

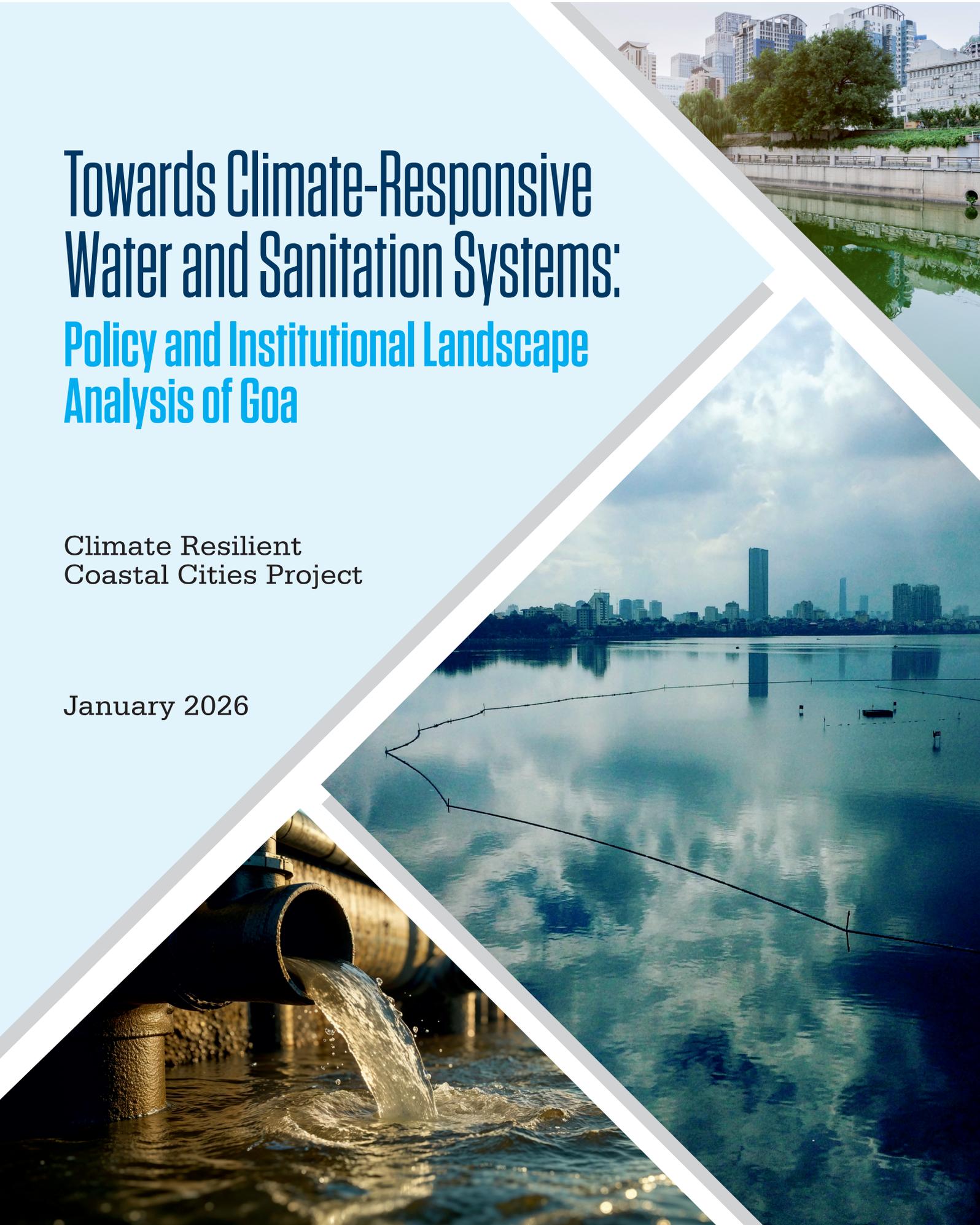
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Towards Climate-Responsive Water and Sanitation Systems: Policy and Institutional Landscape Analysis of Goa

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

Despite Goa's strong fiscal capacity and high Human Development Index, the state remains highly vulnerable to climate risks such as sea-level rise, saltwater intrusion, and seasonal water shortages. A detailed assessment of Goa's institutional, policy, and financial landscape—grounded in fieldwork from Canacona, Mapusa, and Mormugao—reveals critical gaps in the integration of water, sanitation, and climate change agendas. While climate risks are intensifying, particularly in coastal regions, the water and sanitation (WaSH) sectors continue to receive limited policy and financial attention. Fragmented governance, weak institutional coordination, and inadequate investment persist as key barriers, undermining efforts to build climate-resilient infrastructure and adaptive urban systems.

Financial Landscape

Under the State Climate Change Action Plan (SCCAP), Goa has allocated INR 2,341 crore over a ten-year period (2023–2033). However, only 4% of this is directed towards water and sanitation, indicating a significant gap between policy priorities and climate vulnerabilities in the sector. While Urban Local Bodies (ULBs) generate a substantial portion of their revenues (56.14%) from own sources, a large proportion – approximately 77% – of their expenditure goes toward establishment costs such as salaries and contingencies. This leaves little room for capital investments, operations and maintenance, or service improvements. Smaller municipalities remain fiscally constrained and largely dependent on state and central grants, with limited financial autonomy.

The key challenges in this domain include minimal investment in climate-resilient WaSH infrastructure, inconsistent budgetary allocations for the sector, limited fiscal devolution to ULBs, weak cost recovery through user charges and property taxes, and the absence of dedicated climate-linked financing mechanisms for WaSH services. To address these issues, it is recommended that the state increase and stabilize allocations for WaSH under the SCCAP, empower ULBs with greater financial and functional autonomy, create ring-fenced budgets for climate-resilient services, and strengthen ULB capacities in financial planning and cost recovery. Aligning local development plans with SCCAP goals and promoting access to climate and infrastructure finance instruments will be crucial.

Institutional Landscape

Water and sanitation governance in Goa is characterized by institutional fragmentation and overlapping mandates. Key state-level departments such as the Public Works Department (PWD), Sewerage and Infrastructural Development Corporation of Goa Ltd. (SIDCGL), Water Resources Department (WRD), Department of Drinking Water (DDW), and the Town and Country Planning Department (TCPD) share responsibilities without clear functional boundaries. Although ULBs are constitutionally mandated to manage sanitation services, they are largely excluded from infrastructure planning, financing, and operations—further weakening their decision making powers and revenue base. This centralized approach disrupts the flow of critical information and finances, limiting ULBs' ability to make informed decisions, exercise ownership, and effectively manage sanitation infrastructure.

Regulatory oversight of on-site sanitation systems remains weak, and climate and disaster-related planning is mostly top-down, with minimal involvement of municipal institutions.

The challenges here include conflicting departmental roles, inadequate operation and maintenance (O&M) protocols, marginalization of ULBs in project lifecycle management, poor regulation of septic systems, and weak integration between infrastructure and land-use planning. To improve institutional effectiveness, mandates should be streamlined through formal interdepartmental coordination frameworks. ULBs should be empowered and supported to manage infrastructure and climate-resilient services. Regulatory frameworks for on-site systems must be strengthened, shared data platforms must be developed, and clearly defined grievance mechanisms and accountability structures should be established.

Policy Landscape – Adaptation and Mitigation

Goa's policy approach places greater emphasis on climate adaptation, particularly in water resource management, than on sanitation or climate mitigation in the urban water and sanitation sector (UWSS). While adaptation objectives focus on addressing water scarcity, improving access to basic services, and safeguarding environmental health, implementation has lagged. Wastewater infrastructure remains underdeveloped, and decentralized solutions such as rainwater harvesting (RWH) and property-level treatment systems are poorly adopted despite policy support. Enforcement of groundwater regulations and pollution control in tourism zones is weak.

On the mitigation front, the UWSS sector is largely absent from Goa's climate and energy policy agenda. Most efforts focus on transport, buildings, and solid waste, with little attention to energy use or greenhouse gas emissions from water and wastewater systems. Goa treats only 14% of its urban wastewater and lacks Faecal Sludge and Septage Treatment Plants (FSSTPs) or biogas recovery initiatives. Building codes mandating sanitation standards are not enforced effectively.

Key adaptation challenges include the overemphasis on water over wastewater, poor sanitation infrastructure in key towns, low adoption of decentralised systems, and weak policy enforcement. Mitigation challenges include the lack of sectoral integration in energy planning, no focus on biogas or energy recovery, and absence of real-time monitoring of emissions. Recommendations include aligning state water and climate policies to support infrastructure resilience, expanding STPs and decentralized systems, incentivizing energy recovery and efficient technologies, and mandating energy and water audits in all Detailed Project Reports (DPRs). Building technical capacity, linking financial incentives to resilience outcomes, and improving GHG tracking are also necessary.

Infrastructure Resilience

Although Goa's SAPCC (2023) and State Disaster Management Plan (SDMP) (2024) emphasize the need to climate-proof infrastructure, actual implementation remains inadequate. Towns like Mapusa and Mormugao have experienced infrastructure failures—such as monsoon flooding of newly constructed sewer systems—demonstrating a lack of integration of resilience planning into WaSH and urban infrastructure development. Moreover, Goa's cities are not part of the Smart Cities Mission, which limits access to national funding and technical assistance. The resilience challenges include a disconnect between policy vision and sectoral implementation, aging infrastructure vulnerable to extreme weather, fragmented planning across sectors, weak disaster risk reduction (DRR) integration, and inadequate urban sanitation strategies. Key recommendations include updating the Goa State Water Policy to include climate adaptation, conducting climate vulnerability assessments, retrofitting vulnerable infrastructure, and institutionalizing smart monitoring technologies. Early warning systems, nature-based solutions (e.g., mangrove restoration), and performance-linked funding for resilient public services should also be promoted.

Coastal Policies

Goa's coastal policy ecosystem includes several national and state-level frameworks such as the Integrated Coastal Zone Management Plan (ICZMP), the Coastal Zone Management Plan (CZMP 2021), the State Climate Action Plan, and the draft Goa State Biodiversity Strategy and Action Plan (GSBSAP 2025). These frameworks prioritize coastal protection, water efficiency, and ecological preservation. However, sanitation remains a weakly integrated component across these instruments. Untreated domestic wastewater continues to pollute rivers and coastal waters, and existing infrastructure is not adapted to climate impacts like sea-level rise and storm surges. Challenges include the absence of a dedicated national coastal climate mission, poor integration of sanitation in CZMPs, weak enforcement in tourism zones, and fragmented governance across water, climate, biodiversity, and sanitation departments. Recommendations include establishing a National Coastal Climate Resilience Mission, expanding and climate-proofing sanitation systems in coastal towns, enforcing effluent regulation in tourism hubs, mainstreaming nature-based solutions, and enhancing

community participation through local biodiversity committees. Overall, Goa requires stronger alignment of policies, clearer institutional responsibilities, enhanced municipal capacity, and sustainable financing mechanisms to build climate-resilient water and sanitation systems, particularly in its vulnerable coastal regions.

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, causing financial losses of more than 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 (ibid).

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 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 almost 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. The climate change induced water stress and insecurity can increase the incidences of waterborne infectious diseases, thereby, hindering or reversing advancements made in related Sustainable Development Goals (SDG) targets and amplifying inequalities (Braks & Husman, 2013). The IPPC 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). 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) recognizes 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). Further, a 2.5% decrease in growth rate is expected with one-degree Celsius temperature increase for India (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 water supply. This lasted for 8 hours since the town did not have 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, Ye, Shaw, Ullah, & Ali, 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 (CRoSAPs), 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 focussed on providing similar analysis and understanding at the state level (for each state) and national level.

Among the selected states, **Goa 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.** 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 such as sea-level rise, cyclones, storm surges, strong winds, heavy rainfall, and salinity ingress.

This report focuses on presenting the study findings for the state of Goa, one of India's smallest states, covering an area of 3,702 square kilometres and a coastline of approximately 105 kilometresⁱⁱⁱ. According to the 2011 Census, Goa has a population of 1.46 million, constituting around 0.12% of India's total population. **Goa exceeds the national average of 382 people per square kilometre,** with a population density of 394 people per square kilometre, (Government of Goa, 2023). **The state excels in comparison to other states across a range of human development indicators.** The state has about INR 54,000 Crore Gross State GDP - 0.34% of the National GDP. **For instance, Goa has consistently ranked among the top states in terms of Human Development Index (HDI), alongside Delhi and Kerala, maintaining a spot in the top three from 1990 to 2019** (Raj, Gupta, & Shrawan, 2023). Furthermore, **Goa ranks at the top of the Social Progress Index for key basic needs indicators including water and sanitation, and shelter** (PIB, 2022). **In terms of vulnerability, State Climate Change Action Plan (2023) has prioritized the Bardez, Mormugao, Tiswadi and Salcete talukas for**

adaptation efforts, as these regions host the majority of the state's population (80%) and economic activities, and are at higher risk due to climate change (Government of Goa, 2023, p. 147).

Further, the state is particularly vulnerable to sea level rise due to the impacts of climate change, and this phenomenon is already being observed. According to a United Nations Development Programme (UNDP) study cited in the Goa State Climate Action Plan, the state is at risk of losing a significant portion of its land, including many of its iconic beaches and vital tourist infrastructure. **A 1-meter rise in sea level could affect 7% of Goa's population and result in damages estimated at INR 8,100 crore** (Government of Goa, 2023). Additionally, a recent study shows that **between 1990 and 2018, around 26.8 km of Goa's 139.64 km coastlineⁱⁱⁱ (approximately 19%) has been affected by river and coastal erosion** (National Centre for Coastal Research, 2022).

The state is also responsible for **5.40 Mt CO₂e net greenhouse gas (GHG) in 2018, contributing 0.18% to India's GHG emissions** (GHG Platform India, 2018). **The per capita emissions of Goa were higher than India's per capita emissions, across the reference years^{iv}.** The major GHG-emitting sectors in the state are transportation, agriculture, waste, construction, and mining. **Energy sector was the major contributor to Goa's economy-wide emissions, throughout the reference period** (GHG Platform India, 2018). **GHG emissions from the waste sector increased in absolute terms from 0.25 to 0.50 Mt CO₂e between 2005 and 2018.** However, in terms of percentage contribution to the state's total GHG emissions, it decreased from 9% to 5%. **In 2018, the domestic wastewater sector, which includes both rural and urban areas, accounted for 36% of total waste sector emissions (0.50 Mt CO₂e), amounting to 0.30 Mt CO₂e^v.** Emissions from domestic wastewater in both rural and urban areas grew at a **compound annual growth rate (CAGR) of 3.42%**, increasing from 0.07 Mt CO₂e in 2005 to 0.11 Mt CO₂e in 2018. Notably, approximately 65% of the domestic wastewater emissions in 2018 originated from the urban areas of Goa (GHG Platform India, 2018). **Energy consumption analysis of GHG emissions from the domestic wastewater sector, however, has not been included in this report, as it falls outside the scope of research.**

The state has a **Climate Change Action Plan (2023) in place** that aligns with the national climate action framework, supported by **complementary sectoral policies and plans such as a national plan on climate change and human health, groundwater regulations, and rainwater harvesting initiatives.** Given its dependence on tourism sector, Goa also has a **tourism policy (2020) that indirectly addresses environmental pollution, particularly the discharge of untreated domestic and industrial wastewater into beaches, creeks, and rivers.**

The findings provide insights on the policy and governance landscape in Goa 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*^{vi}. **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 (Canacona, Mormugao, Mapusa) that assess 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 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)^{vii}. **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 and services in Goa and vice-versa. Section 2 outlines the methodology adopted for data collection, followed by a brief profile of Goa 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 major 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 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 in section 7 by synthesizing key insights and offering reflections to guide future planning and policy integration.

2. METHODOLOGY

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 enabled the mapping of relevant stakeholders and their 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 carried out with key stakeholders and subject-matter experts to capture contextual insights on policy and institutional frameworks governing water and sanitation and climate change in the state. The study also draws on town-level assessments conducted in Canacona, Mormugao, Mapusa, which included field investigations and interviews with Urban Local Body (ULB) officials and district disaster management authorities. 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 reports).

Table 1: 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, Energy Department, Niti Ayog
		Stakeholder semi-structured Interviews	Canacona, Mormugao, Mapusa
2	To understand status of urban water and sanitation services in study area	Secondary Data through Literature Review, collection from ULBs	CPCB inventory report, State government reports, non-government sources (PAS website)
3	To understand linkages between climate change and urban water and sanitation policies	Secondary Data through Literature Review	Various sectoral reports- health, sanitation, water, climate change, energy, building buy laws, urban development
		Stakeholder semi-structured Interviews	Canacona, Mormugao, Mapusa towns
4	To map current institutional environment	Secondary Data through Literature Review	
		Stakeholder semi-structured Interviews	Canacona, Mormugao, Mapusa towns

5	To map current financial sources for climate change and water and sanitation	Secondary data through literature Review, collection from ULBs	SBM (urban), MoHUA website, State Urban Development Department,
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The current study focusses on the three Urban Local Bodies (ULBs) in Canacona, Mormugao, Mapusa (Table 2). The three towns were selected from a potential list after consultations with the State Mission Director of SBM-Urban, Goa. Selection criteria included climate change vulnerability, position of the town on the sanitation ladder, city size, and governance structure to ensure diverse policy evidence linking WaSH and climate change. All three towns rely primarily upon on-site sanitation systems (OSS) and have no centralised sewerage network, which has implications for both climate change adaptation and mitigations.

Table 2: List of Towns Selected in Goa

State	Town	Population (2011)	Class
Goa	Canacona	12,434	Class-IV
	Mormugao	94,393	Class-II
	Mapusa	39,989	Class-III

Study Limitations

The findings presented in this report should be viewed in consideration of a few study limitations: **Representation of Urban Areas** – Three 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 unless specified otherwise. **Differences in Research Focus** – The *Climate Resilient Coastal Cities* initiative comprises a National Report, four State Reports, and fifteen Town Reports. This document represents one of the four state-level studies. This report primarily draws on research and analysis conducted by the Ashank Desai Centre for Policy Studies at IIT-Bombay. Variation in this report and other state reports (specifically, the Maharashtra State Report) is a reflection of differing research objectives of the two research and implementation partners under the initiative^{viii}. **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. **Data Availability** – The study relies primarily on secondary research, and the extent of analysis is therefore dependent on the quality and



availability of published data and literature. Wherever possible, secondary information has been supplemented with primary inputs.

3. STATE OVERVIEW

Goa is situated between latitudes 14° 53' 57" N and 15° 47' 59" N, and longitudes 73° 40' 54" E and 74° 53' 11" E. The state spans an area of 3,702 square kilometres, making up about 1% of India's total land area. About 34% of the State's area is covered by forests, out of which about 20%, and nearly 35% of the State's geographical area is under cultivation (Government of Goa, 2021). The state is bordered by Karnataka to the south and east, Maharashtra to the north, and the Arabian Sea to the west.

The state is geographically divided into three main regions: the Ghats, the Midland, and the coastal areas (Figure 1). This study specifically focuses on the coastal region. The coastline is characterized by numerous creeks and estuaries formed by rivers. Goa features a predominantly hilly terrain, particularly on its eastern side, where the southern end of the Sahyadri mountain ranges is located. Key rivers in the state include the Mandovi (known as Mhadeyi in many areas along its course), Zuari, Terekhol, Chapora, Sal, Betul, Talpona, Galjibag, Cumbarjua, Valvanti, Mapusa, Siquerim, Khandepar, and Kushavati. These rivers are navigable for a total length of 256 km (Government of Goa, 2023).

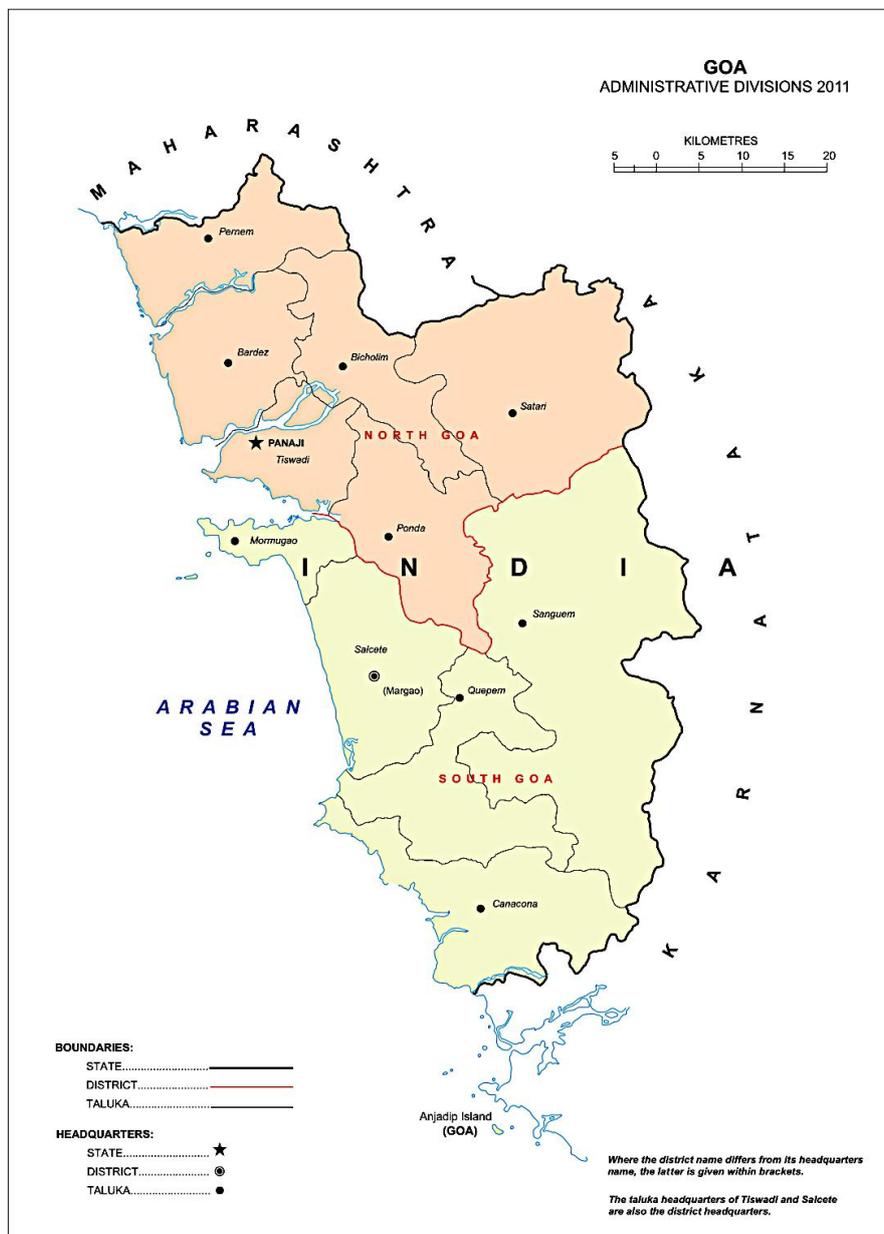
Figure 1: Geographical Zones in Goa



Source: (Government of Goa, 2023)

The state is divided into two administrative districts (Figure 2): North Goa and South Goa, which are further subdivided into 12 talukas: Pedne, Bardez, Bicholim, Sattari, Tiswadi, Ponda, Mormugao, Salcete, Sanguem, Dharbandora, Quepem, and Canacona. The state also includes 14 municipalities and 320 inhabited villages. **The towns selected for this study—Mormugao, Canacona, and Mapusa—are located in the Mormugao, Canacona, and Bardez talukas, respectively.**

Figure 2: Administrative Divisions of Goa



Source: (Census Digital Library, 2021)

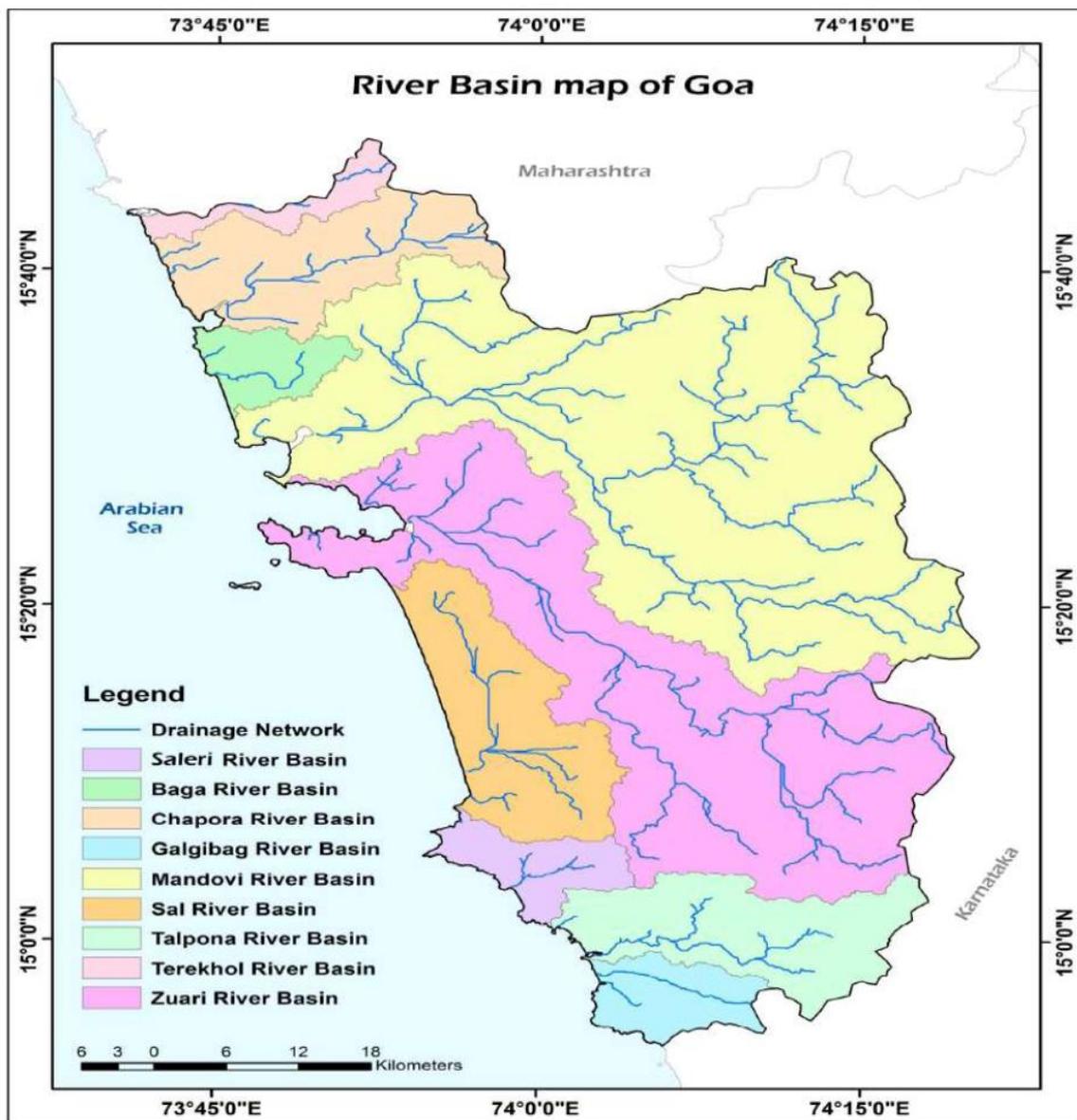
Demography: The state's population is 1.46 million (Census 2011), with an average population density of 394 people per square kilometre. The decennial population growth rate has dropped significantly, from 15.21% between 1991-2001 to 8.23% between 2001-2011. Approximately 62% of the population lives in urban areas, while around 38% reside in rural regions. The sex ratio is 973 females per 1,000 males, higher than the national average of 943. As per the 2011 Census, 1,165,487 individuals in the state are literate, representing 88.7% of the total population. The state's workforce comprises 577,548 individuals, which is 39.58% of the overall population (Government of Goa, 2023).

Climate profile: Goa receives an average annual rainfall of approximately 3,000 mm, which is nearly three times the national average. The rainy season lasts for four months, from June to September, with occasional thunderstorms occurring in May and October. The state has a warm and humid tropical climate, with summer temperatures ranging from 24°C to 36°C. In winter, temperatures typically range between 21°C and 30°C. However, due to the effects of global warming, these climatic patterns appear to be gradually changing (Government of Goa, 2023).

Economy: The Gross State Domestic Product (GSDP) of Goa at current prices for the year 2021-22 stands at INR 78,603.70 crore, an increase from INR 75,705.40 crore (provisional) in 2020-21, marking a growth of 9.11% for 2021-22. Per capita income has steadily risen from INR 454,172 in 2017-18 to INR 486,851 in 2020-21 (provisional), and INR 527,146 in 2021-22 (quick estimates) (Directorate of Planning, Statistics and Evaluation, 2023). Between 2017 and 2022, the secondary sectors dominated Goa's GSDP, contributing average 53%, while the tertiary sectors, including tourism, followed closely with average 39%. The primary sectors made up just 8% of the GSDP (Directorate of Planning, Statistics and Evaluation, 2023). Agriculture has gradually declined as a primary livelihood, from approximately 14% of the state population engaged in this sector in 1971 to just around 4% in 2011 (Government of Goa, 2021).

Water Resources: Goa is drained by nine rivers basins, four of which are inter-state rivers. From north to south, these rivers are: Terekhol, Chapora, Baga, Mandovi, Zuari, Sal, Saleri, Talpona, and Galgibag, as shown in Figure 3. Between the Terekhol and Chapora basins, there is a notable stretch of land that drains directly into the sea through two rivers, Harmal and Mandrem (Government of Goa, 2021).

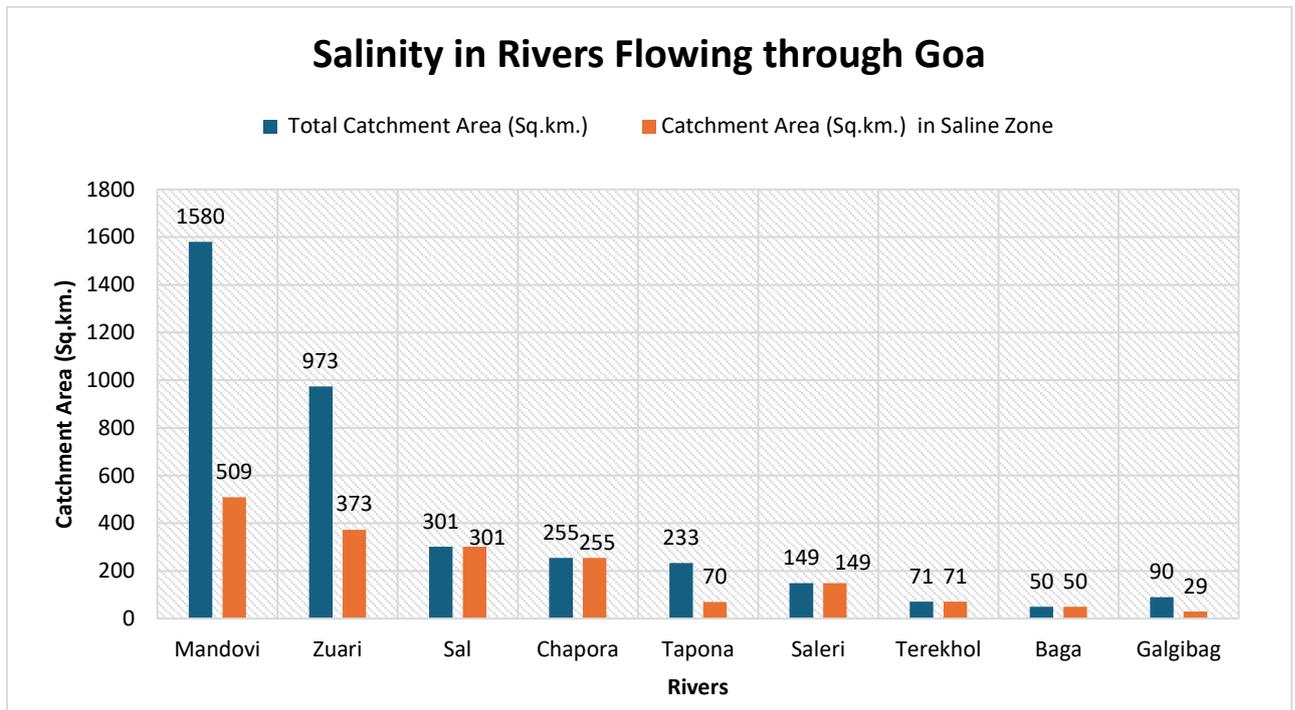
Figure 3: Basin Map of Goa



Source: (Government of Goa, 2021)

As shown in Figure 4, a significant portion of most rivers in Goa is affected by salinity, which reduces the overall surface water yield. The nine rivers have a combined catchment area of approximately 3,702 sq. km. in Goa, with around 49% of this area impacted by salinity. This results in a reduced surface water yield of 2,823 MCuM (Government of Goa, 2021). The river basins most affected by salinity are those of Sal, Saleri, Terekhol, and Baga.

Figure 4: Catchment area (sq.km.) of Rivers in Goa affected by Salinity



Source: data from (Government of Goa, 2021)

As far as **ground water resources** are concerned, Goa's annual extractable groundwater resources are estimated at 160.33 MCuM, with 53.71 MCuM already being extracted for various uses as of March 2017. Of the remaining 106.62 MCuM, the net available groundwater for irrigation development is estimated to be 69.93 MCuM. The average stage of groundwater development is 30% in North Goa and 39% in South Goa, with an overall development stage of 34% for the entire state. **All talukas in Goa are classified as falling under the 'safe category'. The state also has high water table.** In May 2016, the depth of groundwater during the pre-monsoon period ranged from 1.7 meters below ground level (mbgl) to 18.84 mbgl. In the post-monsoon period of November 2016, the depth ranged from 0.61 mbgl to 14.49 mbgl (Government of Goa, 2021).

According to the State Water Policy (Government of Goa, 2021) and Niti Aayog (NITI Aayog , 2024), **Goa is well above the "water stress" threshold in terms of per capita annual water availability (1,807 cubic meters) (Government of Goa, 2021)^{ix}.** As evident Goa is located in a high precipitation zone, however, it has one of the lowest per capita freshwater availabilities (Government of Goa, 2023). The state water **policy notes that factors such as water pollution reduce the amount of water available for human consumption.**

The factors such as salinity in rivers, point pollution of ground water in industrial and coastal areas, and sea-level rise due to climate change contribute to seawater intrusion and increased salinity in groundwater, further reducing the amount of water available for human consumption (Government of Goa, 2023) ; (Government of Goa, 2021). **In summer of 2023, Goa “narrowly missed experiencing a water crisis after an absence of pre-monsoon showers”, followed by a delayed onset of the monsoon** (Malkarnekar, 2023). While groundwater recharge in Goa occurs rapidly during the monsoon season, the state's hydrogeological characteristics limit the retention capacity of percolated water. This limitation leads to water shortages during the non-monsoon months, particularly April and May. Additionally, mining activities have significantly impacted river systems, leading to increased siltation. This siltation reduces the water-holding capacity of rivers, causing overflow and hindering effective water drainage from agricultural fields, which exacerbates water scarcity issues.

4. CLIMATE CHANGE AND 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). This section highlights the status and projected exposure to climate change events, along with their potential impact on people with special focus on water and sanitation infrastructure services. The status of the water and sanitation services, at state and district level, as a function of resilience and adaptive capacity is also discussed. Since climate change exposure and vulnerability are not adequately addressed in the literature at the town level, this section focuses on the districts or taluk to which the selected towns belong to.

4.1 Vulnerability and Impact

This sub-section discusses the vulnerability and impact of disasters and climate-induced events—such as sea level rise, cyclones, floods, droughts, and heatwaves—in the context of Goa, focusing specifically on its talukas and selected towns, including Canacona, Mormugao, and Mapusa. The three towns, selected in consultation with the State Swachh Bharat Mission Director, are located in the Mormugao, Bardez, and Canacona talukas. The State climate change action plan has prioritized the taluks of Bardez, Mormugao, Tiswadi and Salcete for adaptation efforts, as these regions host the majority of the state's population and economic activities, and are at higher risk due to climate change (Government of Goa, 2023, p. 147). The plan specifically talks about the “development of a plan for the resilience of vulnerable structures associated with critical services” and sets a target for the same for above talukas (ibid).

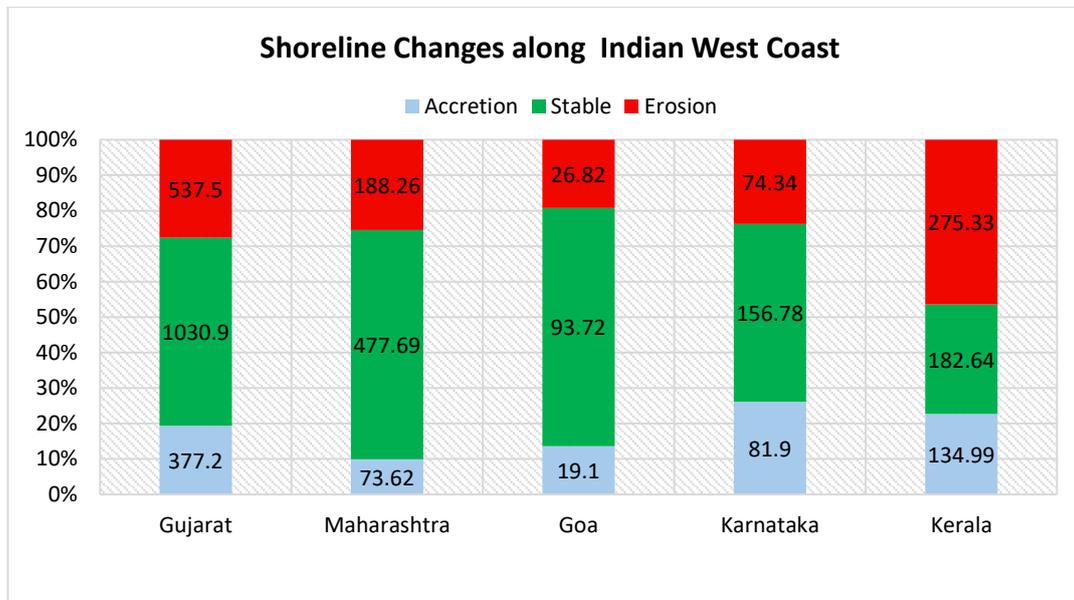
Sea level Rise

Goa is currently experiencing a rise in sea levels. Long-term data from the Mormugao station indicates that the sea level in this area has been rising at a rate of 1.45 mm per year, with 95% confidence, from 1969 to 2013 (Government of Goa, 2023). This translates to an increase of approximately 0.48 feet (about half a foot) over the past 100 years (ibid). According to a UNDP study, a 1-meter rise in sea level could affect 7% of Goa's population and result in damages estimated at INR 8,100 crore (Government of Goa, 2023). **The talukas of Salcete, Bardez (which includes the selected town of Mapusa), and Tiswadi, with a coastal elevation of less than 35 meters and spanning 30 km of coastline, are particularly susceptible to sea-level rise and flooding. The problem of saltwater intrusion will be exacerbated by sea-level rise due to climate change and the indiscriminate use of groundwater (ibid).**

Coastal Erosion

Among the west coastal states, Goa's shoreline is one of the most stable (National Centre for Coastal Research, 2022) – as shown in Figure 5. Figure 6 shows that **approximately 26.8 km of Goa's 139.64 km coastlineⁱⁱⁱ (about 19%) has experienced river and coastal erosion between 1990 and 2018** (National Centre for Coastal Research, 2022). **Coastal belt near Mormugao (one of the selected towns) shows low rate of erosion** (National Centre for Coastal Research, 2022). **Bardez and Salcete Talukas have experienced erosion rates exceeding 0.6 meters per year, while Tiswadi has seen an erosion rate of over 0.3 meters per year** (Government of Goa, 2023).

Figure 5: Shoreline Changes (km) along Indian West Coast



Source: (National Centre for Coastal Research, 2022)

Figure 6: Shoreline Erosion (1990-2018) for Goa



Source: (National Centre for Coastal Research, 2022)

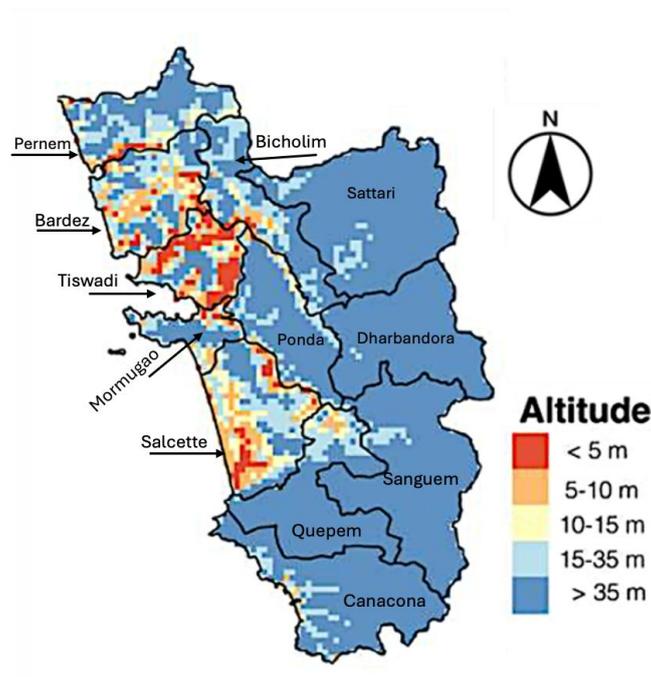
Cyclones

According to NITI Aayog's Climate and Energy Dashboard, both North and South Goa fall within a **moderate damage risk zone for wind hazards** (with wind speeds reaching up to 39 m/s) and **moderate cyclonic activity** (featuring maximum sustained wind speeds ranging from 48 to 63 knots) (Niti Aayog, 2025). The coastal belt of Goa is the only area vulnerable to cyclones. **According to the State Disaster Management Plan 2024, six out of the 12 talukas in the state, including Bardez, Mormugao, and Canacona (which are the selected towns), are highly vulnerable to cyclones, based on the level of severity** (Table 3) (Goa State Disaster Management Authority, 2024). When cyclones and subsequent heavy floods occur, they cause significant damage to infrastructure, livestock, fodder crops, and irrigation systems due to severe flooding and cyclonic impact (Goa State Disaster Management Authority, 2024).

Floods

As shown in Figure 7, the 0-5 meter elevation zone is considered the most vulnerable to flooding in Goa (Government of Goa, 2023). Consequently, the talukas of Salcete, Tiswadi, and Bardez are particularly susceptible to flood-related hazards. In terms of flood severity, Bardez, Pernem, Bicholim, and Canacona talukas are the most vulnerable (refer Table 3).

Figure 7: Flood Vulnerability of Goa



Source: (Government of Goa, 2023)

Table 3: Taluka Wise Multi-hazard Vulnerability (Level of Severity) in Goa

Sl. No.	Taluk	Cyclone	Floods	Drought	Landslides	Soil Erosion
1	Canacona	High	High	Low	Medium	Low
2	Mormugao	High	Low	Low	Low	Low
3	Bardez	High	High	Low	Medium	Low
4	Pernem	High	High	Low	Low	Low
5	Tiswadi	High	Low	Low	Low	Low
6	Bicholim	Low	High	Low	High	Low
7	Sattari	Low	Low	Low	High	Low
8	Ponda	Low	Low	Low	Low	Low
9	Dharbandora	Low	Low	Low	Low	Low
10	Salcete	High	Low	Low	Medium	Low
11	Quepem	Low	Low	Low	High	Low

12	Sanguem	Low	Low	Low	High	Low
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Source: (Goa State Disaster Management Authority, 2024)

Typically, flooding in Goa was primarily confined to the overflow of smaller rivers and the inundation of marginal areas in regions like Pernem, Bicholim, Sattari, Bardez, Canacona, Quepem, and Sanguem. However, as outlined in the State Disaster Management Plan, flooding in Goa is not solely caused by intense rainfall events. It is further exacerbated by unregulated urban expansion, insufficient maintenance of natural water storage systems (such as tanks), and poor management of drainage infrastructure, particularly within municipal areas. These factors collectively amplify the destructive potential of increasing flood hazards (Goa State Disaster Management Authority, 2024, pp. 71-72).

For example, **the flash floods in Canacona** on October 2nd, 2009, were directly attributed by the state disaster plan to heavy rainfall (approximately 271 mm over a brief period of 7 hours). The report notes, "**There are no records to suggest that such a rainfall scenario has occurred in the past**" (Goa State Disaster Management Authority, 2024, p. 72). The incident led to the flooding of the Talpona and Galgibag rivers. Soil saturation triggered mudslides at higher altitudes (around 300m), submerging agricultural and horticultural areas, while livestock were swept away. At lower altitudes (50m or less), the accumulation of water caused widespread flooding, submerging buildings and leading to the destruction of houses, commercial establishments, and especially mud houses(ibid).

Bardez taluka is highly vulnerable to floods, particularly in terms of severity. However, within the taluka, the **Mapusa Municipal Council (MMC) appears to be less directly impacted by cyclones, according to interviews with ULB officials. That said, Cyclone Tauktae in 2021 brought strong winds that uprooted trees, damaging houses in Mapusa and causing debris accumulation in certain areas. Similarly, Cyclone Mora in 2017 triggered heavy rainfall, resulting in ankle-deep flooding in several low-lying areas around the town. This caused water to enter numerous properties within the MMC, with the situation exacerbated by a poorly maintained drainage system** (The Goan, 2017); (The Times of India, 2021); (Goa Times, 2021).

Droughts and Heatwaves

As far as **droughts** are concerned, the State receives an average annual rainfall of approximately 125 inches, which helps protect the region from the risk of drought in the near future (Goa State Disaster Management Authority, 2024). Regarding heatwave episodes, the highest temperature recorded in Goa during the summer is around 40 degrees Celsius. While

there have been no reported casualties due to heatwaves in the region to date, there has been a noticeable rise in average summer temperatures over the past decade (Goa State Disaster Management Authority, 2024). However, the state is witnessing higher levels of temperature increase compared to the national average (IMD, 2013), as the mean temperature in Goa has increased by about 1°C over the period 1901-2018, this will have consequential impacts on the water stress and water demand.

4.2 Climate Change Projections

Rising Temperatures

As per IMD (2013), cited in the State Climate Change Action Plan, highlights that Goa has witnessed a temperature rise greater than the national average. From 1901 to 2018, the mean temperature in Goa increased by about 1°C, with the majority of warming taking place after the 1970s (Government of Goa, 2023). The analysis provides projections for the mean temperature in Goa from 1901 to 2100 under two different scenarios, RCP4.5 and RCP8.5^x. Under the RCP8.5 scenario, temperatures are expected to increase by 4.5°C compared to the 1901-1950 baseline. In contrast, if GHG emissions are reduced as per the RCP4.5 scenario, Goa is projected to see a more moderate temperature rise of about 2.5°C relative to the 1901-1950 baseline (Government of Goa, 2023). Extreme temperatures in Goa are projected to rise significantly by 2040. Maximum temperatures of 40°C or higher are expected to become more frequent, while minimum temperatures are anticipated to increase by 3-7°C (Government of Goa, 2023).

Sea Level Rise

Goa is currently experiencing a rise in sea levels. Long-term data from the Mormugao station indicates that the sea level in this area has been rising at a rate of 1.45 mm per year, with 95% confidence, from 1969 to 2013 (Government of Goa, 2023). This translates to an increase of approximately 0.48 feet (about half a foot) over the past 100 years (Government of Goa, 2023). A study referenced in the State Climate Change Action Plan predicts that the steric sea level (driven by changes in ocean temperature and salinity) along the Indian coast will rise by approximately 20–30 cm by the end of the 21st century.

Increasing Frequency of Heavy Rainfall

The State Climate Change Action Plan identifies the increasing frequency of very heavy and exceptionally heavy rainfall events as a key impact of climate change in Goa (Government of Goa, 2023). **Over the past century, Goa's mean annual rainfall has risen by approximately**

68% (Government of Goa, 2023). While the frequency of light (2.5-7.5 mm daily) and moderate (7.6-35.5 mm daily) rainfall events has declined, **extreme rainfall events have become more frequent**. The number of rainy days with category 1 rainfall (2.5-64.4 mm daily) has decreased from 1901 to 2018, whereas the occurrence of **category 2 rainfall days (64.5-124.4 mm daily) has increased by about 60%**. **Additionally, the frequency of category 3 rainfall days (more than 124.5 mm daily), representing very heavy and exceptionally heavy rain, has surged by over 100%**, highlighting a concerning trend in the state's climate pattern. This heightened rainfall trend is making the state even more vulnerable to flooding and other related hazards (Government of Goa, 2023).

4.3 Socio-economic Vulnerability with Special Focus on Water and Sanitation

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) recognizes 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.

As highlighted in the previous section, Goa faces several climate change-related risks, including rising sea levels, increasing temperatures, more frequent and intense rainfall, higher average precipitation, flooding, and cyclones. These hazards intensify the challenges faced by communities—particularly in densely populated coastal areas—and disproportionately affect individuals whose livelihoods depend on fishing, tourism, or who live below the poverty line. Many of these vulnerable populations lack reliable access to essential services such as safe housing, clean drinking water, and adequate sanitation. Ensuring access to these basic services forms the first line of defence against climate impacts and is critical to enhancing the resilience and adaptive capacity of at-risk communities.

This sub-section discusses vulnerability of people with respect to basic services with 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.

Economic and Physical Vulnerability

The state excels in comparison to other states across a range of human development indicators. The state has about INR 54,000 Crore Gross State GDP - 0.34% of the National GDP. The state has consistently ranked among the top states in terms of Human Development Index (HDI), alongside Delhi and Kerala, maintaining a spot in the top three from 1990 to 2019 (Raj, Gupta, & Shrawan, 2023). Furthermore, Goa ranks at the top of the Social Progress Index for key basic needs indicators including water and sanitation, and shelter (PIB, 2022). The state performed better on social indicators viz. literacy rate, population below poverty line and infant mortality rate (except life expectancy) than the all-India average (Government of Goa, 2023). However, certain areas with high population density, significant slum populations, and a heavy reliance on the fisheries and tourism sectors are particularly vulnerable to the climate change impacts discussed in the previous section. For example, approximately 4% of the state's population lives below the poverty line - although relatively low figure compared to many other states in India (Government of Goa, 2023) - is under risk. Areas such as Mormugao experience a high concentration of slum populations. While **Goa has one of the lowest slum populations in the country (around 2%), around 90% of this population resides in Mormugao. Slum populations typically have lower coping capacities, which makes them more vulnerable to the effects of climate change** (Government of Goa, 2023).

In the event of sea-level rise, densely populated areas are likely to face significant challenges, especially in coastal talukas like Salcete, Bardez, Tiswadi, and Mormugao. Notably, 10% of Goa's population lives in Mormugao taluka, which also has the highest population density in the state. Salcete, Bardez, and Tiswadi together have 30 km of coastline with elevations below 35 meters, making them especially vulnerable to sea-level rise and flooding. Bardez and Salcete have experienced erosion rates of more than 0.6 meters per year, while Tiswadi has seen erosion rates exceeding 0.3 metres per year. **Salcete, Bardez, Tiswadi, and Mormugao talukas are not only densely populated but also major tourist destinations. The surge in tourism has significantly increased water demand in these areas, leading to greater groundwater exploitation** (Government of Goa, 2023, pp. 102-103). **These talukas have also seen coastal erosion, threatening local livelihoods, the tourism industry, and the region's overall resilience to climate change** (Government of Goa, 2023).

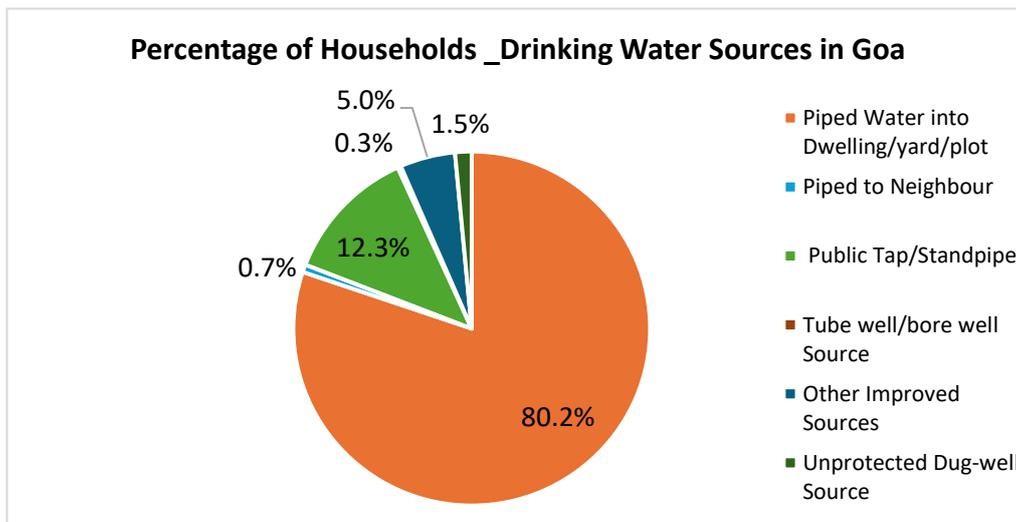
Access to Clean and Improved Drinking water and Sanitation Facilities

The main sources of drinking water supply are River Kalna, Assonora, Valvanti, Madei, Khandepar, Talpona and Salaulim reservoir (River Zuari) in North and South Goa districts.

The state performs well in terms of access to clean and improved drinking water and sanitation facilities, which is positive indicator of the population's adaptive capacity to cope

with climate change extreme weather events. According to National Family Health Survey (NFHS-5) for the 2019-20 period^{xi}. Approximately 90% of households in Goa reside in pucca houses, and all households have access to electricity. Additionally, 98% of households have basic drinking water services, with the same percentage using an improved source of drinking water (Figure 8). However, only 80.2% of households have water piped into their dwelling, yard, or plot. About 1.5% of the households depend upon the unprotected dug wells as a drinking water source (International Institute for Population Sciences and ICF, 2021). A significant 97% of households have access to toilet facilities, with urban areas having higher access (99%) compared to rural areas (94%). Access to sanitation is generally high, ranging from 93% for scheduled tribe households to 98% for households not classified as scheduled caste, scheduled tribe, or other backward classes. The households not having access to individual toilets might be depending upon on community facilities or open fields.

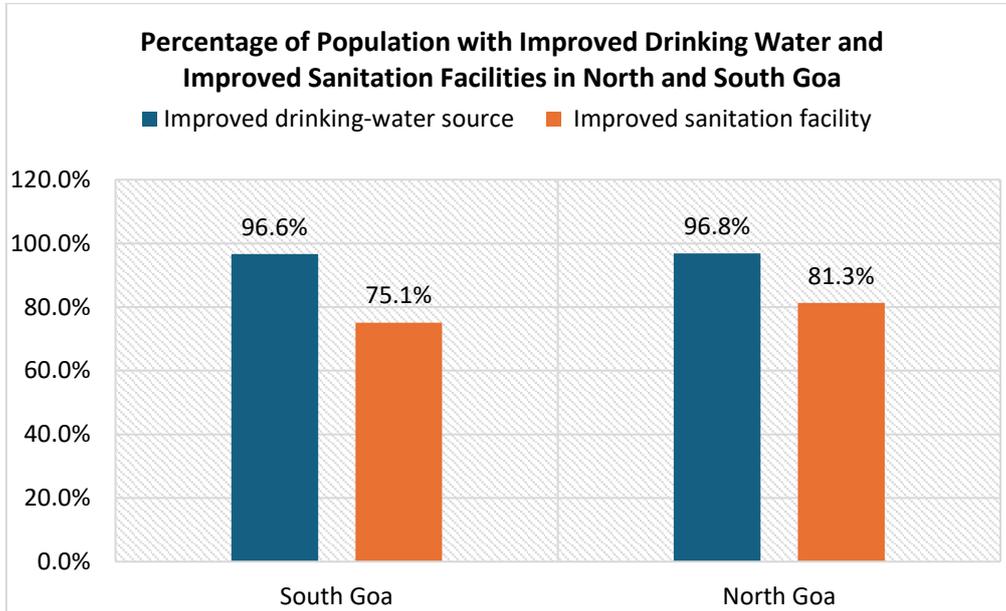
Figure 8: Percentage of Households with Different Source of Drinking Water



Source: (International Institute for Population Sciences and ICF, 2021)

District-level variations indicate that North Goa performs better than South Goa in terms of both improved drinking water and sanitation facilities (Figure 9).

Figure 9: Percentage of Population with Improved Drinking Water and Improved Sanitation Facilities in Districts of Goa

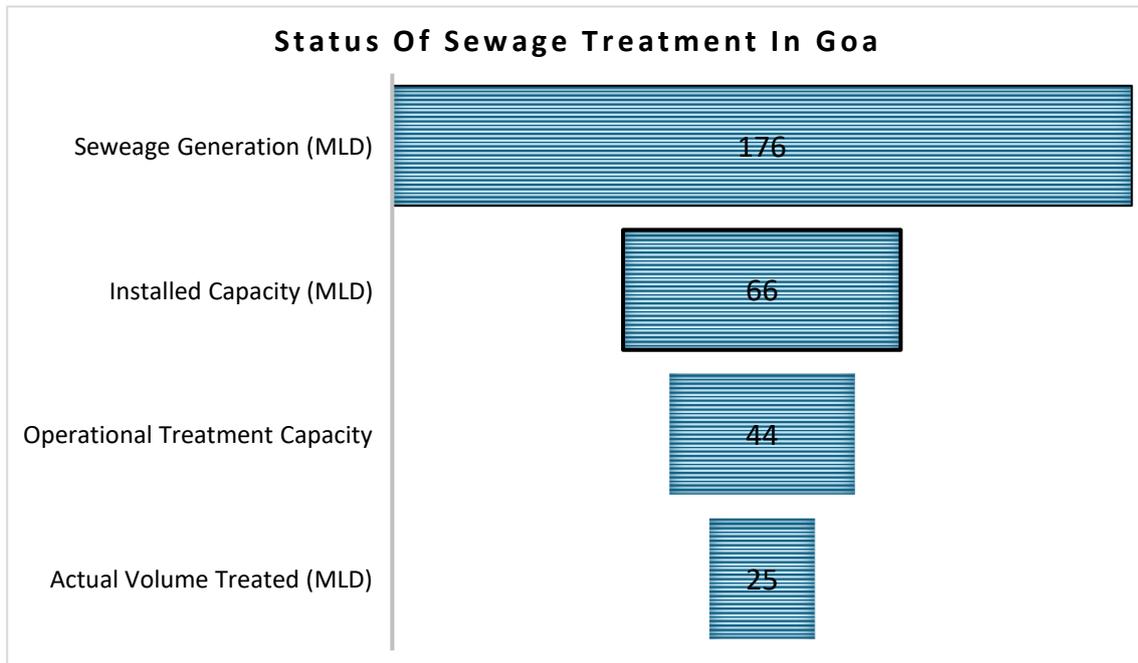


Source: (International Institute for Population Sciences and ICF, 2021)

Wastewater Management, Water Pollution and GHG Emissions

As discussed above majority of the population depends upon the on-site sanitation systems for wastewater management. The sewerage coverage is about 16% in state of Goa. Only three towns / cities have proper sewerage system in Goa i.e. Panaji, Margao (part) and Vasco (Sewerage and Infrastructural Development Corporation of Goa Limited, 2021). In our selected towns, Canacona and Mapusa are heavily reliant on OSS systems. Although a sewerage network has been recently developed in Mapusa, its use has been delayed due to technical issues causing it to overflow during floods. In Mormugao, there is approximately 80-85% sewerage coverage in the town. According to State Climate Change Action Plan, the state generates 253 MLD of wastewater and of which 36% gets treated in sewage treatment plants (STPs) (Government of Goa, 2023). The urban centres in Goa generate 176 MLD of wastewater, with an installed sewage treatment plant capacity of 66 MLD (Central Pollution Control Board , 2021). However, only 25 MLD is treated (Figure 10) (ibid). According CPCB report, all the STPs are complying with norms (ibid).

Figure 10: Status of Sewage Management in Goa



Source: (Central Pollution Control Board , 2021)

Although the state has several projects in the pipeline aimed at addressing this infrastructural gap (Sewerage and Infrastructural Development Corporation of Goa Limited, 2021, pp. 17-18), its subpar performance in providing wastewater infrastructure has led to a significant proportion of untreated wastewater being released, exacerbating water pollution and contributing to increased greenhouse gas (GHG) emissions.

For instance, several studies by the Central Pollution Control Board (CPCB) have revealed that the water in canals, several river stretches, beaches, sea, creeks, and marine areas in Goa exhibits higher concentrations of faecal coliform and biochemical oxygen demand (BOD) than the prescribed standards (Central Pollution Control Board, 2022); (Central Pollution Control Board, 2023a); (Central Pollution Control Board, 2023b).

Further, the release of untreated or partially treated domestic wastewater is also responsible for GHG emissions. **In 2018, the domestic wastewater, of both rural and urban areas, accounted for 36% of total waste sector emissions (0.50 Mt CO₂e), amounting to 0.30 Mt CO₂e.** Emissions from domestic wastewater in both types of areas grew at a compound annual growth rate (CAGR) of 3.42%, increasing from 0.07 Mt CO₂e in 2005 to 0.11 Mt CO₂e in 2018. Notably, **approximately 65% of the domestic wastewater emissions in 2018 originated from the urban areas of Goa (GHG Platform India, 2018).** In the study towns of

Canacona and Mapusa, untreated greywater discharge is leading to leakage of 20.8 tonnes of nitrogen (tN) and 46.5 tN, respectively, into the environment, primarily into nutrient-sensitive estuarine waters. In Mapusa, the leakage is amounting to 413.5 tCO₂e/year. The GHG Platform study, however, overlooks energy consumption in its analysis of GHG emissions from the domestic wastewater sector. Including this factor would offer a more comprehensive understanding of emissions.

Indirect GHG emissions in Municipal Services i.e., public water works and sewage pumping and public lighting result from electricity consumption. Recent data for Goa is unavailable on this. The Central Electricity Authority (CEA) reports that the average annual electricity consumption for public water works and sewage pumping in the state was 130 GWh, accounting for 4% of the total annual consumption of 3,153.32 GWh between 2012-13 and 2014-15. In comparison, public lighting accounted for an annual average of 26 GWh, or 1% of the total (Central Electricity Authority, 2025).

5. PROGRAMMES AND SCHEMES IN URBAN WATER AND SANITATION

According to the State Climate Change Action Plan (SCCAP), the total funds budgeted to implement the plan are estimated at INR 2,341.06 Crores over a 10-year period (2023-2033) (Government of Goa, 2023). This equates to INR 234.106 Crores per year, which represents approximately 1.1% of the annual budget (INR 21,056.35 Crores, estimated for 2020-21) and 0.26% of the Gross State Domestic Product (GSDP) of Goa, which stands at INR 92,260.53 Crores (Government of Goa, 2023). **Of the total INR 2,341.06 Crores allocated for implementing the SCCAP, approximately INR 15 Crores from state (0.64%) is earmarked for sewage management, while about INR 80.6 Crores (3.44%) is designated for water resources in the state** (Government of Goa, 2023, pp. 163-164).

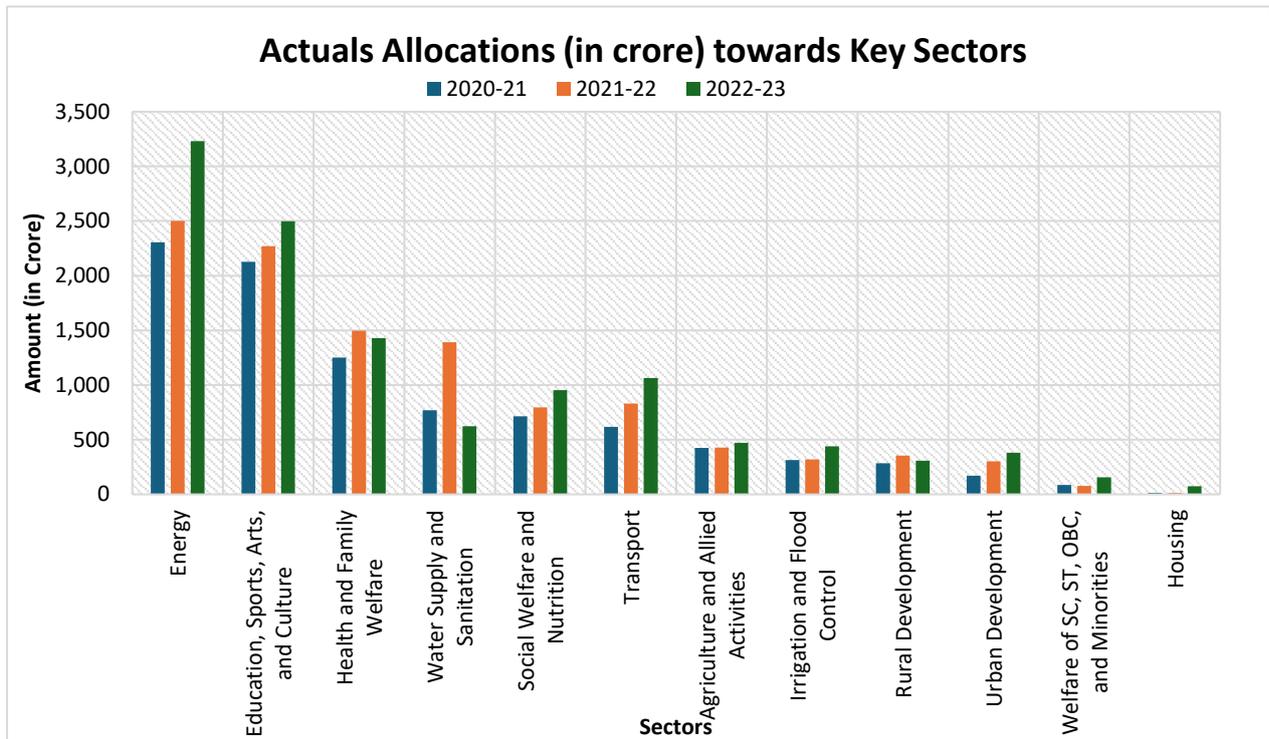
This section highlights key sources of funding for the water and sanitation sector for the state and urban local bodies (ULBs). The State has different sources of receipts such as own tax revenue, non-tax revenue, devolution of states' share in taxes, grants-in-aid and transfers from the Union Government. The State Government's expenditure includes expenditure on revenue account as well as capital expenditure (assets creation, loans and advances, investments, etc.).

In 2022-23, the State's GDP (at current prices) was INR 90,642 crore – a 26.1% increase from INR 71,853 crore in 2018-19 (Government of Goa, 2023). Budget Outlay of the State grew from INR 19,024 crore in 2018-19 to INR 26,366 crore in 2022-23 (Government of Goa, 2023). From 2018-19 to 2022-23, revenue receipts grew by 51% from INR 11,438 crore to INR 17,284 crore. Comparatively, capital receipts which consisted mostly of public debt receipts, registered a marginal increase of INR 44 crore, from INR 2,534 crore to INR 2,578 crore during 2018-23. A significant portion of the revenue receipts (68%) during 2022-23 came from the State's own resources, while central tax transfers and grants-in-aid together contributed 32%.

Total Funds and Trends in Allocations

Figure 11 shows state allocations towards key sector including water and sanitation for period 2020-2023. The allocation towards the water and sanitation sector as a percentage of total allocations for key sectors increased from 8% in 2020-21 to 13% in 2021-22. However, there was a decline in 2022-23, dropping from 13% in 2021-22 to 5% in 2022-23.

Figure 11: State Allocation towards Key Sectors including Water and Sanitation (2020 to 2023)



Source: data from (PRS Legislative Research , 2024)

ULB Funds

The total resources of ULBs can be classified under four major categories: (i) Own resources: tax revenue (property tax, vacant land tax, water benefit tax, advertisement tax, sewerage benefit tax, tax on animals, and taxes on carriages and carts), non-tax revenue (user charges, betterment charges, development charges, sale and hire charges, water supply and sewerage donations, market fees, trade licensing fees, parking fees, layout/building approval fees, slaughterhouse fees, and birth and death registration fees) and other receipts; (ii) Assigned/shared revenues: taxes levied and collected by the State government and shared with or passed on to the local bodies such as Entertainment tax, professional tax, surcharge on stamp duty, entry tax, and motor vehicles tax; (iii) Grants: Central and State Finance Commission grants, central and state grants under various programmes and schemes such as Smart Cities Mission, Swachh Bharat Mission, Atal Mission for Rejuvenation and Urban Transformation; and (iv) Loans from State and Central governments, banks and borrowings through municipal bonds.

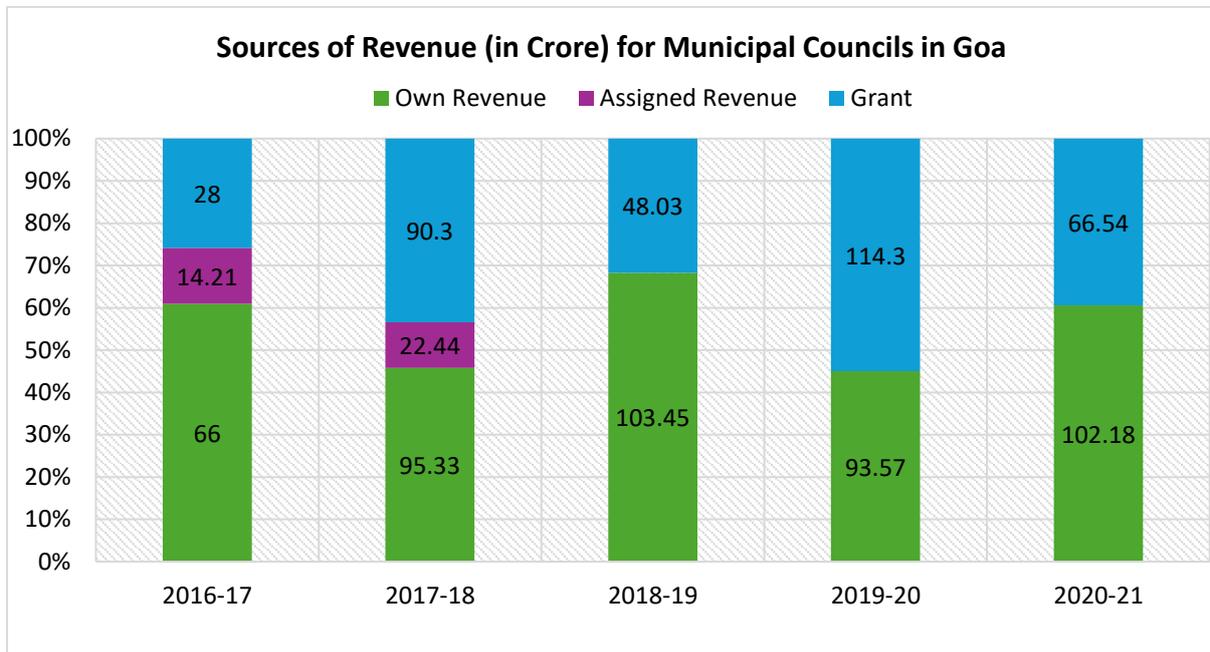
The recent CAG report highlights a steady upward trend in the Municipal Councils’ own revenue resources to their total revenue sources between 2016 and 2021 (Comptroller and

Auditor General of India, 2024). The sources of revenue for ULBs in Goa include own revenues (both tax and non-tax), assigned revenues, and government transfers, including Finance Commission (FC) grants.

The Figure 12 illustrates that fiscal transfers, including grants from the Finance Commission (CFC) and the State Government, contributed between 20% and 49% of the total revenue for ULBs during the period from 2016-17 to 2020-21. Further, between 2016 and 2021, own revenues comprised a substantial portion of the total revenue for Municipal Councils (MCs). In contrast, grants accounted for an average of 39%, while own revenue made up an average of 56.14% of the total revenue. This suggests that Municipal Councils may have a relatively higher degree of financial independence (Comptroller and Auditor General of India, 2024).

However, **CAG report revealed that ULBs were able to generate own revenues covering 74% of their total expenditure.** This is primarily due to approximately 77% of total expenditure being allocated to 'establishment costs' (salaries and contingencies), leaving only 21% for operations, maintenance (O&M), and the execution of schemes or programs. **The heavy reliance on establishment expenses has significantly limited the capacity of ULBs to invest in public amenities or launch new projects and schemes** (Comptroller and Auditor General of India, 2024). Only larger corporations, such as Panaji and Margao, are able to fully meet their expenditure requirements and able to self-sustain (ibid).

Figure 12: Funding Revenue Sources for Municipal Councils in Goa



Source: (Comptroller and Auditor General of India, 2024)

As part of the own revenue, the property tax remains a main contributory sector across different cities in India (Department of Economic and Policy Research, 2024). **However, in Goa, construction license fees account for 29% of the revenue, followed by property tax at 26% and garbage fees at 13%, which is typical for Municipal Councils** (Comptroller and Auditor General of India, 2024, pp. 39-41). For larger corporations like Panaji, property tax makes up a larger share at 48%, surpassing construction fees at 11%. Additionally, the garbage fee becomes the second-largest contributor at 14% for Panaji (Comptroller and Auditor General of India, 2024, pp. 39-41).

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 4 and 5).

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 makes 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.

As per the three-tier structure of governance in India, the state forms the state specific policies within the national policy framework and the ULB implements the action plans based on the policies and guidelines, such as the Atal Mission for Rural and Urban Transformation (AMRUT). The state sponsored schemes in water and sanitation are driven by the Goa State Urban Development Agency (GSUDA). 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) and / Public Works department (PWD) 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 organizations: the CPHEEO and the Bureau of Indian Standards (BIS), respectively. Further, energy-related aspects of water and sanitation sector fall under the purview of the Ministry of Power and the State Energy Development Agency, with programs like MEEP, while renewable energy generation from sanitation facilities is overseen by the Ministry of New and Renewable Energy (MNRE) through various central bioenergy programs.

Goa's institutional framework for managing water, sanitation, urban development, environment, and energy reveals several overlaps in roles and responsibilities across departments, often resulting in fragmented implementation. For instance, the Public Works Department (PWD), Department of Water Resources (WRD), and the newly formed Department of Drinking Water (DDW) share overlapping mandates in water supply. While WRD manages raw water and groundwater resources, PWD has traditionally handled water distribution and sanitation infrastructure. However, with DDW now overseeing household water supply, coordinated planning and service delivery have become more complex. Similarly, while the Town and Country Planning Department (TCPD) is responsible for land-use planning and development approvals, the department often approves large-scale housing and tourism projects without verifying water availability or infrastructure readiness, placing additional burden on Urban Development authorities and municipal bodies.

Goa has distinct institutional arrangement for sanitation infrastructure and service delivery, with the PWD taking the lead in nearly all aspects of water and sewerage planning, implementation, and O&M, wherein ULBs play negligible role (elaborated further in the next section).

The PWD and the Sewerage and Infrastructural Development Corporation of Goa Ltd (SIDCGL) have overlapping roles in sanitation and sewerage management, which often leads to coordination challenges. Both agencies are involved in planning, designing, and executing sewerage infrastructure projects—PWD typically handles minor pipelines and local drainage works, while SIDCGL focuses on large-scale sewerage treatment plants and trunk sewer

networks, especially under programs like AMRUT and the Smart Cities Mission. However, the division of responsibilities is not always clearly defined, resulting in confusion over operations and maintenance (O&M). For example, PWD continues to maintain older sewerage systems and drains, while SIDCGL manages newer centralized systems, causing overlaps in maintenance duties. Additionally, households and urban local bodies often face uncertainty about which agency to approach for sewer connections, billing, or grievance redressal, especially in towns where both agencies operate simultaneously. These overlaps stem from the absence of a unified command structure, unclear geographic and functional boundaries, and inadequate protocols for transferring O&M responsibilities after project completion. To address these challenges, clear coordination mechanisms, formal agreements delineating responsibilities, unified asset management systems, and standardized handover procedures are essential to streamline service delivery and improve sanitation infrastructure governance in Goa. **Such institutional fragmentation underscores the need for integrated planning, formal coordination mechanisms, and interdepartmental consultation to ensure efficient, resilient, and sustainable service delivery across sectors.**

Table 4: Key National Government Agencies in Urban Water and Sanitation and Climate Change

Sl. No.	Name of Department/Institution	Roles and Responsibilities
1.	Ministry of Housing and Urban Affairs	Formulates policies, rules, laws for urban development in India
2	Central Public Health Engineering and Environmental Organisation	Technical wing of MoHUA serves as advisory body to Ministry for WaSH
3	Ministry of Jal Shakti	Responsible for development 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, management of water resources.
5	Central ground Water Board	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	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 formulation of budget, offering policy advice, and review of government programs. Accountable for finance, 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.

Sl. No.	Name of Department/Institution	Roles and Responsibilities
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

Table 5: Key State Government Agencies in Urban Water and Sanitation and Climate Change

Sl. No.	Sector	Department / Body	Key Functions / Responsibilities
1	Water Resources	Department of Water Resources (Goa)	- Planning and execution of irrigation projects - Groundwater management and regulation under the Goa Groundwater Regulation Act, 2002, Regulates groundwater extraction - Grants permits for wells and monitors groundwater availability, Rainwater harvesting - Watershed development
		Public Works Department (PWD)	- Leading agency in Design, construction, operations and maintenance of water supply systems, drainage, and sewerage infrastructure - Operates bulk water supply schemes and sanitation facilities - Managing roads, buildings, and infrastructure
		Department of Drinking Water	- Recently launched (Feb 2025) - Carved out of PWD - Responsible for drinking water infrastructure provision
2	Urban Development	Department of Urban Development	- Urban governance and municipal administration - Sanitation, municipal solid waste management - Coordination with Urban Local Bodies (ULBs)
		Urban Local Bodies / Municipal Councils	- Delivery and maintenance of local water supply, sanitation, solid waste, and drainage services - Local implementation of state-level schemes
		Town and Country Planning Department (TCPD)	- Preparation of regional and development plans - Land-use planning and zoning - Regulation of urban expansion and infrastructure siting
		Sewerage and Infrastructural Development Corporation of Goa Ltd (SIDCGL) (SPV)	- State-owned SPV responsible for planning, execution, operation, and maintenance of sewerage systems across Goa - Implements large sewerage projects under AMRUT and state funding - Coordinates with PWD, ULBs, and Urban Development Department
3	Environment Protection	Department of Environment & Climate Change (DoE&CC)	- Formulation and enforcement of environmental policy - CRZ implementation, wetland and biodiversity protection - Air/water pollution control
		Goa State Pollution Control Board (GSPCB)	- Monitoring and enforcement of environmental norms related to water, air, and hazardous waste
		Goa State Biodiversity Board (GSBB)	- Protection and documentation of biological diversity - Coordination with local biodiversity committees
		Goa Coastal Zone Management Authority (GCZMA)	- Regulates activities in the Coastal Regulation Zone (CRZ) under CRZ Notification 2011

		Goa State Environment Impact Assessment Authority (GSEIAA) & GSEAC	- Review and clearance of projects under Environmental Impact Assessment (EIA) regulations
4	Climate Change	State Climate Change Cell (under DoE&CC)	- Nodal agency for implementing Goa’s State Action Plan on Climate Change (SAPCC) - Coordinates climate adaptation and mitigation measures across sectors
5	Renewable Energy and Energy Conservation	Department of Power & Non-Conventional Energy	- Policy oversight of power and renewable energy sectors - Implements state-level energy efficiency and solar initiatives
		Goa Energy Development Agency (GEDA)	- Nodal agency for promoting renewable energy and energy efficiency in Goa - Implements solar, wind, and other clean energy projects - Conducts awareness programs
6	Disaster Governance	Goa State Disaster Management Authority (SDMA)	- Prepares and updates the State Disaster Management Plan - Coordinates disaster preparedness, risk reduction, and response across departments - Mainstreams resilience into infrastructure and urban planning- Works with District Disaster Management Authorities (DDMAs) and local bodies

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 state-level institutions—are illustrated through the case of Mormugao (refer Table 6).**

Sanitation is a state subject, and under the 74th Constitutional Amendment Act (CAA), Urban Local Bodies (ULBs) are mandated to deliver water supply and sanitation services. However, in practice, a complex multi-stakeholder, multi-level governance structure governs urban sanitation, often resulting in fragmented responsibilities and diluted accountability. **The analysis shows dominance of state level agencies i.e., PWD and relegation of ULBs. The study findings are consistent with the Comptroller and Auditor General of India’s (CAG) Assessment Report for Goa (Comptroller and Auditor General of India, 2024), which underscores that the partial or inadequate devolution of essential functions, as well as administrative and financial powers, from the state to Municipal Councils (MCs) under the 74th CAA remains a widespread challenge across the state.**

Sanitation infrastructure such as toilets and on-site sanitation systems at the household level is largely the responsibility of the household itself. For sludge management, households may opt to rely on vacuum trucks, typically provided by the registered private operators. However, there is a lack of regulation concerning both on-site sanitation systems and toilet designs. At the ULB level, smaller sanitation interventions like CT and public toilets PT are primarily the

ULB's responsibility, with independent decision-making power in key areas such as land selection, technology choice, operation and maintenance (O&M), and funding. SBM, capital funding was provided for some CTs and PTs. The environmental compliance of CTs and PTs is uncertain. The O&M specifically day-to-day cleaning of some of the CTs is given to the communities. The O&M of public toilets have been outsourced to private vendors, who recover the costs through user charges.

For large infrastructure development projects, such as the sewerage network and STP, the Mormugao Municipal Council has no direct involvement. **As illustrated in Table 6, the entire process—including technology selection, land acquisition, capital funding, technology implementation, and operations and maintenance (O&M)—is managed by the central government, state-level departments (such as the Public Works Department, and SIDCGL). This arrangement is unique to Goa state.**

Such an arrangement undermines the spirit of decentralization envisaged under the 74th CAA and significantly restricts ULB autonomy in planning and managing infrastructure. **Being excluded from infrastructure development and planning and O&M, ULBs are not part of the tariff setting process and are unable to collect related revenues—further reducing their revenue base. This centralized approach disrupts the flow of critical information and finances, limiting ULBs' ability to make informed decisions, exercise ownership, and effectively manage sanitation infrastructure.**

As a result, the council's financial and technical capacity to effectively address the specific needs of its local population is severely compromised. Furthermore, interviews with the ULBs revealed that their role in disaster governance and planning is limited. They primarily focus on providing sanitation and water supply during the relief phase of a disaster.

At the household level, sanitation infrastructure—including toilets and on-site sanitation systems—is primarily a private responsibility. Households often depend on unregulated septic systems and private vacuum truck operators for desludging services. There is limited state-level regulation to ensure the safe design, operation, and emptying of these systems, posing risks to both environmental and public health. At the ULB level, interventions such as community toilets (CTs) and public toilets (PTs) are managed with some decision-making autonomy in areas like land use, technology choice, and O&M arrangements. Under the **Swachh Bharat Mission (SBM)**, financial assistance was available for the construction of such facilities, but environmental safeguards and long-term maintenance remain weak. In many cases, O&M of CTs is left to community groups, while PTs are outsourced to private vendors who recover costs through user charges—highlighting both fiscal delegation and the operational limitations faced by ULBs.

In terms of **planning and financing**, large capital-intensive infrastructure projects like sewer networks and sewage treatment plants (STPs) are centrally managed, with little room for ULB participation in project conception or lifecycle management. This bypasses local knowledge and reduces local ownership, leading to operational inefficiencies and potential misalignment with community needs. Moreover, the lack of integrated information systems between central/state agencies and ULBs disrupts financial flows and impairs local-level decision-making. From a **climate resilience** perspective, this top-down model becomes even more problematic. While institutions such as the **State Climate Change Cell (SCCC)** are responsible for coordinating adaptation actions under the **Goa State Action Plan on Climate Change (SAPCC)**, ULBs are not adequately involved in climate planning or urban resilience-building. Interviews with ULB officials confirm that their roles in climate and disaster governance are limited mostly to reactive service provision—such as emergency water supply and sanitation during flood events—rather than proactive risk reduction or resilience planning.

This fragmented institutional architecture—with overlapping mandates between PWD, SIDCGL, ULBs, and other departments—leads to blurred accountability in the sanitation value chain. It not only disrupts infrastructure lifecycle management but also inhibits integrated climate resilience planning, especially in vulnerable coastal towns like Mormugao. Strengthening coordination mechanisms, enabling data sharing, clarifying roles, and aligning funding streams are critical for building robust, climate-resilient urban sanitation systems rooted in local governance and empowered ULBs.

Table 6: Town level Institutional Arrangements in Sanitation Services: A Case of Mormugao

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 Private vehicles	HH
						ULB		

Community Toilets		State Land	Central Government [SBM 1.0]			Day to day cleaning by communities	
Public toilets	ULB	ULB	Central Government [SBM 1.0]	ULB	ULB	Private agency [Sulabh international]	Recovers the costs through user charges.
		Petrol pump					
Sewerage Network	PWD	Public	State Fund	PWD	PWD	PWD	SIDCGL
	SIDCGL		State Fund		No information		
Sewage Treatment Plant	SIDCGL	PWD	State Fund	SIDCGL	SIDCGL	PWD	PWD
		Donated by church					

Source: Ashank Desai Centre for Policy Studies, IIT-Bombay, based on Interviews with Mormugao 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, the chapter incorporates field findings from work conducted in three selected towns in Goa—Canacona, Mapusa and Mormugao—to assess the adoption and effectiveness of state-level policies and measures at the local level.

Aligning with the national commitment of ‘Net Zero target by 2070’ in COP26 in 2021, the Government of Goa has taken various measures in various sectors including urban water and sanitation (**see Annexure - I**). The state demonstrates its commitment to addressing climate change by establishing the Goa State Climate Change Cell (GSCCC), which facilitates inter-

departmental and inter-sectoral collaborations, alongside the State Climate Change Action Plan 2023. The policy landscape review highlights that climate change concerns are effectively integrated at the policy level in water and wastewater management through key frameworks such as the State Water Policy, the State Action Plan on Climate Change and Human Health 2023, the State Pollution Control Board's Consent Mechanisms, the Energy Conservation Building Code Rules 2020, and the Goa (Regulation of Land Development and Building Construction) Act. The section discusses these findings in detail.

6.2.1 Policies with Mitigation Focus

GHG emissions from the UWSS sector can be classified as either direct or indirect, arising from electricity consumption and biological processes. **The review of Goa state policies reveals that there are few policies or schemes that explicitly address mitigation in municipal water and wastewater management.** The state's focus on mitigation primarily targets the transport, power, agriculture, forestry, and waste sectors as these sectors have been identified as the biggest contributors towards the GHG emissions (Government of Goa, 2023). In terms of energy consumption, the transport sector leads with 57.2%, followed by buildings at 14%, and industries (13.7%) (GIZ, 2023).

The mitigation efforts in the municipal UWSS sector primarily focus on improving energy efficiency, with limited attention given to generating energy (from sewage management interventions). Mitigation efforts related to biological processes—such as the safe confinement, transportation, treatment, and disposal of grey and black water—fall under environmental pollution and governance.

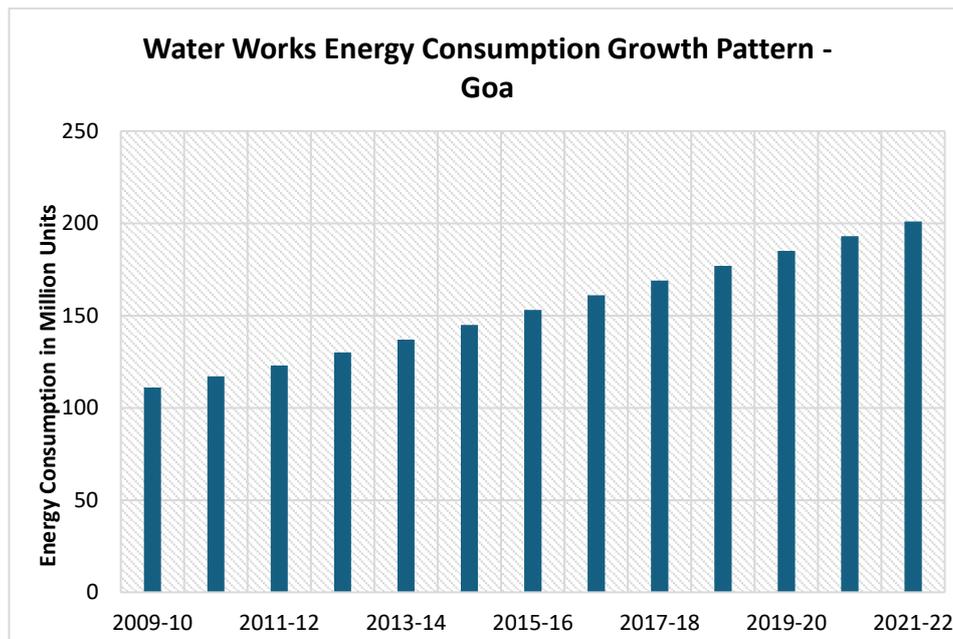
Energy Efficiency in Municipal Sector

Indirect GHG emissions in Municipal Services i.e., public water works and sewage pumping and public lighting result from electricity consumption. Recent data for Goa is unavailable on this. **The Central Electricity Authority (CEA) reports that the average annual electricity consumption for public water works and sewage pumping in the state was 130 GWh, accounting for 4% of the total annual consumption of 3,153.32 GWh between 2012-13 and 2014-15.** In comparison, public lighting accounted for an annual average of 26 GWh, or 1% of the total (Central Electricity Authority, 2025).

Despite this, there appears to be a greater focus on energy efficiency programs for public lighting, rather than on implementing mitigation measures for public water works and sewage pumping (Central Electricity Authority, 2025). The Figure 13 illustrates a steady growth trend, with an average increase of 5% in energy consumption by water works in Goa. According to estimates, **the state has a huge energy saving potential (25%) in municipal**

water works at 2013-14 base values (Kumar P. , 2013), thereby reducing operational costs for the utilities and enhancing the quality of services^{xii}.

Figure 13: Energy Consumption Growth in Water Works in Goa^{xii}



Source: data from (Kumar P. , 2013)

Under State Energy Efficiency Index-2023 (Bureau of Energy Efficiency; Alliance for an Energy Efficient Economy, 2024), 15 states improved their scores compared to 2021-22, with Goa emerging as one of the most improved states. According to the SEEI-2023 report, the state has implemented pump replacement programs to promote the use of energy-efficient pumps and motors in municipal water and sewerage systems (Bureau of Energy Efficiency; Alliance for an Energy Efficient Economy, 2024).

Under the Smart cities project, the state is replacing old water pumps in water works and sewerage network systems (Ministry of Power, 2024). Additionally, Goa State Energy Development Agency (SDA) undertook the renovation of all drinking water pumps in the Public Health Engineering Department by replacing outdated, inefficient pumps with more energy-efficient models. SDA also replaced 506 high-pressure sodium vapor (HPSV) fixtures (250W) along NH-17 from Panaji to Cortalim to Margao (33 km) with energy-efficient LED fixtures (96W) (Bureau of Energy Efficiency, 2023). To take it forward, the state also hosted specialized training sessions for municipal officials on topics such as supply monitoring using

IoT, software applications in water supply, and geo-tagging of assets, including solar-based rural water supply under the Jal Jeevan Mission (Bureau of Energy Efficiency; Alliance for an Energy Efficient Economy, 2024). **Despite these advancements, key state policies, such as the State Clean Energy Roadmap- 2023 (GIZ, 2023), overlook energy efficiency in municipal services.**

According to the PWD representative (at the Stakeholder Consultation Workshop held at IITB on 13th August under the Climate-Resilient Coastal Cities initiative), Goa has undertaken several measures to address climate change by improving energy efficiency. **A key step has been the introduction of energy audits to identify opportunities for reducing consumption and enhancing efficiency across sectors. Multiple projects are already in the pipeline, aimed at lowering carbon emissions, promoting sustainable energy use, and strengthening the state's climate resilience. PWD is planning to conduct energy audits to optimize energy consumption per cubic meter of water supplied. However, the goal of providing 24×7 water supply needs to be examined from both energy and operational efficiency perspectives.**

Energy Efficiency in Building Sector

At the building sector level, key policies include the State Solar Water Policy-2017, the Goa Energy Conservation Building Code Rules- 2020, the Clean Energy Roadmap 2023, and national programs such as the Smart Cities Mission. These policies focus on energy use in buildings and promote the adoption of renewable energy, such as rooftop solar systems for water heating. **They primarily emphasize energy efficiency in water systems (such as cooling and heating facilities), appliances, lighting, and building materials, while energy efficiency in wastewater management interventions receives little attention.** The ECBC 2020 rules also suggests formation of a Goa Energy Conservation Building Code Implementation Committee to oversee the implementation of the rules. Additionally, the State Action Plan on Climate Change and Human Health (2022-27) advocates for the greening of healthcare infrastructure and facilities, including regular energy audits of healthcare facilities, the installation of solar panels, and the implementation of water conservation measures such as rainwater harvesting, wastewater management, and water efficiency initiatives as part of mitigation efforts.

Generating Energy from UWSS

The Goa government has set a goal to achieve 100% renewable energy usage across all sectors in the state by 2050 (The Economic Times, 2023). However, it is not clear, if this includes energy generation from wastewater interventions. The Clean Energy Roadmap for the State-2023 does not address the potential for generating energy from wastewater. Field observations in Canacona, Mapusa, and Mormugao reveal that this option has not been

considered by the authorities, with Mapusa and Canacona relying on nearby utilities for sewage treatment.

Mitigation from biological process

Mitigation efforts related to biological processes—such as the safe confinement, transportation, treatment, and disposal of grey and black water—fall under both the urban development sector and environmental pollution and governance. Within the urban development sector, the provision of toilets, on-site sanitation systems, underground networks, sewage treatment plants (STPs), and FSSTPs are addressed through schemes like SBM Urban, AMRUT, and state government funding as discussed in the previous section. However, the state can treat only 14% of their urban wastewater highlighting a significant infrastructure shortfall, which leads to the release of untreated and partially treated sewage contributing to environmental pollution and GHG emissions. The state has no FSTPs according to the SBM-Urban dashboard^{xiii}. Insights from the selected towns of Canacona, Mapusa, and Mormugao reveal a heavy reliance on private desludging trucks to manage the safe disposal of septage and mitigate methane emissions from septic tanks.

In terms of environmental governance, key policies include the consent mechanism established by the Goa State Pollution Control Board and the Goa (Regulation of Land Development and Building Construction) Act- 2008, the Goa Land Development and Building Construction Regulations- 2010, and the amendments made in September 2018, Ground water Regulation Act, and Goa, Daman and Diu Public Health Act-1985 and Goa Public Health (Amendment) Bill- 2022.

While groundwater regulations impose fines for polluting or contaminating groundwater by injecting treated or untreated water into aquifer systems, other policy provisions regulate the environmental pollution at the household and establishment level. These policies mandate specific designs for toilets and septic tanks, and require properties of certain sizes and water consumption, as well as properties in non-sewer areas, to install decentralized (non-network) wastewater management systems, including provisions for recycling and reuse^{xiv}. **However, our studies in the selected towns of Canacona, Mapusa, and Mormugao found no evidence of decentralized sewage treatment units' implementations particularly in residential areas.** The town studies found that the enforcement of the Goa (Regulation of Land Development and Building Construction) Act, which involves building plan approval by the Town and Country Planning Department (TCPD), ensures compliance with the design standards for toilets and septic tanks, thereby promoting effective environmental pollution management.

6.2.2 Policies with Adaptation Focus

Most state policies at the intersection of climate change, water, and sanitation primarily focus on adaptation strategies, where water resources management is given more importance than sewage management. The policies, whether intentionally or unintentionally, focus on the interlinked issues of: (i) water scarcity and water security, (ii) equitable access to safe drinking water and improved sanitation services, and (iii) human and environmental health. In the case of Goa, the impact of economic activities, particularly tourism, along with biodiversity conservation, is also a critical factor that must be addressed.

The policies addressing water scarcity and security primarily suggest measures such as rainwater harvesting, ground water regulation, groundwater recharge, improving water use efficiency across sectors, and promoting the recycling and reuse of treated wastewater. The policies addressing wastewater and sewage recycling offer dual benefits: freshwater savings, and an additional revenue stream for utilities. These measures are especially important as; despite receiving heavy precipitation, Goa faces significant water quality issues—such as high salinity in river water and pollution due to inadequate sewage management infrastructure—along with low groundwater retention. In fact, the state narrowly avoided being declared water-scarce in 2023.

The key policies addressing this issue include the State Action Plan on Climate Change-2023, the State Action Plan for Climate Change and Human Health-2023, the State Water Policy 2022, the Tourism Policy- 2020, the Goa (Regulation of Land Development and Building Construction) Act 2008 (along with subsequent amendments), the Rainwater Harvesting Policy 2008 (Amendment 2022), the Groundwater Regulation Act 2002 and Rules 2003, and the Goa Groundwater Regulation (Amendment) Bill 2024.

The policies and programs directly addressing access to improved drinking water and sanitation services include national funding initiatives such as SBM (Urban), AMRUT, and the Smart Cities Mission, alongside state government funding programs. The state is in the process of upgrading and enhancing its wastewater infrastructure, a critical need, especially as two of the three towns we studied face significant infrastructural deficiencies in their sewerage networks and sewage treatment plants, resulting in a reliance on inter-city solutions for sewage treatment and disposal. Further, the Tourism Policy 2020 addresses the lack of infrastructure and environmental pollution, emphasizing their negative impact on the tourism sector. It highlights that poor waste management can strain the industry by affecting cleanliness, air and water quality, and overall hygiene. The policy stresses the adoption of modern wastewater disposal methods, especially in high-tourism areas. Additionally, it calls for improving the capacity and quality of infrastructure facilities, including accommodation, connectivity, power, water supply, wastewater treatment, and other essential support services to ensure sustainable tourism development.

From water security perspective, the State Climate Change Action Plan-2023 suggests development of master plans for development and management of water resources for all river basins of the State.

To enhance water distribution efficiency and reduce non-revenue water (NRW), the state is actively pursuing smart metering. They have considerably reduced their NRW which is estimated at 25%, of which 15% is due to manual errors. Current initiatives include the installation of 3,000 smart meters in Panaji, provision of free water up to 16 m³, and slab-wise tariffs tailored for the tourism industry (PWD official, Stakeholder Consultation Workshop, IITB, 13th August, under the Climate-Resilient Coastal Cities initiative).

The State Climate Change Action Plan-2023 proposes measures such as wastewater recycling and reuse to maintain e-flows, along with rainwater harvesting and groundwater recharge. To achieve this, the plan recommends promoting the installation of Sewage Treatment Plants (STPs) for bulk consumers, including through Public-Private Partnership (PPP) models. The plan sets a short-term (6-month) target for the Public Works and Public Health Engineering Departments to assess the existing potential for recycling and reusing treated wastewater. However, interactions with these departments did not reveal any such assessments. At the city level, our field observations and SLB data from the selected towns of Canacona, Mormugao, and Mapusa highlight significant potential for improvement in meeting the recycling and reuse norms under the Service Level Benchmark (SLB).

Wastewater recycling at the property level (under Goa Regulation of Land Development and Building Construction- Act, and national guidelines to Regulate And Control Ground Water Extraction In India) offers a solution for environmental pollution and freshwater savings. However, our field work revealed none of the towns implementing decentralised sewage management and releasing wastewater either to septic tanks or drains. Furthermore, property owners receive no incentives to comply with these policies, which further discourages adherence and maintenance of decentralized wastewater systems.

The ground water and rainwater harvesting policies (2008, 2022) provide both adaptation and mitigation co-benefits, including freshwater savings and improved energy efficiency. As decentralized systems, they are less energy-intensive compared to traditional water distribution networks. Additionally, the costs are shared by users, reducing the financial burden on utilities. The 2022 amendment expanded the scope of the Rainwater Harvesting Policy to include government buildings and colleges. 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). **Goa ranked twenty-ninth with respect to rainwater harvesting structures under the**

programme (status from 22-03-2025 to 28-07-2025) (Ministry of Jal Shakti, 2025). **Further, despite the provision of subsidies under the Rainwater Harvesting Policy 2008 (Amendment 2022), our field studies in the selected towns of Canacona, Mormugao, and Mapusa revealed limited adoption of rainwater harvesting systems^{xv}. The limited takers of RWH scheme is primarily due to the time required for clearance to avail subsidies and the high upfront costs involved (Malkarnekar, 2023). Same is the case with the ground water regulation implementation, our field studies in the selected towns of Canacona, Mormugao, and Mapusa revealed limited adoption of the water extraction regulations.**

6.2.3 Policies with Infrastructure Resilience Focus

The key document that addresses ‘infrastructure resilience’ explicitly is the State Climate Change Action Plan-2023, which serves as the primary guidance for climate action in the state. The plan highlights the importance of focusing of resilience in water and sanitation infrastructure as a critical strategy for enhancing the adaptive capacity (Government of Goa, 2023, pp. 94,98, 147). The resilience of Water and sanitation infrastructure and services is talked in context of adaptation as part of the ‘Habitat’ (Government of Goa, 2023, p. 24).

The plan specifically addresses the development of a resilience plan for vulnerable structures associated with critical services in the prioritized talukas of Bardez, Mormugao, Tiswadi, and Salcete, and sets a target for its implementation (Government of Goa, 2023, p. 147). The plan suggests ‘climate-based infrastructure vulnerability assessments’ of ‘critical services’ including water and sanitation, tourism, agricultural, and human health. The plan urges the responsible authorities to develop strategies for enhancing the resilience of vulnerable structures related to critical services. As part of this approach, it emphasizes the climate-proofing of water infrastructure and suggests incorporating this aspect into the state water policy. However, the Goa State Water Policy 2022 does not address infrastructure resilience of water and wastewater infrastructure.

The state climate action plan-2023 also highlights the need for climate-proofing and disaster management for key water supply and sewerage systems in vulnerable areas, such as low-lying zones. In the water sector, the plan advocates revisiting the infrastructure maintenance strategy and developing a climate-resilient maintenance plan to ensure the functionality of infrastructure during peak events and disasters, as well as preventing flooding and maintaining water resources. For the sanitation sector, the plan recommends that cities either create or strengthen climate-resilient city sanitation plans. At the planning level, it proposes redesigning regional land use planning maps for the most vulnerable areas, incorporating climate considerations, and integrating climate resilience into disaster management and planning efforts.

In line with this, the State Disaster Management Plan - 2024, connects climate change, disaster resilience, and the Sustainable Development Goals (SDGs). The plan identifies impacts of climate change as a risk multiplier intensifying the uncertainties associated with nearly every hydrometeorological hazard. Hence, effective disaster risk reduction (DRR) approaches must incorporate the ways in which climate change alters risk scenarios.

One of the aims is “strengthening and promoting the resilience of new and existing critical infrastructure”. Plan also acknowledges that “The unfortunate fact that DRR mainstreaming has remained somewhat improperly understood or vaguely interpreted theme by both decision-makers and practitioners is weakness that needs to be corrected. Undoubtedly, going forward, DRR mainstreaming will assume a more central role in both development and DM” (Goa State Disaster Management Authority , 2024, p. 35). To achieve this, the plan suggests mainstreaming of DRR principles and inclusion of disaster safety in all the development schemes and projects, new and existing critical infrastructure such as water resources management and public investments. This, according to the plan, will help in enhance disaster resilience, reduce losses and hasten the progress towards development goals. Key structural measures for addressing drought-like hazards include the implementation of rainwater harvesting systems (both individual and community-based), expanding water storage capacity for communities, constructing check dams and reservoirs with excess capacity, and enhancing groundwater recharge systems. The plan suggests key non-structural measures such as groundwater regulation, hazard-resistant construction, and the strengthening and retrofitting of essential structures and critical infrastructure. Furthermore, conducting safety audits for lifeline buildings and infrastructure, and investments in global risk mapping.

In India, the ‘housing for all’ programme and ‘smart cities’ initiatives represent such opportunities. At the city level, the Smart Cities Mission encourages cities to integrate risk resilience aspects into their proposals by evaluating the environmental impact of each project and its capacity to withstand disasters. However, none of the selected cities in Goa are part of the Smart Cities initiative. Additionally, our field experience in Mormugao, Canacona, and Mapusa reveals that much of the water and wastewater infrastructure, built in earlier years, did not account for disaster risks or prioritize climate resilience. For instance, a part of the recently developed sewerage network in Mapusa was flooded during the last monsoon season.

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 climate change impacts 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, minimize wastage and ensure more equitable distribution both across and within states. The Mission will take into account the provisions of the National Water Policy and develop a framework to optimize 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 waste water, **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 included are 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, Forest 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 using science-based decision support systems and by facilitating collaboration among communities, government bodies, and national and international institutes. 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 such as **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 **Goa 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 Goa. **The state has development CRZ (Draft) master plan.**

The **Draft Goa Coastal Zone Management Plan (CZMP)-2021**, prepared under the CRZ Notification 2011, **addresses water and sanitation issues within the broader context of climate change by focusing on the regulation of tourism infrastructure and the protection of ecologically sensitive areas, though it falls short of offering a comprehensive sanitation framework** (National Centre for Sustainable Coastal Management, 2021). It frames the problem largely in terms of unplanned development, degradation of coastal ecosystems, and inadequate control over sewage discharge, particularly from tourism-related activities. While it does not clearly address domestic wastewater pollution, sewerage connectivity, or the impacts of climate change on water infrastructure, it proposes certain regulatory measures. These include mandating elevated construction for beach shacks with on-site toilets, sewage holding tanks, oil and grease traps, and STP installation where municipal access is unavailable, along with reuse of treated wastewater within the premises. The plan also identifies Khazan lands, aquaculture ponds, and salt pans as eco-sensitive zones and calls for the removal of illegal infillings to preserve their hydrological functions and prevent saline intrusion and waterlogging. Additionally, it supports the restoration of mangroves and sand dunes as natural buffers against sea-level rise and erosion, and recommends hazard-line mapping to guide development away from high-risk coastal areas. However, the plan lacks specific strategies to address broader domestic wastewater management, climate-resilient sewerage expansion, stormwater drainage, or integration with municipal sanitation planning. While it makes initial attempts to incorporate sanitation into coastal climate planning through ecosystem protection and tourism regulation, the approach remains fragmented and insufficient for addressing the full scale of climate-related water and sanitation challenges in Goa's coastal areas.

The Goa State Action Plan on Climate Change (SAPCC 2023–33) **identifies 43 coastal villages** as highly vulnerable and prioritises them for climate-resilient interventions. **The plan highlights declining freshwater availability due to disrupted rainfall patterns and salinisation of groundwater, and notes that untreated sewage is contaminating rivers, estuaries, and coastal waters, posing serious public health and ecological risks.** To address these issues, the SAPCC proposes a multi-pronged strategy: upgrading water supply systems, sewerage networks, and sewage treatment plants (STPs) to withstand climate impacts; expanding sewerage coverage under the Sewerage Master Plan 2050 with penalties for non-compliance; enforcing advanced STP technologies (e.g. MBBR, SBR, MBR) with strict effluent reuse mandates to reduce freshwater stress and nutrient loading into coastal ecosystems; and promoting non-potable reuse of treated wastewater for agriculture, toilet flushing, landscaping, and industry. It also emphasises nature-based solutions like mangrove and sand dune restoration to act as natural buffers against erosion and flooding, alongside planning

tools such as hazard-line mapping and erosion surveys. Institutional reforms include forming biodiversity management committees in coastal villages, appointing nodal officers across 60 departments to coordinate actions, and launching public awareness campaigns. Through this integrated approach, the SAPCC aims to build the climate resilience of Goa's coastal communities, improve sanitation coverage, and reduce pollution of water bodies.

The recently released **(draft) Goa State Biodiversity Strategy & Action Plan (GSBSAP, 2025)** addresses water, sanitation, sewerage, and domestic wastewater pollution within the larger context of climate change by framing these issues through the lens of coastal ecosystem degradation and hydrological disruption. It identifies escalating threats to Goa's biodiversity-rich ecosystems—particularly mangroves, wetlands, and khazan lands—due to sea-level rise, increased rainfall intensity, saline intrusion, and frequent flooding. While the plan does not explicitly frame domestic wastewater pollution or sanitation infrastructure gaps as standalone problems, it integrates them into broader concerns around declining water quality, ecological imbalance, and the weakening of natural systems that traditionally support water purification and flood control. Among its proposed solutions, the GSBSAP prioritizes the restoration and conservation of khazan systems, wetlands, and aquaculture ponds as eco-sensitive zones that provide natural buffers against saline intrusion and function as filters for pollutants. It also emphasizes mangrove regeneration, dune protection, and embankment reinforcement to strengthen hydrological stability, mitigate flood risks, and improve the resilience of coastal water bodies to contamination. These nature-based solutions are complemented by infrastructure-focused recommendations, such as climate-proofing water supply networks, sewerage lines, and treatment plants to withstand extreme weather events, sea-level fluctuations, and overflow during monsoons. Regular desilting of rivers, stormwater drains, and maintenance of sewerage infrastructure are also advocated to ensure continued flow and prevent waterlogging or pollution from untreated wastewater.

The plan promotes community-based coastal management, encouraging local stakeholders—particularly in khazan and wetland zones—to act as custodians of these landscapes, integrating traditional knowledge with modern conservation practices. By linking wetland restoration to sustainable livelihoods like small-scale aquaculture, edible shellfish harvesting, and eco-tourism, the GSBSAP aims to embed sanitation awareness and water stewardship into everyday economic practices. It also calls for the use of hazard-line mapping and climate risk assessments to inform land-use planning, prevent encroachment in flood-prone or saline-affected areas, and safeguard both ecosystems and sanitation infrastructure from future climate shocks. Finally, the plan underscores the need for institutional strengthening, including enhanced capacity for biodiversity boards, ecosystem committees, and inter-departmental coordination, to mainstream water and sanitation considerations into climate adaptation frameworks. While it does not offer technical prescriptions for sewerage expansion or STP installations, the GSBSAP embeds sanitation and water management into



an ecological resilience paradigm, viewing them as essential components of sustaining Goa's coastal biodiversity and community well-being in the face of climate change.

7. RECOMMENDATIONS

Goa's policy and institutional landscape was examined through a grounded assessment in the towns of Canacona, Mapusa, and Mormugao 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.**

Goa, with its strong fiscal independence and high Human Development Index (HDI), has significant potential to lead in climate-resilient urban planning. Despite being vulnerable to sea-level rise, saltwater intrusion, and water shortages—especially in summer—the state can strengthen its resilience through integrated water management and wastewater strategies. Improving wastewater systems offers both environmental and climate mitigation benefits, such as pollution reduction and better water quality. While the focus so far has been on adaptation—understandable given the state and towns' failure to meet basic water and sanitation service benchmarks—there's a need to expand into mitigation. Strategies like IoT-driven monitoring, pump efficiency improvements, decentralized sewage systems, and scientific desludging should be enforced. Empirical data from towns like Canacona, Mapusa, and Mormugao can guide policy refinements. Goa's disaster management, climate, and public health plans provide platforms for mainstreaming resilience through infrastructure safety assessments and climate-proofing investments. A coordinated, multi-departmental approach can further enhance water security and long-term sustainability, with Goa emerging as a potential model for integrated climate resilience in coastal urban settings.

7.1 Financial Programmes and Schemes

The **State Climate Change Action Plan (SCCAP)** allocates **INR 2,341.06 crore** over ten years (2023–2033), equivalent to **INR 234.1 crore annually**, representing just **1.1%** of Goa's annual budget and **0.26%** of its Gross State Domestic Product (GSDP). However, **only 0.64% (INR 15 crore)** is earmarked for **sewage management**, and **3.44% (INR 80.6 crore)** for **water resources**, indicating limited prioritization of climate investments in these sectors. Budget allocations to water and sanitation increased from **8% (2020-21)** to **13% (2021-22)** but then declined to **5% (2022-23)**, reflecting fluctuating commitment.

At the **Urban Local Body (ULB)** level, **own revenue sources** (taxes, user charges) contribute **56.14%** on average, while **grants from Finance Commissions and state/central schemes**

contribute about **39%**. **Construction license fees** are the dominant revenue source (29%) in most councils, followed by **property tax (26%)** and **garbage fees (13%)**. In Panaji, **property tax leads (48%)**, with **garbage fees (14%)** as the second-largest contributor. Despite showing some degree of **financial independence**, ULBs spend **77% of their budget on establishment costs** (salaries, contingencies), leaving **only 21%** for infrastructure, O&M, or service delivery. This limits the ability of smaller municipalities to invest in climate-resilient water and sanitation infrastructure. Only larger cities like **Panaji and Margao** are financially self-sustaining.

Key Challenges

1. **Low Climate Investment in WaSH:** A **marginal share (4%)** of SCCAP funds is allocated to water and sanitation, despite their vulnerability to climate risks.
2. **Fluctuating Sectoral Budgeting:** State allocations to water and sanitation are **inconsistent**, falling from 13% to 5% in one year.
3. **Revenue-Expenditure Mismatch in ULBs:** ULBs generate **74% of expenditure through own revenue**, but most of it is absorbed by **salaries**, restricting service delivery and infrastructure investment.
4. **Weak Fiscal Capacity in Smaller ULBs:** Only **larger cities** like Panaji and Margao are able to **self-sustain**; smaller towns depend heavily on grants and lack fiscal space.
5. **Under-utilization of User Charges and Property Tax:** Construction license fees dominate ULB revenues in most towns, showing **limited diversification** of local tax and fee structures.
6. **Lack of Dedicated WaSH Financing Tools:** No mention of climate funds, or ring-fenced budgets for WaSH infrastructure in vulnerable areas.
7. **Limited Financial Devolution:** **Centralized control** over capital projects leaves ULBs out of climate-sensitive planning and financial decision-making.

Recommendations

1. **Increase SCCAP allocations** to water and sanitation to reflect their role in adaptation and resilience.
2. **Stabilize budgetary allocations** to the sector over multiple years to enable long-term planning.
3. **Enhance fiscal devolution** to empower ULBs in planning, financing, and managing WaSH infrastructure.

4. **Reform user charges and improve property tax collection** to increase ULB revenues sustainably.
5. Create **ring-fenced budgets** for climate-resilient WaSH services at the ULB level.
6. Support **green funds**, or **climate-linked borrowing mechanisms** for urban infrastructure.
7. Train ULBs in **financial planning, cost recovery, and service-based budgeting** to improve efficiency.
8. Link ULB development plans with **SCCAP goals**, and provide performance-based grants for meeting climate resilience targets.
9. Leverage central schemes (e.g., **AMRUT 2.0, SBM 2.0**) with matched funding and **clear O&M roadmaps**.

7.2 Institutional Landscape

Goa's **institutional architecture** for managing **urban water, sanitation, and environmental services** is characterized by **fragmentation, overlapping mandates, and weak coordination**. Key agencies like the **Public Works Department (PWD)**, **Water Resources Department (WRD)**, and the new **Department of Drinking Water (DDW)** share responsibilities without clear demarcation. Similar overlaps occur between **PWD** and the **Sewerage and Infrastructural Development Corporation of Goa Ltd. (SIDCGL)** in sanitation infrastructure planning, execution, and maintenance.

Urban Local Bodies (ULBs), despite being constitutionally responsible for water and sanitation under the **74th Constitutional Amendment Act**, are largely **marginalized** in infrastructure development. Most capital-intensive projects (e.g., STPs, trunk sewer networks) are controlled by higher-level state agencies, limiting local ownership, participation, and accountability. Further, **land-use approvals** by the **Town and Country Planning Department (TCPD)** often proceed without ensuring water or sanitation readiness, placing undue stress on infrastructure and ULBs. Meanwhile, **households rely on poorly regulated on-site sanitation systems**, with limited oversight or standards enforcement, leading to environmental and public health risks. The **Comptroller and Auditor General (CAG)** has also flagged the **inadequate devolution** of powers to ULBs. Climate and disaster resilience planning remains mostly top-down, with ULBs playing a reactive rather than proactive role. The **absence of data-sharing systems**, unclear protocols for operation and maintenance, and lack of coordination across departments significantly **undermine climate-resilient urban sanitation planning**, especially in coastal towns like **Mormugao**.

Key Challenges

1. **Overlapping Mandates and Fragmented Roles:** Multiple departments (PWD, DDW, WRD, SIDCGL, TCPD) operate with **unclear functional boundaries**, leading to duplicated or conflicting efforts.
2. **Marginalization of ULBs:** ULBs lack authority over infrastructure planning, financing, and lifecycle management, contrary to the **spirit of decentralization**.
3. **Unclear O&M Responsibility:** No formal protocols exist to transfer **operation and maintenance** of assets from state agencies to ULBs, creating confusion for service delivery and grievance redressal.
4. **Weak Regulation of On-Site Sanitation:** Households use septic systems with **little regulation** or monitoring, risking environmental contamination and methane emissions.
5. **Lack of Integrated Planning:** Infrastructure and land-use planning remain disconnected—**TCPD clears projects without verifying water/sanitation serviceability**.
6. **Limited ULB Role in Climate Resilience:** ULBs are not engaged in **climate or disaster planning**, despite being frontline service providers during crises.
7. **Poor Data Integration and Institutional Coordination:** Absence of **integrated data systems** and inter-agency communication disrupts financial flows and hinders informed decision-making.
8. **Weak Accountability Mechanisms:** Citizens and ULBs face ambiguity on which agency is responsible for **sewer connections, billing, or infrastructure upkeep**.

Recommendations

1. **Clarify and streamline mandates** between PWD, WRD, DDW, and SIDCGL through formal MoUs and joint operational frameworks.
2. **Establish a unified coordination mechanism**, such as a state-level Urban Water and Sanitation Mission with interdepartmental representation.
3. **Devolve financial and functional powers** to ULBs as per the 74th CAA, including authority over planning, budgeting, and O&M of sanitation services.
4. **Provide capacity building and technical assistance** to ULBs for managing infrastructure and climate-resilient urban services.
5. **Strengthen regulation and monitoring** of on-site sanitation systems, including licensing and performance tracking of desludging operators.
6. **Enforce building codes** mandating decentralized sanitation solutions in unsewered areas with incentives for compliance.

7. **Integrate ULBs into climate resilience and DRR planning**, ensuring their role shifts from reactive to proactive governance.
8. **Align climate resilience goals with sanitation infrastructure investments**, especially in vulnerable coastal towns.
9. **Establish a shared information platform** linking central, state, and municipal data on sanitation assets, performance, and service delivery.
10. **Create grievance redressal systems** that map responsibility zones of agencies to ensure quick response and accountability.

7.3 Policy Landscape

State policies and programmes place greater emphasis on climate adaptation, with comparatively limited focus on mitigation and the resilience of water and sanitation infrastructure. This emphasis is well-founded—like most states in India, the priority must be to first strengthen adaptive capacity and enhance the resilience of communities before focusing on long-term mitigation goals.

7.3.1 Adaptation

In Goa, most state policies at the intersection of **climate change, water, and sanitation** emphasize **adaptation**, with a stronger focus on **water resource management** than on **sewage and wastewater infrastructure**. Key policy objectives include addressing water scarcity, ensuring equitable access to drinking water and sanitation, and safeguarding environmental and public health—especially in the context of biodiversity and tourism. Despite Goa’s high rainfall, the state faces serious **water quality** challenges due to high salinity, poor sewage infrastructure, and low groundwater retention. Several national and state-level policies aim to improve water use efficiency, promote rainwater harvesting, enhance groundwater recharge, and incentivize wastewater recycling. However, implementation lags behind policy intent. Although recent policies such as the **State Climate Change Action Plan 2023, Tourism Policy 2020, and State Water Policy 2022** propose measures (e.g., STP installation, decentralized recycling), **ground realities in towns like Canacona, Mormugao, and Mapusa** reveal poor infrastructure, low adoption of rainwater harvesting and decentralized sewage systems, and minimal enforcement of groundwater regulations. National programs like SBM, AMRUT, and Jal Shakti Abhiyan are present, but uptake and effectiveness remain low at the town level.

Key Challenges

1. **Water Over Wastewater Bias:** Policies prioritize water management over sewage and sanitation infrastructure development.
2. **Poor Infrastructure in Key Towns:** Towns like Canacona, Mormugao, and Mapusa rely on inter-city sewage solutions and have weak STP coverage.
3. **Lack of Incentives:** Property-level wastewater treatment is not enforced or incentivized; residents have little motivation to comply.
4. **Low Adoption of Rainwater Harvesting:** Despite subsidies, uptake is limited due to complex clearance procedures and high initial costs.
5. **Regulation Without Implementation:** Groundwater extraction rules and wastewater reuse targets are not enforced or monitored.
6. **Disconnect Between Departments:** Departments like Public Works and Health Engineering lack coordination and haven't acted on policy targets such as wastewater reuse assessments.
7. **Tourism-linked Pollution:** Tourism is acknowledged as a pollution source, but there is weak enforcement of eco-regulations in high-footfall zones.

Recommendations

1. Align **State Water Policy 2022** with the **Climate Action Plan 2023** to integrate infrastructure resilience and sewage management.
2. Enforce **short-term targets** like wastewater reuse assessments by departments (e.g., PWD, PHED) with transparent reporting.
3. Expand and **upgrade STPs and sewerage networks**, especially in Mormugao, Canacona, and Mapusa. Install decentralised and nature based solutions wherever applicable.
4. Incentivize **decentralized sewage treatment** at the property level through tax rebates, faster subsidy clearance, and compliance checks. Develop and institutionalize monitoring systems to ensure environmental compliance in decentralized systems.
5. Simplify and fast-track **rainwater harvesting (RWH) subsidy approvals** and expand awareness about scheme benefits.
6. Strengthen enforcement of **groundwater extraction regulations**, particularly in tourism zones and peri-urban areas.
7. Integrate **wastewater regulations into tourism licensing** processes; enforce eco-guidelines for hotels, resorts, and shacks.
8. Link **infrastructure ratings to environmental compliance** for tourism establishments.

9. Develop **city-level water and sanitation master plans** that integrate climate risks, and disaster resilience.
10. Conduct regular **training for ULB staff** on sustainable wastewater management and climate-resilient infrastructure design.
11. Establish a **central monitoring dashboard** tracking water reuse, STP coverage, and decentralized system compliance across towns.

7.3.2 Mitigation

GHG emissions in Goa’s **UWSS sector** stem from two main sources: **Indirect emissions** from **electricity consumption** for water supply, pumping, and treatment. **Direct emissions** from **biological processes**, including greywater and blackwater treatment, storage, and disposal.

While **mitigation** is a central theme in Goa’s climate and energy policies, **municipal water and wastewater systems receive limited attention**. The state’s mitigation priorities remain focused on **transport, buildings, industry, and solid waste**—the top contributors to emissions. Mitigation in UWSS is largely confined to **energy efficiency improvements**, especially pump replacements. Goa has made **recent strides** in energy-efficient pump retrofitting and LED lighting, but lacks a cohesive approach to UWSS mitigation in its **Clean Energy Roadmap (2023)**. There is **almost no policy focus on energy generation from wastewater**, despite national and global best practices. Field visits to Canacona, Mapusa, and Mormugao confirm this absence. In terms of biological process mitigation, Goa treats **only 14%** of its urban wastewater. There are **no Faecal Sludge and Septage Treatment Plants (FSSTPs)**, and most towns rely on **private desludging operators**. While Goa’s environmental laws and building regulations mandate septic design standards and decentralized wastewater systems, **actual implementation is absent**, especially in residential areas.

Key Challenges

1. **Neglect of UWSS in Climate Mitigation Policy:** Most mitigation initiatives overlook water and sanitation, focusing on sectors like transport and power.
2. **No Energy Recovery from Wastewater:** Goa has not explored the potential of **biogas or heat recovery** from sewage or sludge treatment.
3. **Low Wastewater Treatment Coverage:** Only **14%** of urban wastewater is treated; the rest contributes to **GHG emissions** and environmental degradation.
4. **Absence of FSSTPs and Decentralized Systems:** No **FSSTPs exist**, and **decentralized wastewater solutions** are neither incentivized nor implemented.

5. **Limited Data and Monitoring:** There is no recent or real-time data on energy use in water/sewer services or emissions from wastewater treatment.
6. **Poor Implementation of Building Codes:** While Goa's building codes mandate pollution control designs (e.g., septic tanks, reuse systems), enforcement is weak.
7. **Missed Opportunities in the Clean Energy Roadmap:** The state's flagship energy policy fails to incorporate UWSS mitigation potential.
8. **Inadequate Training and Institutional Capacity:** Municipal officials often lack technical knowledge on mitigation technologies (e.g., biogas, energy-efficient STPs).

Recommendations

1. **Revise the Goa Clean Energy Roadmap (2023)** to include **UWSS mitigation targets**—energy efficiency and biogas generation.
2. **Integrate UWSS into state and municipal GHG inventories** to track and prioritize mitigation actions.
3. **Mandate energy and water audits** for water and sewer systems under the Goa Energy Conservation Building Code Implementation framework.
4. **Strengthen the capacity of Urban Local Bodies (ULBs) to conduct comprehensive water and energy audits of water and sanitation systems, and to evaluate Detailed Project Reports (DPRs) accordingly.**
5. **Mandate energy audits for all proposed infrastructure projects included in DPRs to ensure long-term sustainability and cost-efficiency.**
6. **Establish Faecal Sludge and Septage Treatment Plants (FSSTPs) in where feasible,** and incentivize biogas recovery from faecal sludge and sewage treatment plants (STPs) to promote resource recovery and circular sanitation.
7. **Promote decentralized wastewater treatment systems (DEWATS)** through financial incentives and mandatory building code enforcement.
8. **Invest in energy-efficient technologies,** including solar-powered pumps, IoT monitoring tools, and SCADA for water and sewerage utilities.
9. **Set up a cross-departmental task force** linking climate, energy, urban planning, and sanitation to mainstream mitigation in UWSS.
10. **Offer subsidies or tax rebates** for buildings that implement RWH, decentralized treatment, and water reuse systems.
11. **Include wastewater energy recovery** projects under carbon credit programs (e.g., under the Green Credit Programme).
12. **Develop an online dashboard** for UWSS energy and GHG monitoring in partnership with utilities and ULBs.

7.3.3 Infrastructure Resilience

The **Goa SAPCC 2023** serves as the state’s primary framework for climate action, explicitly highlighting the importance of strengthening the resilience of **water and sanitation infrastructure** as part of its “Habitat” agenda. Vulnerable talukas such as Bardez, Mormugao, Tiswadi, and Salcete are prioritized for climate-based vulnerability assessments and resilience planning across critical sectors including water, sanitation, health, agriculture, and tourism. While the SAPCC calls for **climate-proofing infrastructure**, these priorities are not reflected in the **Goa State Water Policy 2022**, which lacks any mention of infrastructure resilience. The plan recommends integrating climate concerns into **land-use planning**, strengthening **city-level sanitation plans**, and updating maintenance protocols to address extreme weather and disaster events. Complementing this, the **Goa SDMP 2024** recognizes climate change as a **risk multiplier** that intensifies hydrometeorological hazards. It advocates for **mainstreaming disaster risk reduction (DRR)** across all infrastructure projects and highlights both structural (e.g., check dams, rainwater harvesting) and non-structural (e.g., hazard mapping, infrastructure audits) measures to enhance resilience. Despite strong policy intent, **ground realities in cities like Mapusa, Canacona, and Mormugao** reveal major infrastructure gaps. For instance, recently constructed sewerage systems in Mapusa were inundated during the monsoon, underscoring the absence of climate-resilient planning. Moreover, **Goa’s cities are not part of the Smart Cities Mission**, limiting access to national funding and technical support for resilience-building.

Key Challenges

1. **Policy-Implementation Disconnect:** SAPCC emphasizes resilience, but the State Water Policy remains silent on infrastructure adaptation.
2. **Legacy Infrastructure Vulnerability:** Existing water and sanitation systems are not designed to withstand extreme climate events.
3. **Fragmented Planning:** Poor coordination among land use, urban sanitation, and disaster management plans.
4. **Weak Urban Sanitation Planning:** Lack of city-level climate-resilient sanitation strategies.
5. **Inadequate DRR Mainstreaming:** Disaster risk reduction remains poorly understood and under-integrated in infrastructure projects.

Recommendations

1. Update the **Goa State Water Policy** to incorporate climate resilience and infrastructure adaptation explicitly.
2. Mandate **climate vulnerability assessments** for all critical infrastructure in high-risk talukas.
3. Develop and implement **climate-resilient sanitation plans** in all urban local bodies.
4. Integrate **climate and disaster risk assessments** into all future water and sanitation (WaSH) infrastructure planning and investments.
5. Retrofit and upgrade vulnerable infrastructure to withstand extreme weather and flooding.
6. Adopt **stormwater infrastructure** designs that can accommodate future climate variability.
7. Institutionalize the use of **smart technologies** (e.g., IoT sensors, GIS mapping) for real-time monitoring and adaptive system management.
8. Include **early warning systems**, flood forecasting, and retention basins in urban infrastructure design.
9. Strengthen coordination among the **Goa State Disaster Management Authority, ULBs**, and sectoral departments.
10. Train ULB officials to review **Detailed Project Reports (DPRs)** through a climate-resilience lens.
11. Develop **climate-resilient engineering standards** and embed them in design and technical manuals.
12. Promote **nature-based solutions**, including mangrove restoration and dune protection, as co-benefits for sanitation and flood resilience.
13. Create performance-linked incentives to encourage local governments to invest in **climate-resilient public services**.

7.3.4 Coastal Policies

While India lacks a dedicated national mission for coastal climate adaptation under the NAPCC, several policies and programs address the intersection of water, sanitation, and climate change in coastal areas like Goa. These include the National Water Mission, Integrated Coastal Zone Management Plan (ICZMP), CRZ Notifications, Goa's Coastal Zone Management Plan (CZMP 2021), the Goa SAPCC (2023–33), and the draft Goa State Biodiversity Strategy & Action Plan (GSBSAP 2025). These instruments collectively promote water efficiency, regulate tourism infrastructure, protect ecologically sensitive zones (e.g., khazan lands, mangroves, salt pans), and advocate for integrated and nature-based coastal resilience approaches. However, sanitation is weakly integrated in most frameworks, and domestic wastewater management remains under-addressed.

Key Challenges

1. **Absence of a dedicated coastal climate mission** under the NAPCC limits national-level guidance and funding for vulnerable coastal areas.
2. **Fragmented policy integration:** Wastewater, sanitation, and climate adaptation efforts remain poorly coordinated.
3. **Limited sanitation framework in CZMP:** While the CZMP regulates tourism infrastructure, it lacks comprehensive plans for sewerage connectivity and domestic wastewater management.
4. **Sewage pollution of rivers and coasts:** Untreated sewage continues to contaminate water bodies, posing serious health and ecological risks.
5. **Inadequate infrastructure resilience:** Existing and planned systems are often not climate-proofed or adapted to sea-level rise and extreme rainfall.
6. **Slow adoption of advanced treatment technologies and effluent reuse.**
7. **Weak enforcement and compliance** with existing CRZ and sanitation guidelines.
8. **Gaps in institutional coordination** across coastal, climate, water, sanitation, and biodiversity sectors.

Key Recommendations

1. **Establish a National Coastal Climate Resilience Mission** to integrate water, sanitation, and climate adaptation in coastal zones.
2. **Strengthen policy coherence** between CRZ norms, biodiversity plans, and sanitation frameworks.
3. **Expand climate-resilient sanitation infrastructure** in coastal towns, including decentralized systems and stormwater drainage.
4. **Upgrade and climate-proof existing water and sewage networks, STPs, and water supply systems.**
5. **Enforce stricter wastewater regulation** in tourism hubs and promote reuse of treated wastewater in non-potable applications.
6. **Mainstream nature-based solutions** (mangrove restoration, dune protection, khazan land rehabilitation) as buffers against flooding and saline intrusion.
7. **Enhance local governance** by forming biodiversity management committees and appointing nodal officers across departments.
8. **Promote community-based management** and integrate traditional knowledge into conservation and sanitation efforts.
9. **Improve hazard mapping and climate risk assessments** to guide land-use and infrastructure planning.

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Annexure – I: Policies in Climate Change and Water and Sanitation

Policy Name		Organisation
Climate Change		
1	Goa State Climate Change Cell (GSCCC)	Government of Goa
2	Goa State Action Plan on Climate Change Version	Department of Environment and Climate Change
3	Goa State Action Plan on Climate Change and Human Health 2022-27	Directorate of Health Services
Water		
4	State Water Policy 2022	
	Ground Water Regulation Act 2002; Goa Ground Water Regulation Rules, 2003; The Goa Ground Water Regulation (Amendment) Bill, 2024	
5	Rainwater harvesting policy 2008, Amendment 2022	Department of Water Resource, GoG
Public Health		
7	Goa, Daman and. Diu Public Health Act; 1985; The Goa Public Health (Amendment) Bill, 2022	
Energy		
8	Energy Conservation Building Code, 2006 of Bureau of Energy Efficiency adopted for State of Goa	Goa State energy Development Department
9	Clean Energy Road Map for Goa	Agency
Urban Development		
10	The Goa (Regulation of Land Development and Building Construction) Act, 2008. The Goa Land Development and Building Construction Regulations, 2010 (Incorporating Amendments upto September, 2018)	Department of Town and Country Planning
Tourism		
11	Goa Tourism Policy 2020	Department of Tourism
Disaster		

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 the author. 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 Goa referenced in this report is based on sources reviewed and compiled by the author. During report finalization, the official coastline length of Gujarat was revised to 193.95 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} Emissions from the state of Goa increased at an estimated CAGR of 5.05% from 2.85 Mt CO₂e in 2005 to 5.40 Mt CO₂e in 2018.

^v GHG emissions from waste sector (including solid waste and domestic wastewater) increased at a CAGR of 1.22% from 0.25 Mt CO₂e in 2005 to 0.30 Mt CO₂e in 2018 (GHG Platform India, 2018).

^{vi} 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.

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

^{viii} The *Climate Resilient Coastal Cities* initiative was rolled out in September 2023. Project partners include - Funding Partner: HSBC; Communication, Outreach, and Advocacy Partner: India Sanitation Coalition (ISC); Research Partner: Ashank Desai Centre for Policy Studies (IIT-Bombay); and Research and Implementation Partner: CDD India.

^{ix} The state has a per capita annual water availability of 1,807 cubic meters, which is derived from 2,823 Million Cubic Meter (MCM) of surface water and 160 MCM of groundwater, totalling 2,983 MCM, based on a population of 1.65 million in 2021.

^x Representative Concentration Pathways (RCPs) are used by the IPCC to describe different GHG concentration trajectories and their associated climate outcomes by 2100. RCP 4.5 is an intermediate scenario with moderate mitigation, leading to stabilization of emissions and approximately 2.4–3°C warming by the end of the century. RCP 8.5 reflects a high-emissions pathway with minimal climate action, resulting in continued reliance on fossil fuels and warming of 4°C or more.

^{xi} NFHS definition for Improved Drinking Water Sources = Piped water into dwelling/yard/plot, piped to neighbour, public tap/standpipe, tube well or borehole, protected dug well, protected spring, rainwater, tanker truck, cart with small tank, bottled water, community RO plant. Improved Sanitation Services = Flush to piped sewer system, flush to septic tank, flush to pit latrine, flush to don't know where, ventilated improved pit (VIP)/biogas latrine, pit latrine with slab, twin pit/composting toilet, which is not shared with any other household. This indicator does not denote access to toilet facility completely.

^{xii} At the time of report finalisation, it was noted that these figures reflect the authors' interpretation.

^{xiii} SBM-Urban Dashboard. Mission Progress. Ministry of Urban and Housing Affairs, Government of India <https://sbmurban.org/swachh-bharat-mission-progress> Accessed on 24 March 2025

^{xiv} Sewage Treatment Plant is mandatory for residential complexes having 50 flats/residential units and above. Sewage Treatment Plant will not be required if the area is already served by existing sewer lines, according to the Goa (Regulation of Land Development and Building Construction) Act.

^{xv} Exempted: all the users of these groups who incorporate Sewage Treatment Plants (STP) or Wastewater Recycling processes in their premises shall be exempted from the mandatory inclusion of rainwater harvesting structures in their building. Rainwater harvesting shall be mandatory for the following groups of users: (i) Residential complexes including apartments on a plot area of 2000 square meter and above. (ii) Commercial complexes on plot areas of 1500 square meter and above. (iii) Industrial units on plot areas of 10,000 square meter and above. The 2022 amendment included government buildings, government schools and colleges. All building complexes especially group housing societies having a minimum discharge of 10,000 litres and above per day shall install and incorporate wastewater recycling system. The recycled water shall be used for horticultural purposes only. 2022 amendment includes other ground water recharge methods and users (pits, farmers). Subsidy is same - 50%.

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