-level planning.
- **Expand Saltwater Intrusion Mitigation Measures** through wider implementation of Bandharas, groundwater recharge, and regulation of coastal groundwater extraction.
- **Promote Ecosystem-Based Adaptation**, including mangrove restoration, and wetland protection to act as natural buffers.
- **Scale Up Alternative Water Solutions**, such as rainwater harvesting and wastewater recycling, in coastal towns.
- **Enhance Local Institutional Capacity**, especially of Urban Local Bodies (ULBs), through training, funding access, and decentralised climate planning mandates.
- **Foster Cross-Agency Coordination**, including between the Maharashtra Maritime Board, local governments, and the Coastal Zone Management Authority, to streamline coastal infrastructure resilience projects.
- **Replicate Local Best Practices**, like those seen in Vengurla, across other coastal towns through knowledge sharing and financial incentives.

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Annexure - I: Climate Change-Urban Water and Sanitation Policies and Programmes in Maharashtra

SI. No.	Policy /Programme Name	Type of Policy Measures	Organisation	Measures	Implications for Adaptation and Mitigation
State Climate Change					
1	Maharashtra State Adaptation Action Plan on Climate Change - 2014	Prescriptive and directive	Department of environment and Climate change, Government of Maharashtra	<ul style="list-style-type: none"> • Primary concern – water scarcity and security • Adaptation forward measures <ul style="list-style-type: none"> ○ Water use efficiency in all sectors ○ Recycling and reuse of treated wastewater ○ Rainwater harvesting ○ Groundwater regulation ○ Reduction in NRW 	<p>All the suggested measures, if applied, lead to reduced GHG emissions.</p> <p>Linkages between suggested measures and GHG emission reduction:</p> <p>Less reliance on fresh water – reduced burden on water supply system – reduced need for water supply abstraction and transportation – reduced energy consumption – reduced operational GHG emissions</p>
2	State CC cell	Administrative, institutional mechanism	Department of environment and Climate change, Government of Maharashtra	<ul style="list-style-type: none"> • Dedicated state-level cell with a budget on climate change 	
3	State Action Plan for climate change and human health, Maharashtra-2022	Prescriptive and directive	National Programme on Climate Change & Human Health, Ministry of Health and Family Welfare, Government of India	<ul style="list-style-type: none"> • Primary concern – resilience of the health sector and people • Energy and water-efficient health care facilities (HCF) • Water conservation in HCF • Rainwater harvesting 	All the suggested measures, if applied, lead to reduced GHG emissions.
Water and Sanitation					
4	Maharashtra State Water Policy-2019	Prescriptive	Water Resources Department, Government of Maharashtra	<ul style="list-style-type: none"> • Primary concern – water scarcity and security, linking it directly with Climate change • To ensure clean water and sanitation • Adaptation forward measures <ul style="list-style-type: none"> ○ Water use efficiency in all sectors 	All the suggested measures, if applied, lead to reduced GHG emissions.

SI. No.	Policy /Programme Name	Type of Policy Measures	Organisation	Measures	Implications for Adaptation and Mitigation
5	Integrated State Water Plan for West Flowing River Basin in Maharashtra - Volume I	Prescriptive and directive	Konkan development corporation, Water Resources department, Government of Maharashtra	<ul style="list-style-type: none"> ○ Recycling and reuse of treated wastewater ○ Rainwater harvesting ○ Groundwater regulation ○ Water footprint and audit analysis at the utility level <ul style="list-style-type: none"> ● Primary Concern – to maintain E-flows and regulate pollution ● Adaptation forward with mitigation elements <ul style="list-style-type: none"> ○ Efficient water use in all water resource development infrastructures ○ Recycling and reuse of treated wastewater ○ Proper septic tank ○ Decentralised and non-network systems ○ Solar power grids for supply 	<p>All the suggested measures, if applied, lead to reduced GHG emissions.</p> <p>Linkages between suggested measures and GHG emission reduction:</p> <ul style="list-style-type: none"> - Proper septic tanks – better treatment process – reduced GHG emissions - Efficient water use – reduced freshwater demand/extraction – reduced energy consumption – reduced operational GHG emissions - Decentralised and non-network systems – shorter network – reduced energy consumption – reduced operational GHG emissions - Solar power grids for supply – reduced reliance on coal-based energy – reduced GHG emissions
6	Maharashtra Water Resources Regulatory Authority Act (MWRA) – 2005	Administrative, institutional mechanism	MWRA, Government of Maharashtra	<ul style="list-style-type: none"> - Adaptation forward as the primary concern is water security (No mention of adaptation or Mitigation) - Establish MWRA ● To promote efficient use of water and minimise the wastage of water, and fix reasonable use criteria for each category 	<p>Adaptation-Mitigation co-benefits</p>

SI. No.	Policy /Programme Name	Type of Policy Measures	Organisation	Measures	Implications for Adaptation and Mitigation
7	Guidelines for Septage Management in Maharashtra -2016	Directive	Urban Development Department, Government of Maharashtra	<p>The primary concern is water pollution and public health risks due to unsafe sanitation practices. Both Mitigation, adaptation and ecological linkages</p> <ul style="list-style-type: none"> Suggest waste-to-energy solutions such as biogasification for GHG reduction 	Adaptation-Mitigation co-benefits
8	Maharashtra Suvarna Jayanti Nagarotthan Maha Abhiyan (MSJNMA) and Vasishpurna Scheme	Economic (state funds to ULBs)	Government of Maharashtra	<p>Adaptation forward as infrastructure and services provision in WaSH is a necessary step for building a resilient community against CC and is one of the most effective adaptive strategies.</p> <ul style="list-style-type: none"> Funds for extending and establishing water and sanitation infrastructure in cities 	Adaptation-Mitigation co-benefits
9	Maharashtra Groundwater (Development and Management) Act- 2009	Institutional mechanism, Regulatory (through registration)	MWRRA, Government of Maharashtra	<p>No mention of adaptation and mitigation words, but it focuses on adaptation as the key to addressing water scarcity and security.</p> <ul style="list-style-type: none"> Establishes the State Groundwater Authority and District Level Authorities Instructions to establish the Watershed Water Resources Committee measures for the protection and preservation of the water quality of the drinking water source Registration of all the owners of wells and drilling agencies Prohibition of drilling of deep wells Levy of user charges on groundwater users 	Adaptation-Mitigation co-benefits

SI. No.	Policy /Programme Name	Type of Policy Measures	Organisation	Measures	Implications for Adaptation and Mitigation
10	State and central pollution control board standards	Regulatory	Maharashtra Pollution Control Board and the Central Pollution Control Board, Government of India	<ul style="list-style-type: none"> - issue guidelines for rainwater harvesting to recharge groundwater • groundwater pollution abatement measures <p>The primary concern is water pollution. Both Mitigation, Adaptation and ecological linkages</p>	<p>Proper wastewater treatment up to the standards</p> <ul style="list-style-type: none"> - reduced pollution and GHG emissions - improved water quality – increased availability of clean water (adaptation)
Energy Sector					
11	Maharashtra Electricity Duty Act- 2016	Regulatory	Law and Judiciary Department, Government of Maharashtra	<p>No mention of adaptation and mitigation words, but indirectly mitigation forward</p> <ul style="list-style-type: none"> - Improve a definition of “Renewable Energy Sources” by including energy from urban or Municipal Solid Waste processing units - Electricity duty shall not be levied on the consumption charges or energy consumed by sewerage systems 	<p>Waste processing units can offset their carbon emissions by producing energy.</p>
National					
Urban Water and Sanitation					
12	SBM-Urban and AMRUT	Economic (grants to states and ULBs)	Ministry of Housing and Urban Affairs (MoHUA), Government of India	<p>Adaptation forward as infrastructure and services provision in WaSH is a necessary step for building a resilient community against CC</p> <ul style="list-style-type: none"> - Funds for extending and establishing water and sanitation (including septage and faecal) infrastructure in urban areas 	<p>Mitigation co-benefits</p>
Energy Sector					

SI. No.	Policy /Programme Name	Type of Policy Measures	Organisation	Measures	Implications for Adaptation and Mitigation
13	Bureau of Indian Standards on design, construction, and installation of septic tanks (IS 2470 (Part 1): 1985) and CPHEEO guidelines	Regulatory	Ministry of Consumer Affairs, Food and Public Distribution, Government of India	The primary concern is water pollution. Both Mitigation, Adaptation and ecological linkages	Proper wastewater treatment up to the standards - reduced pollution and GHG emissions - improved groundwater quality – increased availability of clean water (adaptation)
14	Municipal Energy Efficiency Programme (MEEP)	institutional and economic measures	Energy Efficiency Services Limited (public sector entity under the Ministry of Power, Government of India	Mitigation forward, as it promotes the adoption of energy-efficient pumps in the WaSH infrastructure	

Source: IIT-Bombay

Endnotes

ⁱ Global Climate Risk Index 2021. Who suffers Most from Extreme Weather Events? Weather-related Loss Events in 2019 and 2000 to 2019 <https://www.germanwatch.org/en/19777>

ⁱⁱ The coastline length of Gujarat referenced in this report is based on sources reviewed and compiled by Ashank Desai Centre for Policy Studies, IIT-Bombay. During report finalization, the official coastline length of Gujarat was revised to 2340.62 km as per the Press Information Bureau (PIB), Government of India, Delhi vide press release dated 04 December 2025, (Release ID: 2198800). <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=2198800®=3&lang=1>

ⁱⁱⁱ The coastline length of Maharashtra referenced in this report is based on sources reviewed and compiled by Ashank Desai Centre for Policy Studies, IIT-Bombay. During report finalization, the official coastline length of Maharashtra was revised to 877.97 km as per the Press Information Bureau (PIB), Government of India, Delhi vide press release dated 04 December 2025, (Release ID: 2198800). <https://www.pib.gov.in/PressReleaseDetailm.aspx?PRID=2198800®=3&lang=1>

^{iv} As per IPCC, Adaptation is understood as adjustments in human systems in response to actual or expected climate impacts, aimed at moderating harm or capitalizing on beneficial opportunities. Adaptive capacity refers to the ability of systems, institutions, and individuals to adjust to potential damage, seize opportunities, or respond effectively to consequences.

^v CDRI. <https://lexicon.cdri.world/topic/240> Retrieved on 23 July 2025.

^{vi} Palghar District Website. Home: About District. <https://palghar.gov.in/en/about-district/> Retrieved on September 2025

^{vii} Indian Council of Agricultural Research. <https://ataripune.icar.gov.in/Images/latest/agroclimaticzone.pdf>. Retrieved on September 2024.

^{viii} Government of Maharashtra. https://www.maharashtra.gov.in/Site/Upload/Images/Maharashtra_Divisions_Eng.jpg Retrieved on September 2024.

^{ix} Maharashtra Water Resources Regulatory Authority. <https://mwrra.maharashtra.gov.in/wp-content/uploads/2022/08/1-River-Basins-of-Maharashtra-Source-MWRRRA.pdf> Retrieved on September 2024.

^x Urban population figure for Palghar district was derived. As per Palghar original district, urban population = 13,52,283 and total population = 29,95,428 in the year 2011. Palghar District Website. Home: About District: Geographical Information. <https://palghar.gov.in/en/geographical-information-2/> Retrieved on September 2025

^{xi} The 2030s projection corresponds to the mean of forecasts for period from 2021 to 2040.

^{xii} Based on global mean sea level rise which is projected to rise by 0.3m to 0.55m by the end of the 21st century for a medium range climate change scenario (RCP 4.5). Global Mean Sea level will rise between 0.43 m (0.29–0.59 m, *likely* range; RCP2.6) and 0.84 m (0.61–1.10 m, *likely* range; RCP8.5) by 2100 (*medium confidence*) relative to 1986–2005

^{xiii} Municipal corporation >3,00,000 population; Class A: 1,00,001 - 3,00,000; Class B: 40,001 - 1,00,000; Class C: < 40,000; Class NP: As Notified.

^{xiv} Performance Assessment System.

https://www.pas.org.in/web/ceptpas/stateprofile?p_p_id=StateProfile_WAR_Portal&p_p_lifecycle=1&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&actionVal=Retrieve&SkipAccessChecking=false. Retrieved on February 2024.

^{xv} Frost and Sullivan. (2020, May 25). *World Water Day: India Tackling Water Utility Issues with Smart Water Meters*. <https://www.frost.com/growth-opportunity-news/world-water-day-india-tackling-water-utility-issues-with-smart-water-meters/>. Retrieved on September 2025

^{xvi} Performance Assessment System.

https://www.pas.org.in/web/ceptpas/stateprofile?p_p_id=StateProfile_WAR_Portal&p_p_lifecycle=1&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&actionVal=Retrieve&SkipAccessChecking=false. Retrieved on February 2024.

^{xvii} Performance Assessment System.

https://www.pas.org.in/web/ceptpas/stateprofile?p_p_id=StateProfile_WAR_Portal&p_p_lifecycle=1&p_p_state=normal&p_p_mode=view&p_p_col_id=column-1&p_p_col_count=1&actionVal=Retrieve&SkipAccessChecking=false. Retrieved on February 2024.

^{xviii} Performance Assessment System.

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^{xix} As per another estimates by Maharashtra state pollution control board, the total sewage generated in urban local bodies during 2021-2022 was 5,464.59 MLD, with installed treatment capacity of 7,367.8 MLD (Maharashtra Pollution Control Board, 2022).

^{xx} As per another estimates by Maharashtra state pollution control board, the total sewage generated in urban local bodies during 2021-2022 was 5,464.59 MLD, with installed treatment capacity of 7,367.8 MLD (Maharashtra Pollution Control Board, 2022).

^{xxi} Performance Assessment System.

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^{xxii} Performance Assessment System.

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^{xxiii} Mangrove restoration efforts, as well as proactive solid waste management, are also emerging in Malvan and Guhagar, as noted by CDD India.

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