Status Report on Coastal Area Management

An Indian Perspective, Regional Issues & Remedial Measures

CENTRAL WATER COMMISSION
Department of Water Resources,
River Development &
Ganga Rejuvenation

Ministry of Jal Shakti

September 2024

सत्यमेव जयते

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अध्यक्ष, केंद्रीय जल आयोग एवं पदेन सचिव, भारत सरकार
सेवा भवन, नई दिल्ली-110066

सत्यमेव जयते

Chairman, Central Water Commission & Ex-officio Secretary to Government of India
Sewa Bhawan, New Delhi-110066

Message

As we embark on this journey of understanding and managing our coastal resources, it is essential to recognize the profound significance of the coastal areas of India. Our coastline, stretching over 7,500 kilometers, is not only a vital economic zone but also a region rich in biodiversity and cultural heritage. The challenges posed by coastal erosion, climate change, and salinity ingress necessitate a collaborative approach to manage coastal areas. Despite having such issues, various research institutions and departments at both the Central and State levels have been working with their own understanding when it comes to coastal management. Recognizing the need for a coordinated approach, the Central Water Commission took the initiative to bring all the Maritime States, UTs and other stakeholders together through a series of Quarterly Dialogues. A total of nine such elaborate dialogues were conducted during April-May 2024, covering all nine Maritime States and four Union Territories. These dialogues served as a platform to address pressing issues related to coastal sustainability. Discussions were focused on addressing key challenges faced by coastal regions, including coastal erosion, salinity ingress, and the absence of a centralized data-sharing system. Further extensive deliberations held in various meetings under aegis of Coastal Protection and Development Advisory Committee (CPDAC), a high-level inter-departmental Committee offering collaborative platform for all stakeholders involved in coastal area management to voice their concerns and engage in discussions on sustainable solutions also furthered the common cause. The discussions thereto led to bringing out this report.

The report encapsulating the findings and discussions from the Quarterly Dialogues and CPDAC meetings held among various stakeholders, including State/UT governments, academic institutions, and central agencies, aspire to highlight the importance of integrated coastal management practices and the need for a cohesive framework that aligns the efforts of all stakeholders involved. It is for furtherance of collective responsibility to safeguard these invaluable ecosystems for future generations while promoting sustainable economic growth and resilience against environmental challenges.

I am confident that this report will significantly contribute to advancing our understanding and management of coastal areas in India. I appreciate the dedicated efforts made by the drafting team of the Coastal Management Directorate in bringing forth this publication, which serves as a crucial resource for stakeholders and policymakers alike.

I hope that use of this report by Maritime State/UT governments and all other stakeholders shall help in coastal protection and mitigation efforts in a long way.

(Kushvinder Vohra)

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Foreword

As we move forward in our endeavor to better understand and manage India's coastal resources, it is crucial to acknowledge the immense value of our coastline. India’s coastline is not just a geographical boundary; it is a dynamic and valuable asset vital to our nation’s economy, environment, and heritage. With over 7,500 kilometers of coastline, the diversity of ecosystems, coupled with the complex challenges of climate change, coastal erosion, and salinity ingress, demand a well-coordinated response from all stakeholders.

This report represents a significant step taken towards addressing above challenges. It encapsulates the outcomes of the Quarterly Dialogues, where stakeholders—ranging from State authorities to research institutions— are engaged in collaborative discussions aimed at enhancing the resilience of our coastal areas. The key objective of these dialogues has been to foster a shared understanding of coastal vulnerabilities and to develop effective management strategies.

I strongly believe that the insights and findings presented in this document will serve as an invaluable resource, guiding future efforts in coastal area management. The combined knowledge and experiences of diverse stakeholders reflected in this report would form a strong foundation for building a sustainable, resilient future for India's coastal regions.

As we navigate the complexities of coastal resource management, this publication stands as a testament to the power of collaboration, innovation, and team work.

(A.S. Goel)

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Acknowledgement

India's coastline, stretching over 7,516 kilometers, is a vital asset nurturing rich ecosystems and millions of livelihoods. However, this dynamic environment faces significant challenges that threaten its ecological and economic sustainability. The intricate interplay between natural forces and human activities has resulted in pervasive issues such as coastal erosion and salinity ingress, jeopardizing both coastal communities and ecosystems. This report provides a comprehensive analysis of these pressing challenges, drawing insights from extensive research and data collected by various institutions, Maritime States/UTs etc

As we delve into the multifaceted nature of coastal erosion processes, we recognize alarming trends emerging from various studies that nearly one-third of India's coastline is experiencing erosion. The factors contributing to this phenomenon are complex and varied, encompassing natural elements like waves and currents, as well as human-induced actions such as infrastructure development and unsustainable land practices. Similarly, the issue of salinity ingress presents an invasive but silent threat to freshwater resources, significantly impacting agriculture, drinking water availability, and the delicate balance of coastal ecosystems. The threats and impacts may be entirely irreversible.

The Report advocates for a paradigm shift in coastal management strategies, urging a transition from reactive, localized approaches to integrated and proactive framework. By highlighting the importance of collaborative governance and the roles of various stakeholders—including government bodies, research institutions, and local communities—this report underscores the need for comprehensive management plans and sustainable funding mechanisms.

This analysis is intended to provide a comprehensive prognosis of issues plaguing maritime issues for presentation before policymakers, practitioners, and stakeholders about the urgent need for coordinated efforts to safeguard India’s coastal resources. Through enhanced data collection, innovative research, and community engagement, a path toward a resilient and sustainable future for our coastlines can be chartered.

I would like to personally thank drafting team of Coastal Management Directorate Shri. Deepak Kumar, Director, Shri Ashish Kumar Ranjan, Deputy Director and Shri. Vishnu V.V. Assistant Director for their commendable and exceptional effort in systematic analysis, and compilation of information and documentation.

(D.P. Mathuria)

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- **A&N Islands:** Andaman & Nicobar Islands
- **ADB:** Asian Development Bank
- **APCZMA:** Andhra Pradesh Coastal Zone Management Authority
- **AWS:** Automatic Weather Station
- **BEB:** Beach Erosion Board
- **CGWB:** Central Ground Water Board
- **CMIS:** Coastal Management Information System
- **CMP:** Coastal Management Plan
- **CPDAC:** Coastal Protection Development Advisory Committee
- **CRZ:** Coastal Regulation Zone
- **CSIR:** Council of Scientific and Industrial Research
- **CTD:** Conductivity, Temperature, and Depth (sensor)
- **CWC:** Central Water Commission
- **CWPRS:** Central Water and Power Research Station
- **CZMP:** Coastal Zone Management Plan
- **DOD:** Department of Ocean Development
- **DPR:** Detailed Project Report
- **DRCS:** Disaster Risk Reduction, Climate Change & Salinity Management
- **DWRB:** Directional Wave Rider Buoy
- **DWRIS:** Development of Water Resources Information System
- **DWLR:** Digital Water Level Recorders
- **EMCB:** Environment Management Capacity Building
- **EFC:** Expenditure Finance Committee –
- **FMBAP:** Flood Management & Border Areas Program
- **GIS:** Geographic Information System
- **GSI:** Geological Survey of India
- **GWRDC:** Gujarat Water Resources Development Corporation
- **ha:** Hectares
- **HED:** Harbour Engineering Department
- **ICMAM-PD:** Integrated Coastal and Marine Area Management
- **ICZMP:** Integrated Coastal Zone Management Plan
- **ICON:** Integrated Coastal Observation Network
- **IESWM:** Institute of Environmental Studies & Wetland Management
- **IHH:** Institute of Hydraulics and Hydrology
- **INCOIS:** Indian National Centre for Ocean Information Services
- **INHD:** Indian Naval Hydrographic Department
- **IRS:** Indian Remote Sensing
- **ISRO:** Indian Space Research Organisation
- **IT:** Information Technology
- **IIT:** Indian Institute of Technology
- **km:** Kilometers
- **KERS:** Karnataka Engineering Research Station

- **KGBO:** Krishna & Godavari Basin Organization
- **LISS:** Linear Imaging Self-Scanning Sensor
- **LISST:** Laser In-Situ Scattering and Transmissometry
- **ADCP:** Marine Acoustic Doppler Current Profiler
- **MERO:** Mahanadi & Eastern Rivers Organization
- **MFF:** Multi-tranche facility
- **MI & GWI:** Minor Irrigation & Ground Water Investigation
- **MMB:** Maharashtra Maritime Board
- **MoD:** Ministry of Defence
- **MoEF:** Ministry of Environment, Forest and Climate Change
- **MoES:** Ministry of Earth Sciences
- **MoJS:** Ministry of Jal Shakti
- **MoWR, RD & GR:** Ministry of Water Resources, River Development and Ganga Rejuvenation
- **MoU:** Memorandum of Understanding
- **MSO:** Mahanadi & Southern Rivers Organization
- **MTBO:** Mahi Tapi Basin Organization
- **NABARD:** National Bank for Agriculture and Rural Development
- **NAQUIM:** National Aquifer Mapping and Management
- **NCCR:** National Center for Coastal Research
- **NCESS:** National Center for Earth Sciences Studies
- **NCSCM:** National Centre for Sustainable Coastal Management
- **NCPP:** National Coastal Protection Project
- **NHO:** National Hydrographic Office
- **NIH:** National Institute of Hydrology
- **NIO:** National Institute of Oceanography
- **NIOT:** National Institute of Ocean Technology
- **PBTG:** Pressure Based Tide Gauge
- **PPTA:** Project Preparatory Technical Assistance
- **PWD:** Public Works Department
- **RIDF:** Rural Infrastructure Development Fund
- **RM:** River Management
- **RTK:** Real Time Kinematics
- **SAC:** Space Applications Centre
- **SCP&MIP:** Sustainable Coastal Protection and Management Investment Programme
- **SMP:** Shoreline Management Plan
- **SoI:** Survey of India
- **TAC:** Technical Advisory Committee
- **T&BDBO:** Teesta & Brahmaputra Damodar Basin Organization
- **UT:** Union Territory
- **WAPCOS:** Water and Power Consultancy Services
- **WRD:** Water Resources Department

List of Annexures

1. Introduction

1.1. General

India's coastline is richly endowed with natural resources. The country's 7,517-km* coastline is the territorial frontier of a resource-rich zone of immense economic activities, socio-cultural significance, and environmental importance encompassing 9 States (Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha & West Bengal) and 4 Union Territories (Daman & Diu, Lakshadweep, Puducherry and Andaman & Nicobar Islands). As per the census of 2011, nearly 15% of the national population was living within the coastal region and about 4.4 lakh people reside in the Island territories. Nearly 70 cities & towns are situated in these areas which includes some of the world's largest and most densely populated urban agglomerations—Mumbai, Kolkata, Chennai, Kochi, Visakhapatnam etc. A significant share of country's GDP comes from various economic activities viz. ports & harbours, industries, oil & gas industries, import based industries, fishing etc thus generating millions of employment opportunities. These ecosystems have home to mangroves, coral reefs, seagrasses, and seaweeds.

India, being one of the fastest growing economies of the world, fast-paced development is taking place in the coastal region too. These developmental activities along with increased human population have put tremendous pressure on the fragile coastal environment. A significant portion of India's coastline is under the relentless assault of sea erosion, causing widespread devastation. This erosion, varying in intensity across States and Union Territories, has caused a heavy toll on lives, properties, pristine beaches, and vital coastal ecosystems. Moreover, it jeopardizes critical infrastructure such as historic monuments, highways, and strategic installations, signaling a dire threat to India's coastal stability and environmental sustainability. While natural forces play a role, human activities exacerbate this coastal crisis, making urgent intervention imperative to preserve our coastal treasures for future generations. Further, as per the Climate Change Adaptation Guideline for Coastal Protection and Management in India, the climate change projections outlined by the Intergovernmental Panel on Climate Change (IPCC) in 2014 suggest global warming and an increase in mean global sea level. Sea level rise is expected to further heighten the coastal erosion, tidal inundation, and storm surges, thereby increasing the risk of local flooding.

Coastal erosion is more extensive and severe in some States/Union Territories, while in others, it is observed in varying intensities at isolated stretches. The maritime states and Union Territories have been implementing anti-sea erosion schemes depending on the severity of the problems faced by them. Considerable expenditure has been incurred and is increasing almost every year in protection measures, largely to handle emergency situations. In most cases, the protection works are planned, designed and executed in isolation with the sole aim of mitigating erosion at the given site. The localized planning and design process for shore protection has adversely affected the adjacent coasts.

* under revision

1.2. Coastal Features

1.2.1. Indian Coastal Zone

The Indian peninsula is bordered by the Arabian Sea in the west and south-west, Indian Ocean in the south and the Bay of Bengal in the east and south-east. India's mainland coastline spans from the south-west Indian coastline along the Arabian sea from the Gulf of Kutch in its westernmost corner and stretches across the Gulf of Khambhat, and through the Salsette Island of Mumbai along the Konkan and southwards across the Raigad region and through Kanara and further down through Mangalore and along the Malabar through Cape Comorin in the southernmost region of South India with coastline along the Indian Ocean and through the Coromandal Coast on the South Eastern Coastline of the Indian Subcontinent along the Bay of Bengal through the Utkala Kalinga region until the easternmost Corner of shoreline near the Sunderbans in Coastal East India.

Fig. 1 Coastal Zone of India

The Indian coast has seen significant tectonic changes, with the west coast's geomorphology differing from the east. While the east coast is primarily made up of the tectonically active East Coast Mobile Belt, much of the west coast is located in the stony Dharwar Craton composed of the deltaic formation found in the rivers of the Indian peninsula. The "Southern Granulite" portion of the Indian coastline is located south of the Dharwar Craton and is divided by the Bhavani-Palghat Mobile Belt. Additionally, the coastal region of Gujarat, along with the Rann of Katch, is said to represent the elevation of the shallow Arabian Sea.
The major characteristic of Indian Coast is as shown in Table 1.

Table 1 Characteristics of Indian Coastline

State	Coastal regions	Characteristic features of Coastline
Gujarat and Daman & Diu	Kachchh, Morvi, Jamnagar, Devbhoomi Dwarka, Porbandar, Junagadh, Gir Somnath, Amreli, Bhavnagar, Anand, Ahmedabad, Vadodara, Bharuch, Surat, Navsari, Valsad and Daman (Daman & Diu).	Gulf of Kachchh and Gulf of Khambat with extensive continental shelf area and shallow coast; sandy intertidal zone with vast stretches of muddy or sand stone areas.
Maharashtra	Palghra, Thane, Raigarh, Ratnagiri, Sindhudurg, Mumbai City, Mumbai Suburban	Rocky coastal belt broken by small bays, creeks and fringed with islands; no major rivers.
Karnataka and Goa	Goa, Uttar Kannada, Udupi, and Dakshin Kannada	Straight coastline broken at numerous places by rivers, rivulets, creeks and bays; northern part is rocky coast.
Kerala	Kasaragod, Kannur, Kozikhode, Mallappuram, Ernakulam, Kollam, Thrissur, Alappuzha, and Thiruvananthapuram	Chain of brackish water lagoons and backwaters parallel to the coast, beaches and estuaries.
Tamil Nadu and Puducherry	Tiruvallur, Kancheepuram, Vilupuram, Puducherry (Karaikal), Cuddalore, Nagapattinam, Thanjavur, Thiruvarur, Pudukkottai, Ramanathapuram, Tuticorin, Tirunelveli, and Kanyakumari.	Narrow belt of sand dunes, low lying beach, plains mostly formed by rivers.
Andhra Pradesh	Srikakulam, Vizianagaram, Vishakhapatnam, East Godavari, West Godavari, Krishna, Guntur, Prakasam and Nellore	Coast line is smooth with inundations; deltaic coast of Krishna and Godavari, marshy muddy coasts.
Odisha	Baleshwar, Bhadrak, Kendrapara, Jagatsinghpur, Puri, Khordha and Ganjam	Coast is depositional, formed by Mahanadi, Brahmani and Baitarani delta.
West Bengal	North 24 Parganas, South 24 Parganas Haora, Purba Medinipur	Ganga and Brahmaputra river systems create large intertidal, deltaic mass. Hooghly mouth is uneven formed by massive sedimentation, coast sand riffed with numerous tidal creeks & estuaries.

1.2.2. West Coast of India

The Western Coastline of India stretches from Gujarat in the north and runs through Maharashtra, Goa, Karnataka, and Kerala. It can be segmented into two distinct regions: the Konkan and the Malabar Coast. The majority of the region's rivers originate from the Western Ghats and flow swiftly. Prominent rivers such as the Tapi, Narmada, Mandovi, and Zuari discharge into the Arabian Sea. Moreover, numerous smaller rivers carry substantial sediment loads to the west coast. However, the prevailing wave conditions hinder sediment settling, resulting in unfavorable conditions for delta formation. Beach morphology along the west coast is primarily influenced by the southwest monsoon, with the most significant alterations occurring during the early monsoon season. Additionally, seasonal upwelling along the west coast facilitates the exchange of temperature and nutrients between surface and subsurface water layers, leading to higher productivity rates compared to the east coast (Bay of Bengal), which experiences limited vertical mixing.

(i) Gujarat

Gujarat boasts the largest coastal area in the country, spanning approximately 28,500 sq. km and having length of 2340.62 kms which is approximately one third of total coastline of mainland India. Two gulfs, Gulf of Kachchh and Gulf of Khambhat covers 60% of coastline in Gujarat. The coastal landscape in Gujarat showcases a diverse range of features, transitioning from a deltaic coast in the west to an irregular drowned programed coast, a straightened coast, a complex of spits and cuspate forelands, and finally to a mudflat coast in the east. This coastline is further categorized into five distinct regions, proceeding from west to east: the Rann of Kutch, the Gulf of Kachchh, the Saurashtra coast, the Gulf of Khambat, and the South Gujarat coast, based on their specific coastal geomorphological characteristics. The Gulf of Kachchh area is characterized by extensive mudflats and numerous cliffed rocky islands, while the Rann of Kutch remains a saline desert for most of the year. Coral reefs and mangroves fringe the coastline. Moving along the Saurashtra coast, one encounters a multitude of cliffs, islands, tidal flats, estuaries, embankments, sandy beaches, dunes, spits, bars, bays, marshes, and raised beaches. The Gulf of Khambat is marked by inundation from estuaries and consists predominantly of mudflats. As for the southern Gujarat coast, it is distinguished by numerous creeks, estuaries, marshes, and mudflats, presenting a relatively uniform appearance. From the Great Rann to the southern Gujarat coast, evidence of both emergent and submerged coasts can be observed along the Gujarat coastline.

Gujarat Coastline is having a diversity of habitats, especially mangroves, salt marshes, coral reefs, wetlands, and sea grasses. The Gulf of Kachchh is home to coral reefs and India's first marine national park. Gujarat's coastline supports a large human population that is dependent on the rich coastal and marine resources and ecosystem services, which play a significant role in economic growth. The Gulf of Kachchh situated on the west coast of Gujarat. The Gulf of Kachchh is also known as the 'Gulf of Rich' due to the economic activities in this region. These activities and resources provide significant benefits to the coastal communities in terms of fisheries and tourism and supports their livelihoods. Further, ecosystem degradation and destruction are taking place due to conversion of habitats to other forms of land use, overexploitation of species and associated destructive harvesting practices, the spread of invasive alien species and the impacts of agricultural, domestic and industrial sewage and waste. Additionally, climate change is likely to have a growing impact on the coastal and marine ecosystems, including an increase in extreme weather events, a sea level rise, warming of sea surface temperatures and ocean acidification. Accordingly, there is a vital need to address the concerns due to coastal erosion & also salinity ingress.

(ii) Maharashtra

The Maharashtra coastline stretches along the Sahyadri mountain range, also known as the Western Ghats. Several major rivers, including the Dudh, Vaitarna, Ulhas, Amba, Kundalika, Vashishthi, and Savitri originate in the Western Ghats and drain westward into the Arabian Sea. The Maharashtra coastal region is characterized by its hilly and narrow terrain, marked by transverse ridges extending from the Western Ghats. These ridges frequently project into the sea, forming prominent headlands. The coastline features pocket beaches nestled between rocky cliffs composed of Deccan basalt, along with estuaries and pockets of mangroves. The beaches are typically small and crescent-shaped, often flanked by headlands, though longer and linear beaches are also present, particularly near estuaries and bays where mudflats exist. Mangrove vegetation is primarily concentrated in the intertidal regions of these estuaries and creeks.

Maharashtra coastal area is significant for its natural beauty, biodiversity, and historical importance, making it vital for tourism, which is a major economic activity. The coastal zones support rich marine biodiversity of the Arabian Sea essential for the fishing industry and thus providing livelihoods for local communities. Apart from tourism & fishing, these beaches have many historical & heritage sites. Agriculture, especially in Palghar district, is notable for products like Chiku (sapodilla), which supports local farmers. Additionally, the unique tribal customs, dances, and crafts, particularly in Palghar, contribute to cultural tourism and economic diversity, enriching the overall economic landscape of these coastal regions.

(iii) Goa

Goa, the smallest maritime state in India, is located along the Central West Coast of India. Goa's coastline is predominantly cliffy, comprising Deccan basalts in the north and granite gneisses in the south. Renowned for its beaches, Goa's coastal plains feature a diverse landscape, including sandy beaches, sea cliffs, promontories, estuaries, spits, sand dunes, wave-cut platforms, and wooded or bare hill slopes, which are dissected by rivers such as the Terekhol, Chapora, Mandovi, and Zuari. Northern Goa is characterized by long, linear, and wide beaches, while the southern coast has rocky cliffs.

Beach tourism is a main attraction for Goa providing livelihoods for many coastal inhabitants. Goa has a population of about 15 lakh with a significant portion concentrated in coastal talukas and a large floating population approx. 50 lakh per year, which is ever increasing. However, erosion along the coastline, especially during monsoon, has been noticed in recent years despite having long coastline has created concerns about the future of beach tourism and tourism-based livelihoods.

(iv) Karnataka

The Karnataka coast, stretching along the Arabian Sea, features diverse landscapes including rocky headlands in the north and long linear beaches in the south. This coastline encompasses unique coastal geomorphic features such as beaches, estuaries, shallow lagoons, mudflats, and mangroves. Notable features include shallow lagoons near Coondapur and the Kalinadi, and rocky coastlines from Ankola to Karwar. The coastline is divided into two sectors: the northern sector, predominantly rocky, covering Uttara Kannada, and the southern sector, more dynamic, encompassing Udupi and Dakshina Kannada. This coastal region is renowned for its natural beauty, cultural richness, and historical significance. Modern urban centers like Mangalore and Karwar blend seamlessly with traditional fishing villages and heritage sites, while popular destinations such as Gokarna, Udupi, and Murudeshwar attract both domestic and international tourists, significantly contributing to Karnataka's vibrant tourism industry.

Various economic activities in the coastal area of Karnataka, fishing and aquaculture are major sources of livelihood, employment and food security for coastal communities. Ports such as Mangalore and Karwar facilitate maritime trade, enhancing Karnataka's connectivity with global markets. Investments in port infrastructure and logistics have bolstered economic growth and attracted international investments. Furthermore, the region's potential for renewable energy sources like wind, solar, and tidal power presents opportunities for sustainable development and reduced dependency on fossil fuels. Initiatives in marine biotechnology, seaweed cultivation, and ocean-based renewable energy are fostering innovation and creating new economic avenues while promoting environmental sustainability through the concept of the blue economy. However, beach erosion poses a significant challenge in certain sections along this stretch.

(v) Kerala

Kerala's coastline, stretching from Kasargod to Thiruvananthapuram, is a rich tapestry of landscapes including beaches, cliffs, islands, estuaries, and deltas. Sand ridges, extensive lagoons, and the presence of around 700 landlocked islands signify the dynamic nature of this coast. The state is endowed with 44 rivers originating predominantly from the Western Ghats, contributing to its lush biodiversity and fertile plains. The Kerala Backwaters, an interconnected system of brackish water lakes and estuaries, further enhance the ecological diversity of the region. Waves predominantly approach from the southwest, resulting in northerly littoral drift during monsoons, albeit at varying speeds. Certain sections of the Kerala coast are renowned for their abundant heavy-mineral deposits. The coastline is segmented into three sectors based on district boundaries: a) Northern Sector encompassing Kasaragod, Kannur, and Kozhikode districts experiencing both erosion and accretion, with notable changes at river mouths like Chittari and Valapattanam. Erosion hotspots include areas north of the Mogral River and Kottikulam. b) Central Sector covers Malappuram, Thrissur, and Ernakulam districts. The sector is facing erosion and accretion along the coast, particularly between the Bharathapuzha and Periyar rivers, with severe erosion in Ponnani and Putiyirutti. c) Southern Sector encompassing Alappuzha, Kollam, and Thiruvananthapuram districts is plagued with notable erosion at locations such as Panmana, Nirkunnam, and Purakkad. The construction of coastal breakwaters near Kottamkulangara has influenced erosion and accretion dynamics.

The coastal areas of Kerala are vibrant hubs of diverse economic activities, primarily centered on fisheries and tourism. Fishing communities rely heavily on coastal resources for their sustenance, significantly contributing to the state's economy. Tourism also thrives on the picturesque beaches, vibrant marine life, and rich cultural heritage of these regions, attracting both domestic and international visitors. However, the area faces challenges such as erosion and accretion, which threaten the stability of coastal ecosystems and livelihoods.

1.2.3. East Coast of India

The Coastal Plain in the eastern part of the country spans a wide expanse of land nestled between the Eastern Ghats and India's oceanic boundary. It extends from Tamil Nadu in the south to West Bengal in the east. Major rivers such as the Ganges, Mahanadi, Godavari, Cauvery, and Krishna irrigate its plains, which typically range in width from 100 to 130 km. While the larger rivers boast well-developed deltas and estuarine systems, nearly all smaller rivers feature estuarine mouths characterized by extensive mudflats, saltmarshes, and some even harbor estuarine islands. This region experiences rainfall from both the northeast and southwest monsoons, with annual precipitation averaging between 1,000 and 3,000 mm.

(i) Tamil Nadu

Tamil Nadu, located on the southern part of the Indian peninsula, exhibits a variety of coastal ecosystems, **including** mangroves, corals, and sand dunes. The state's coastline is shaped by dynamic coastal processes, creating diverse geomorphological features. The region hosts a rich biodiversity, supported by numerous rivers draining into the coastline. Mangrove systems such as Pichavaram and Muthupet are present at some locations, along with fringing and patchy reefs in the Gulf of Mannar and Palk Bay areas. Different sectors i.e. Southern coastline area, Gulf of Mannar and Palk Strait Sector, Cauvery Deltaic Plain Sector and Northern Sector faces significant erosion and accretion. Given its geographical location, the coast is vulnerable to severe cyclones, storm surges, and was notably impacted by the tsunami in 2004.

Tamil Nadu's coastal areas support diverse economic activities, primarily centered around fisheries and tourism. The rich biodiversity and numerous rivers draining into the coastline support vibrant ecosystems, which are crucial for the livelihoods of fishing communities. These communities rely heavily on coastal resources, significantly contributing to the local economy. The beauty of Tamil Nadu's beaches, along with its rich cultural heritage, attracts droves of tourists, further boosting the state's economy. However, challenges such as erosion and accretion pose threats to the stability of these coastal ecosystems and the livelihoods of coastal communities. Comprehensive coastal management strategies are necessary to combat this erosion problem.

(ii) Andhra Pradesh

The Andhra Pradesh coast, located on the eastern coast of India facing the Bay of Bengal. The extensive coastline is distributed among twelve coastal districts and is characterized by a variety of coastal features such as spits, wide beaches, mangroves, mudflats, bars, barriers, lagoons, sand dunes, and salt pans. The islands situated in the Krishna delta are mostly intertidal and submerged to a large extent during springtide. Prominent rivers, the Krishna and the Godavari, form large deltaic regions with extensive mangrove forests. Sediments carried by the Godavari

River have contributed to the formation of a sand spit known as Hope Island, which serves as a natural barrier protecting the city of Kakinada from storms and also offers a natural harbor due to the presence of Kakinada Bay. The Pulicat lagoon, situated at the southeastern end of Andhra Pradesh, is the second largest lagoon in India. The Andhra Pradesh coastline can be divided into three sectors based on coastal features and district boundaries: a) Southern Sector: Comprising Nellore and Prakasam districts, this sector features diverse coastal landscapes. b) Central Sector: Encompassing the Krishna and Godavari deltas, this sector includes the districts of Guntur, Krishna, West Godavari, and East Godavari. These deltas are notable for their large mangrove forests and rich biodiversity. c) Northern Sector: Covering the shoreline along Visakhapatnam, Vizianagaram, and Srikakulam districts, this sector is known for its unique coastal formations and ecosystems.

The Andhra Pradesh coast supports a variety of economic activities that are vital to the state's economy. Key economic activities include fisheries, with the extensive coastline and rich marine biodiversity providing ample opportunities for fishing, which is a major livelihood for coastal communities. The fertile plains of the Krishna and Godavari deltas support extensive agricultural activities, contributing significantly to the state's food production. The presence of salt pans along the coast facilitates salt production, which is an important economic activity in the region. Scenic beaches, mangrove forests, and unique coastal formations attract tourists, boosting the local economy through tourism-related activities. Additionally, the presence of major ports such as Visakhapatnam supports trade and commerce, playing a crucial role in the economic development of the region.

(iii) Odisha

Odisha is geographically positioned in eastern India, bordered by the Bay of Bengal to the east. The state boasts a coastline which is heavily influenced by numerous rivers such as the Mahanadi, Brahmani, Baitarani, Devi, Budhabalanga, Subarnarekha, and Rushikulya. These rivers carry significant sediment loads, contributing to the formation of extensive deltas. The Odisha coast is continually shaped by freshwater inflows and delta-building processes. The coastline runs obliquely to the global wind system, generating strong littoral currents, making it one of the largest littoral drift areas in the world. In the northern region of Odisha, particularly north of Dhamra, tidal ranges increase while wave energy decreases, leading to the formation of mudflats. The Chilika Lagoon, a prominent brackish water coastal feature, has formed due to the growth of a barrier spit from Paluru. Other notable coastal features of Odisha include extensive mangroves, estuaries, and diverse sedimentary and sandy environments such as sand dunes. Given its geographical characteristics, the Orissa coast is susceptible to severe cyclones and storm surges.

The coastal regions of Odisha support diverse economic activities, including fishing, aquaculture, and agriculture, which are crucial for the local economy. Odisha is endowed with rich natural resources, including iron ore, bauxite, chromite, manganese, and coal, further driving industrial activities. The economy of Odisha has been undergoing a significant transformation from being predominantly agriculture-based to being driven by services and industries. Additionally, the state's natural attractions such as Similipal National Park, Chilika Lake, Bhitarkanika Wildlife Sanctuary, and extensive mangrove forests promote eco-tourism, enhancing the economic landscape of the coastal areas. With 11% of India's water resources, Odisha's coastal regions are well-supported for agricultural and allied activities, contributing significantly to the state's economic profile.

(iv) West Bengal

The Hooghly River and its distributaries form a prominent drainage system, shaping an estuarine typical deltaic flat plain. This region's major geomorphic features include mudflats, bars, shoals, beach ridges, estuaries, a network of creeks, paleo-mudflats, coastal dunes, and islands. The Bengal Fan, also referred to as the Ganges Fan, stands as the largest submarine fan globally. Predominantly, sediment is sourced from the Ganges and Brahmaputra rivers, nourishing both the Lower Meghna delta in Bangladesh and the Hooghly estuary in West Bengal, India. Additionally, several other sizable rivers in both Bangladesh and India contribute smaller sediment loads. Turbidity currents transport these sediments through a network of submarine canyons, some exceeding lengths of 1,500 miles (2,414 km), ultimately depositing them in the Bay of Bengal. The West Bengal coast extends along the land-sea boundary of the Purba Medinipur district resulting into high saline seawater influence. This area also features the cuspate delta of the Subarnarekha River. The coast in this region is largely inhabited and cultivated. The Sundarban area, which forms the largest single block of tidal halophytic mangroves in the world, is fed by numerous rivers that create a network of creeks. These creeks are affected by daily tides, and many small sandy islands and mudflats mark the river channels and the coast. Most of these islands and mudflats are completely inundated during high tide. The West Bengal coast is susceptible to severe cyclones and storm surges.

The coastal areas of West Bengal are hubs for diverse economic activities, including fisheries, where fishing communities rely on coastal resources for sustenance, significantly contributing to the state's economy; aquaculture and salt pans, particularly in the Purba Medinipur district; and tourism, which thrives on the beaches of West Midnapore and the region's cultural heritage, attracting both domestic and international visitors to unique coastal landscapes like the Sundarbans and scenic beaches.

1.2.4. Islands

Islands are formed by geological processes such as changes in sea level, volcanic eruptions, and coral building. The major offshore islands in the country include the Andaman and Nicobar Islands and the Lakshadweep Islands. Despite being narrow, these islands feature bays, lagoons, creeks, and reefs.

(i) Lakshadweep Islands

The Lakshadweep Islands are a group of coral islands located in the Arabian Sea, situated between 200 to 470 kilometers off the coast of Kerala, India. This archipelago consists of approximately 36 islands, with only 10 of them inhabited. A distinctive feature of the Lakshadweep Islands is the presence of well-developed coral reefs, specifically atolls. Atolls are ring-shaped coral formations that often enclose lagoons and are typically topped by low-lying sand islands. These atolls contribute to the formation of sandy beaches that are characteristic of the coasts of all the islands in the Lakshadweep group. Shoreline change analysis, focusing on erosion and accretion patterns, has been conducted along 141 km of the Lakshadweep Islands' coastline.

(ii) Andaman and Nicobar Islands

The Andaman and Nicobar Islands form an archipelago in the Bay of Bengal and consist of over 350 islands. Geographically, they represent the visible peaks of a submerged mountain range that stretches southward from Myanmar's Irrawady delta region. The Andaman group and the Nicobar group, separated by the Ten Degree Channel, constitute this archipelago. A notable characteristic of the Andaman and Nicobar Islands is the abundance of small tidal estuaries, long inlets, and lagoons. These coastal features provide a habitat for a diverse range of mangrove flora, contributing to the islands having approximately 18% of India's total mangrove forest cover.

1.2.5. Coastal Length of India

Coastal length is one of the basic maritime parameters to gauge the extent of problem of the coastal erosion. However, there is subjectivity in determining the coastal length because of dynamic nature of coast and confluences of the river and tidal inlets. As of now the total coastal length of India is 7516.6 Km as per the measurement done in 1970. India’s mainland has a coastline of 5422.6 km and A&N and Lakshadweep islands have total coastline of 2094 km together. In the wake of methodological changes based on Survey of India maps, Coastal Protection and Development Advisory Committee (CPDAC), headed by Member (RM), CWC in its 11th meeting asked NHO, Dehradun for re-evaluation of the coastal length. Accordingly, comprehensive exercise for re-evaluating the coastal length was taken up by NHO, Dehradun by closing the river mouth and treating offline islands as separate entity. While evaluating length of coast line, the mouths of creeks were closed along the general direction of the coast. The state boundaries were extracted from available information at NHO. The coastline length has, now, been computed by NHO as 11,098.81 km. The main reason for change in coastline length is scale of measurement, inclusion of lengths of offshore islands, closing of river mouths, inclusion of harbour or port infrastructure, removal of manmade structures viz. Jetty etc. This length of coastline has also been agreed by National Security Council Secretariat (NSCS). NSCS, further, asked SoI to promulgate the revise coastal length of India.The comparative State-wise Coastline as assessed vis-à-vis earlier Coastline is as shown in Table 2.

Table 2 comparative State-wise Coastline as assessed vis-à-vis earlier Coastline

S.No.	State/UT	Earlier Coastline (in km)	Re-verified Coast Length (in km)
i)	Gujarat	1214.70	2340.62
ii)	Maharashtra	652.60	877.97
iii)	Karnataka	280.00	343.30
iv)	Kerala	569.70	600.15
v)	Tamil Nadu	906.90	1068.69
vi)	Andhra Pradesh	973.70	1053.07
vii)	Odisha	476.40	574.71
viii)	West Bengal	157.50	721.02
ix)	Goa	160.50	193.95
x)	Daman & Diu		54.38
xi)	Puducherry	30.60	42.65
xii)	A & N Islands	1962.00	3083.50
xiii)	Lakshadweep Islands	132.00	144.80
Total Coastline length of India (in km)		**7516.60**	**11098.81**

2. Overview on Coastal Erosion/ Salinity Ingression

2.1. Shoreline Change

2.1.1. Space Applications Centre

The coastal region, due to the influence of natural and anthropogenic forces and the sporadic events like cyclones undergo severe erosions. Quantifying coastal change is essential for calculating trends in erosion, evaluating processes that shape coastal landscapes and predicting the response of coast to future storms and sea level rise. The dynamic natures of the coast prompt for frequent monitoring and comprehending the coastal erosion activities. Planning measures for sustainable development along the coastal region require a systematic inventory of shoreline changes. Space technology has been effectively deployed in identification and measurement of such activities. Based on recommendation of CPDAC, Space Applications Centre (SAC), ISRO, Ahmedabad, has prepared Shoreline Change Atlas of India for time frames of 2004-06 and 2014-16 at 1:25,000 scale using IRS LISS IV data. The atlas also shows location and type of coastal protection measures taken up by maritime states and UTs based on the data provided.

Covering 7549 km of the Indian coastline, the maps suggest that about 1144 km is under erosion, 1084 km is under accretion and 5321 km of the coastline has been observed showing no change. The Indian coastal region has in total lost around 3680 ha of land due to erosion whereas around 4042 ha of area have been gained due to accretion. West Bengal coast is having around 35 percentage of its coast under erosion, which is the largest among the Indian coastal state and percentage of shoreline under accretion is the largest for Andhra Pradesh state (26%). Percentage of stable coast is largest along the Gujarat coast (87%) followed by the Lakshadweep Islands (82%), while more than 57% of the West Bengal coast is under either erosion or accretion. A long coastal stretch to the northern Andhra Pradesh coast is eroding whereas a long coastal stretch along the Saurashtra coast of Gujarat is stable in nature. State-wise erosion, accretion and stable length of coastline assessed by SAC is given in the Table 3.

Table 3 State-wise erosion, accretion and stable length of coastline assessed by SAC

S. No.	State/UT	Coastline (in km)	Erosion		Accretion		Stable	
			Km	%	Km	%	Km	%
i)	Gujarat, Daman & Diu	1210.40	109.70	9.06	49.20	4.06	1051.50	86.88
ii)	Maharashtra	724.07	75.10	10.37	60.20	8.31	588.60	81.32
iii)	Karnataka	318.80	40.20	12.61	47.70	14.96	230.90	72.43
iv)	Kerala	585.63	137.33	23.45	121.13	20.68	327.17	55.87
v)	Tamil Nadu & Puducherry	849.07	128.90	15.18	188.60	22.21	531.60	62.61
vi)	Andhra Pradesh	810.40	188.90	23.31	208.20	25.69	413.30	51.00
vii)	Odisha	450.50	143.60	31.87	98.80	21.93	208.20	46.20

viii)	West Bengal	157.40	56.30	35.77	33.90	21.54	67.20	42.69
ix)	Goa	145.50	21.70	14.91	7.10	4.88	116.70	80.21
x)	A & N Islands	2156.80	230.70	10.70	256.40	11.89	1669.70	77.41
xi)	Lakshadweep Islands	140.60	11.70	8.32	13.20	9.39	115.80	82.29
Total		**7549.17**	**1144.13**	**15.15**	**1084.43**	**14.36**	**5320.67**	**70.48**

2.1.2. National Centre for Coastal Research

Considering the need for resolute coastal processes and shoreline management the National Centre for Coastal Research (NCCR), Chennai an attached office of the Ministry of Earth Sciences, is engaged in mapping the shoreline changes along the Indian coast to enhance the country's preparedness to face coastal hazards like storm surges, tsunami, etc. and to guide towards sustainable coastal development. Under its National Shoreline Assessment System (N-SAS), NCCR has published *National Assessment of Shoreline Changes along Indian Coast* in March, 2022. This report on shoreline changes has been prepared for the period 1990 to 2018 (28 years), using 11 shoreline data sets, i.e. the years 1990, 2000, 2006, 2008, 2012, 2013, 2014, 2015, 2016, 2017 and 2018. It provides details of shoreline changes, 3 types of map, shoreline vulnerability for erosion/accretion, land loss/gain, etc. for the entire mainland coast of India. These maps will be available online for each of the coastal states/UT on the NCCR's website.

In this report, about 6907.18 km long shoreline (in 1:25000 scale) distributed among nine coastal states and two union territories was analysed for the period 1990-2018 to estimate the shoreline change i.e., erosion, accretion and stable. Shoreline length used in the analysis is the shore face length (excluding the interior parts of river/creeks) obtained from Resourcesat-2, LISS-IV satellite data (by zooming in 1:15000 scales). The shoreline analysis suggests that 33.6% of coast is eroding, 26.9% is accreting and 38% is in stable state (Table 4).

Table 4 Summary of shoreline changes along the Indian coast

State		Coast Length (in km)	Coast length (in Km)					
			Erosion		Stable		Accretion	
			Km	%	Km	%	Km	%
West Coast	Gujarat	1945.6	537.5	27.6	1030.9	53.0	377.2	19.4
	Daman & Diu	31.83	11.02	34.6	17.09	53.7	3.72	11.7
	Maharashtra	739.57	188.26	25.5	477.69	64.6	73.62	10.0
	Goa	139.64	26.82	19.2	93.72	67.1	19.1	13.7
	Karnataka	313.02	74.34	23.7	156.78	50.1	81.9	26.2
	Kerala	592.96	275.33	46.4	182.64	30.8	134.99	22.8
East Coast	Tamil Nadu	991.47	422.94	42.7	332.69	33.6	235.85	23.8
	Puducherry	41.66	23.42	56.2	13.82	33.2	4.42	10.6
	Andhra Pradesh	1027.58	294.89	28.7	223.36	21.7	509.33	49.6
	Odisha	549.5	140.72	25.6	128.77	23.4	280.02	51.0
	West Bengal	534.35	323.07	60.5	76.4	14.3	134.88	25.2
		6907.18	2318.31		2733.86		1855.03	
			33.6		39.6		26.9	

The state-wise analysis suggests that in the West Bengal (60.5%) and Pondicherry (56.2%) coastal area, erosion exceeds more that 50%, followed by Kerala (46.4%) and Tamil Nadu (42.7%). Odisha (51%) is the only coastal state, which is having more that 50% of accretion, followed by Andhra Pradesh with 49.6%. Apart from Kerala coast, the remaining west coast of India falls in stable condition.

2.2. Coastal Erosion/Accretion

A coastline is a complex series of interlinked physical systems in which both offshore and onshore processes are involved. Coastal Erosion is one of these physical processes, wearing away and redistributing solid elements of the shoreline as well as sediment, normally by such natural forces as waves, tidal and littoral currents and deflation. Erosion occurs when material being removed, for deposition elsewhere, exceeds the rate of supply finally resulting in the landward shifting of the shoreline. The coastal sediments, together with those arising from inland erosion and transported seaward by rivers, are redistributed along the coast, providing material for dunes, beaches, marshes and reefs. Various developmental projects are made in coastal areas, placing great pressure on it, leading to diverse coastal hazards like soil erosion, sea water intrusion, coral bleaching, shoreline change; etc. The sand can be moved to another beach, to the deeper ocean bottom, into an ocean trench or onto the landside of a dune.

The causes of erosion are either natural or man-made. Sometimes, it is a combination of both the natural and man-made factors. While the former is a relentless process which is often impossible to resist, the latter is often due to ill-planned activities and can certainly be contained, or even reversed. Effects of climate change, sea level rise and other long-term causes for the erosion are still unaccounted for.

2.2.1. Natural Reasons

Natural factors influencing coastal erosion are wave, winds, tides, near-shore currents, storms, sea level rise etc. The combined action of different processes on the coastline like waves and tides maintain the stability of the shoreline. If, for any reason, the sediment supply to a section of beach is reduced due to littoral drift/sea level rise or constant impact of waves, it can cause severe erosion.

a. **Wave Action and Tidal Forces:** Waves are the main cause of coastal erosion. Wave takes birth in the mid ocean and moves towards the coast thus bringing an enormous amount of energy to the coast that is dissipated through wave breaking, generation of currents, water level changes, and movement of sediment, turbulence and heat. Waves are the major factor in determining the geometry and composition of the beaches. The action of waves dictates the processes of removal and addition of material/sediment on the coast. The two processes of accretion and erosion play a major role in defining the coastal geography. The shoreline changes induced by coastal erosion and accretion are natural processes that take place over a range of time scales.
b. **Sea-Level Rise:** An increasing sea level will promote shoreline setback. This setback is higher in the littoral coasts, consisting of finer sediments, as compared to coasts consisting of coarser sediments. Rising sea levels increase the frequency and intensity of high tides and storm surges, leading to the gradual erosion of coastlines.

c. **Storms and Cyclones:** Catastrophic events like severe storms, tidal surges and cyclones cause the sea level to rise to abnormal heights and cause severe erosion. The sudden and furious rush of water causes the bars to move seawards. The high surge also causes an offshore movement of sand due to non-equilibrium in the profile.
d. **River Sediment Supply:** Rivers that carry sediment to the coast play a crucial role in maintaining beaches and deltas. When sediment supply is reduced due to upstream dams or river channelization, the coastline becomes more susceptible to erosion.

2.2.2. Man-induced erosion

Most of the human induced erosion is due to human interventions in the natural transportation process as well as in the sediment load of the rivers. Human activity may be enumerated as Coastal defense structures, river regulation works, dredging aggregate extraction/ sand mining, oil/gas exploration (in the form of long-term subsidence), ports/harbours that impacts sediment transport.

Coastal activities can also directly or indirectly result in beach erosion. The following are some examples:

- Building houses via land reclamation or within sand dune areas has a long-term impact on coastal processes and the sediment stability.
- Harbors, meant to provide safe mooring and navigation for the calling vessels, often have shore-perpendicular/inclined solid quays and breakwaters, which obstruct the long shore transport of sand and cause accretion on the up drift side, and erosion down drift.
- Sand removal above replenishable quantities from the coast upsets the long shore sand transport budget and can result in erosion down drift.
- Groynes and jetties and other structures on the coast/shoreline interfere with long shore sand transport and can result in erosion when these are ill-designed. Groynes protect a part of the shoreline by blocking littoral transport by accumulation of the littoral sediments on the upstream side of the groynes. This causes a deficit in the littoral drift budget and this has negative consequences on the downstream as the erosion problem shifts to the downstream area.
- Structures like Seawalls, bulkheads and breakwaters etc. have side effects in terms of erosion of adjacent areas. The protective structures like sea walls lead to enhanced erosion at the end of the structure generate scouring at the toe of seawall and shorten the beach face.
- The mining of sand/gravel along beaches and in the surf-zone will cause erosion by depleting the shore of its sediment resources.
- The maintenance Dredging of harbours, navigational channels and tidal inlets causes loss of sand from the littoral zone and the sand is dumped into the deep sea. This disturbs the dynamic sediment equilibrium of the coast and promotes erosion to re-establish the equilibrium.
- Coral mining and other means of spoiling the protective coral reefs will also cause coastal erosion and beach degradation. The production of carbonate sand stops due to killing of the corals and the protective function of the reef disappears.

- Vegetation is important for maintaining/improving the sediment slope stability and consolidating the sediments by trapping the sediments. The removal of dune vegetation and mangroves due to man interventions causes exposure of the low-energy shorelines to the increased energy and reduced sediment stability. This further promotes erosion of coastal zone.

In most of the cases, coastal erosion would be attributed to cumulative effect of the both natural and human-induced factors.

- Excessive groundwater extraction in coastal areas can lead to land subsidence, where the ground sinks as water is withdrawn. This can exacerbate erosion by lowering the elevation of the land relative to the sea.
- The phenomenon of Climate Change has recently emerged as an important determinant in the coastal environment. The phenomenon of Climate Change is not new to the scientific and research community. An overwhelming scientific and research consensus maintains that climate change is real. Climate change affects coastal erosion through more intense storms, altered rainfall patterns, and ocean acidification. These changes can accelerate erosion and damage coastal ecosystems that help protect the shore.

Coasts are sensitive to sea level rise, changes in the frequency and intensity of storms, increases in precipitation, and warmer ocean temperatures. In addition, rising atmospheric concentrations of carbon dioxide (CO_2) are causing the oceans to absorb more of the gas and become more acidic. This rising acidity can have significant impacts on coastal and marine ecosystems. The low-lying areas along the coast are likely to be prone to salinization due to sea water intrusion (surface and ground).

The extent of the coast undergoing erosion is rapidly increasing. According to a recently completed study by the National Centre for Sustainable Coastal Management (NCSCM), almost 40 percent of the Indian coast is subject to coastal erosion. This figure is much higher than earlier estimates.

Fig. 2 Damage due to coastal erosion

2.3.Coastal Protection Measures

Coastal protection measures moderate the long-term average erosion rate of shoreline change from natural or man-made causes. Nature not only erodes but also protects. Protection of coastline from erosion is provided by nature in the form of a stable beach, capable of dissipating incident wave energy.

Protection works to prevent erosion should be on long-term basis and must be planned to suit the particular site conditions on the basis of thorough field investigation and available data which obviously require observations over an extended period of time. However, before any measures to protect the coast is implemented, Shoreline Management Plan (SMP) should be first prepared. However, where urgent steps are imperative to stem the onslaught of erosion and to prevent serious damages immediately, short-term measures will become necessary relying on the design and performance of the structures existing elsewhere.

The measures to control erosion include non-structural and structural or their combination. A combination of hard and soft options has become more popular recently for optimum results because they have weaknesses when used singularly. Many schemes have failed and resulted in environmental and socio-economic problems owing to improper design, construction and maintenance, and were often only implemented locally in specific places or at regional or jurisdictional boundaries, rather than at system boundaries that reflect natural processes.

Brief description of these measures is given below.

2.3.1. Non-structural measures

The Non-structural measures aim at dissipation of the wave energy by mirroring the natural forces and maintaining the natural topography of the coast.
These measures are also called soft solutions. Some of these are:

- Artificial nourishment of beaches
- Coastal vegetation such as mangrove and Palm plantation
- Sand bypassing at tidal inlets
- Dune reconstruction/rehabilitation

Fig. 3 (a) Artificial nourishment of beaches (b) Coastal vegetation such as mangrove and Palm plantation (c) Sand bypassing at tidal inlets (d) Dune reconstruction/rehabilitation

Before opting for the hard structures, non-structural measures like adaptation to natural coastal processes (by using large setback distances, relocating vital structures etc) and moderation of coastal erosion (by stabilizing coastal slopes, tripping the waves etc) should be used.

These measures have limitations. While artificial nourishment of beaches is complicated and costly, mangrove plantation is possible only in marshy land and in semi-tropical or tropical conditions.

2.3.2. Structural Measures

The structural measures, also known as the hard structural/engineering measures use physical structures constructed near the coast to prevent or restrict water from reaching the potential damage areas. These solutions influence the coastal processes to stop/reduce the rate of coastal erosion.

The Structural measures used for coastal erosion prevention are as follows:

- Seawall
- Revetment
- Off-shore breakwater
- Groins/groynes/spurs
- Offshore-Reefs

Out of the above measures, Seawall is popular and generally used in almost all maritime States in varying proportions.

Fig. 4 Various Structural coatal protecton measures (a)Sea Wall (b) Groyne field (c) Off shore breakwater (d) Artificial headland

2.3.3. Combination of the Structural and Non-Structural Measures:

It has already been stated that using a combination of the structural and non-structural measures helps in providing better efficacy and efficiency. The combination gives synergetic outcomes and provides an environmentally and economically acceptable coastal protection system. The hard solutions offer a wide variety of disadvantages like causing erosion and unnecessary accretion at various points, being expensive and also, at times, spoil the economic value of the site by making its look less beautiful. In terms of the soft solutions, it may be noted that these are not quick-fix solutions and they take time to be effective and these are effective only in a medium to long term perspective.

In view of aforesaid aspects and also to optimize the long-term positive impact of soft solutions, many combinations of soft and hard solutions can be selected. These combinations act as interim hard structures and some of the common approaches of combinations are:

- combining beach nourishment with artificial headlands/groynes
- Re-vegetation with temporary offshore breakwaters/artificial reefs and are commonly used.

Using a combination of beach nourishment and groynes/artificial headlands promotes the trapping of the downdrift movement of the sediment, thus reducing downdrift erosion. This also reduces the frequency of re-nourishment.

Coastal erosion is an extensive and multi-dimensional problem for a vast country like ours. Efforts are being made to counter the menace of coastal erosion and to protect our coasts, using both the traditional approaches (using hard structures like Seawall etc) and also using the new, innovative soft measures like dune rehabilitation. The protection works are prioritized, planned and designed as per the graveness and extent of the problem. This also helps in deciding the resources-input needed for executing a particular solution. In view of this, it is of immense importance to accurately gauge the extent and graveness of coastal erosion as a problem.

2.4. Measured adopted by various States & UTs

Measures taken by States/UTs: States/ UTs have been taking measures for protection of sea coast as per their requirement & necessity from their own fund. In some cases, Government of India has facilitated multilateral funding to States/ UTs in tackling the coastal erosion. The total expenditure incurred by various Maritime States/ UTs for protection of coastal erosion in the last 10 years is Rs 2641.39 crore and the total cost of planned schemes as well as ongoing works for the next 5 years is Rs 7218.63 crore. State-wise details are given below in Table 5.

Table 5 State-wise details of Coastal Protection measures adopted

S.no.	State	Length of Coastline (Km)#	Affected Coastline Length (Km)	Protected Coastline Length (km)	Project Cost (Rs. Crore)	Source of Funding
1	Gujarat	1241.70	45.727	26.489	201.277	State Govt.
2	Maharashtra	652.60	124.800	19.423	174.470	State Govt.

3	Goa, Daman & Diu	160.50	25.020	9.193	73.160	State Govt.
4	Karnataka	280.00	93.730	54.807	872.631	State, ADB Loan
5	Kerala	569.70	229.030	68.1178	657.872	State Govt.
6	Tamil Nadu	906.90	136.710	30.400	302.350	13th Finance Commission, NABARD, State Fund
7	Andhra Pradesh*	973.70	No information provided			
8	Odisha	476.40		6.820	144.110	State, RIDF, NABARD
9	West Bengal	157.50	14.760	12.715	215.520	State Govt.
	Total	**6720.34**	**544.977**	**227.965**	**2641.39**	

Table 6 State-wise proposed or on-going coastal protection works in next 5 years

S.no.	State	Length of Coastline (Km)#	Coastline Length to be protected (km)	Project Cost (Rs. Crore)	Source of Funding
1	Gujarat	1241.70	49.25	677.115	State Government
2	Maharashtra	652.60	28.77	282.42	State Government
3	Goa, Daman & Diu	160.50	0.97	28.05	State Government
4	Karnataka	280.00	33.34	556.35	State, ADB Loan
5	Kerala	569.70	138.024	2952.82	State Government
6	Tamil Nadu	906.90	43.06	2127.61	Central Fund, NABARD
7	Andhra Pradesh*	973.70	No information provided			

8	Odisha	476.40	3.72	260.93	State
9	West Bengal	157.50	1.58	16.05	State Government
	Total	**6720.34**	**298.714**	**6901.35**	

Length of coastline are as per SoI (1970)

* APCZMA, Andhra Pradesh has communicated that in the last 10 years, no coastal protection works have been executed in affected areas/districts of Andhra Pradesh. However, recommendations have been forwarded for some projects in West Godavari Distt., Nellore Distt. and shore protection works near Sriharikotta for ISRO.

2.4.1. Gujarat & Daman and Diu

Gujarat coast is the northern part of west coast of India. It is bounded by the Arabian Sea in the west and has two Gulfs i.e. Gulf of Khambhat and Gulf of Kachchh. The tidal range upto 8-11 m has been observed with strong tidal currents in the Gulf of Khambhat. These regions show wide intertidal zone. Tide dominating, wave dominating and fluviomarine coastal processes have shaped the major coastal landforms viz., sub-tidal mudflats, inter-tidal mudflats, high-tidal mudflats, palaeo-mudflats, shoals, islands, salt flats, salt marshes, beaches, sand dunes, coastal plains, creeks, estuary, mangroves, coral reefs, coral islands, rocky/cliffy coasts etc. Besides the natural coastal processes, large industrial and developmental activities along the coast such as salt industries, cement industries, oil & natural gas exploration, brackish water aquaculture, ports and harbours is altering the coastal landforms, land use and land cover causing changes in the coastal dynamics and shoreline changes.

As per the latest Shoreline Change Atlas of SAC for the timeframes between 2004-06 to 2014-16, Erosion is estimated along 110 km while accretion is along 49 km. Gujarat state is estimated to have gained an area of 208 ha of land due to deposition of sediments while due to erosion, the State has lost an area of 313 ha.

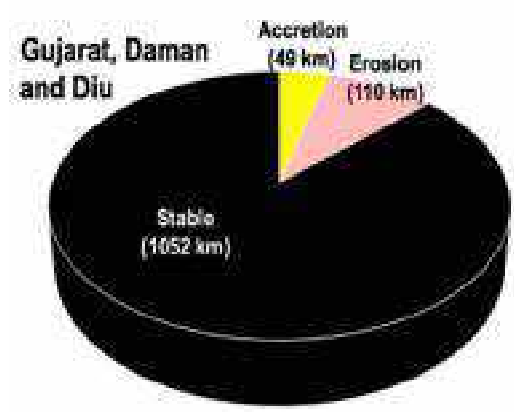

Fig. 5 Shoreline change status of Gujarat

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of coastline affected by erosion and accretion. The list for Gujarat is given below as per Table 7.

Table 7 District-wise distribution of coastline affected by erosion and accretion of Gujarat

District-wise Length of Coastline of Gujarat Affected by Erosion/ Accretion/ Stable									
SNo	**District**	**Coast Length (in km)**	**Length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Valsad	75.46	2.36	3.90	24.78	25.76	14.34	2.44	1.88
2	Navsari	43.32	1.18	3.00	7.20	18.4	9.38	0.66	2.64
3	Surat	42.48	0.00	0.42	4.82	17.62	13.62	5.4	0.6
4	Bharuch	77.32	1.84	4.54	16.64	29.7	20.96	2.56	1.08
5	Anand	59.88	0.28	1.08	13.12	34.18	9.02	1.52	0.68
6	Ahmedabad	77.52	0.64	0.62	3.00	53.32	17.56	1.34	1.04
7	Bhavnagar	173.66	6.04	3.30	27.92	67.4	56.94	9.3	2.76
8	Amreli	57.00	0.16	0.88	22.40	18.68	14.5	0.34	0.04
9	Gir Somnth	114.40	1.42	2.56	46.70	44.72	17.64	0.92	0.44
10	Junagadh	42.98	0.08	4.64	23.48	11.2	3.48	0.1	0
11	Porbandar	112.60	0.02	0.38	52.70	54.7	4.48	0.08	0.24
12	Devbhumi Dwarka	228.60	5.26	6.36	80.40	95.54	35.22	3.14	2.68
13	Jamnagar	177.38	5.22	4.68	34.70	87.6	31.48	8.44	5.26
14	Kachchh	386.64	6.42	7.92	78.38	169.66	103.58	12.76	7.92
15	Diu	18.36	0.00	0.82	9.54	5.96	1.82	0.04	0
16	Daman	14.36	0.04	0.08	2.06	7.54	3.62	1.02	0
TOTAL		**1701.78**	**30.96**	**46.04**	**447.84**	**741.98**	**357.64**	**50.06**	**27.26**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast in its report published in 2022. The hotspot locations for Gujarat & Daman and Diu are given in Fig. 6.

Belt of Gujarat is formed by sand and silty sand which can be easily eroded by waves and heavy current of sea and tides which ultimately results in huge amount of erosion. There are various techniques used to control costal erosion such as Tetrapod, Zn+PVC coated box wiremesh gabion, Armour layer of Heavy Stone Concrete wall with toe protection of heavy stones, Geo fabric in foundation and core & Heavy Stone in Armor layer.

The works of coastal management in Gujarat is being taken up by Water Resources Department. The subject of coastal protection falls within the purview of the States. Accordingly, the measures of erosion control in coastal areas are formulated and implemented by Gujarat States as per their priority. As per their requirement, State involves or consults the expertise like CWPRS, NIO Goa, IIT Bombay etc.

Fig. 6 Hotspot locations for Gujarat & Daman and Diu

Various types of Coastal Protection Works were executed by Gujarat State in different districts as per the feasibility and type of works required. The details of Anti-Sea Erosion work like coastal protection walls, gabion protection works, heavy stone pitching etc and Salinity Ingress Prevention works like Check dam, Cause way, Bandhara etc. were carried out in Gujarat State. A total of 42 nos. of coastal protection works were implemented by Govt. of Gujarat costing nearly 201.28 crore in the last 10 years thus protecting more than 26 km of coastal length. Govt of Gujarat also proposes to implement more than 40 such projects in the next 5 years, amounting to nearly Rs 677 Crore.

The details of all coastal protection measures adopted by Govt of Gujarat along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-I a and I b**.

2.4.2. Maharashtra

As per the Shoreline Change Atlas of SAC, Erosion is estimated along 75 km and accretion along 60 km out of long 724 km of Maharashtra Coast. Due to the deposition of sediments Maharashtra is estimated to have gained an area of 210 ha of land while due to erosion the state have lost an area of 105 ha as shown in Fig.7. The shoreline of Maharashtra is divided into four sectors. The northern sector comprises of Palghar, Thane, Mumbai Suburban and Mumbai city. The northern sector of Maharashtra coast is fringed with vast tidal mudflats and interleaving river/creek systems. The percentage of shoreline under erosion along the northern sector is more compared to the other regions, where 17% (33 km) of the coast is eroding, while along 12 km the shoreline is accreting. The second sector is of the shoreline at Raigarh District, where 11 km of the shoreline is eroding and accretion is along 16 km. A long stretch of coastline of around 112 km is observed to be in stable condition. The third sector is along the Ratnagiri District and around 22 km of the shoreline is estimated to be eroding along the coast in Ratnagiri. The southern sector covers the shoreline of the Sindhudurg District. Along Sindhudurg District, only 9 km of the coast is under erosion. Likewise, the Raigad and Ratnagiri Districts, Sindhudurg also have coastal area with rocky cliffs that make the coast stable and shoreline changes is observed along confined areas of pocket beaches and spits near the river/creek mouths.

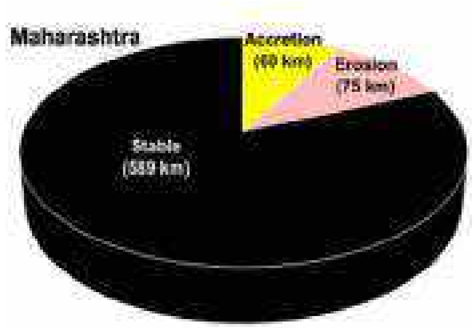

Fig. 7 Shoreline change status of Maharashtra

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of coastline affected by erosion and accretion. The list for Maharashtra is given in the Table 8 below:

Table 8 District-wise Length of Coastline of Maharashtra Affected by Erosion/ Accretion/ Stable

District-wise Length of Coastline of Maharashtra Affected by Erosion/ Accretion/ Stable										
S No	**District**	**Coast Length (in km)**	**Coast length (in km)**							
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Sindhudurg	137.02	0.04	0.20	6.50	82.00	46.88	1.02	0.38
2	Ratnagiri	258.93	0.78	1.08	36.32	203.39	15.80	0.82	0.74
3	Raigad	134.83	0.58	2.90	42.98	81.73	5.16	0.7	0.78
4	Mumbai city	41.02	0.00	0.00	1.34	38.36	1.32	0.00	0.00
5	Mumbai suburban	41.15	0.02	0.22	17.54	18.77	2.78	0.58	1.24
6	Palghar & Thane	126.64	1.12	4.98	61.66	48.44	6.28	2.26	1.90
TOTAL		**739.57**	**2.54**	**9.38**	**166.34**	**472.67**	**78.22**	**5.38**	**5.04**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Maharashtra are given in Fig 8.

Maharashtra Maritime Board (MMB) is the main agency associated with the works of coastal management in Maharashtra. The coastal protection structures are planned & implemented by MMB either through State's fund or through multilateral funding. The measures of erosion control in coastal areas are formulated and implemented by State of Maharashtra as per their priority.

Fig. 8 Hotspot locations for Maharashtra

Maharashtra was one of the State under Sustainable Coastal Protection and Management Investment Programme (SCP&MIP) which have implemented schemes with financial support from Asian Development Bank (ADB). As per their requirement State involves or consult the expertise like CWPRS, Pune; NIO Goa; IIT Bombay etc.

A total of 68 nos. of coastal protection works were implemented by Govt. of Maharashtra costing nearly Rs 174.47 crore in the last 10 years thus protecting more than 19 km of coastal length. Govt of Maharashtra has also proposed to implement more than 111 such projects in the next 5 years, amounting to nearly Rs 578 Crore. The details of all coastal protection measures adopted by Govt of Maharashtra along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-II(a) and II (b)**.

2.4.3. Goa

Goa is the smallest maritime state of India located along the Central West Coast of India.
As per the Shoreline Change Atlas of SAC, the coast of Goa is observed to have a long stable shoreline of around 117 km. Erosion is along 22 km of the coastal region, while accretion is observed merely along 7 km as shown in Fig.9. Area of erosion is around 29 ha for the entire Goa coast and the area that have accreted is about 14 ha. North Goa district is observed to have severe erosion, where the erosion is along 16 km and accretion is observed along 4 km of its coast. 23 km of the coast at North Goa district is stable in nature. Goa is famous for its beaches. However, several stretches of its famous beaches in the Northern Goa are under erosion. Beaches of the South Goa District is mostly stable in nature, where the total length of stable coast is around 94 km. About 6 km of coast at South Goa is under erosion and 3 km of the coast is being accreted. The coast at South Goa is mainly rocky cliffs and rocky headlands, where sandy beaches are observed between the headlands forming pocket beaches and along the spits of river or streams.

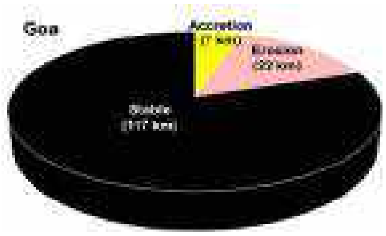

Fig. 9. Shoreline change status of Goa

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of coastline affected by erosion and accretion. The list for Goa is given in Table 9 below.

Table 9 District-wise Length of Coastline of Goa Affected by Erosion/ Accretion/ Stable

District-wise Length of Coastline of Goa Affected by Erosion/ Accretion/ Stable										
S. No.	**District**	**Coast Length (in km)**	**Coast length (in km)**							
			Erosion			**Stable**	**Accretion**			
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**	
1	North Goa	36.40	0.06	1.36	9.18	19.46	6.08	0.22	0.04	
2	South Goa	103.24	0.02	0.10	6.10	76.12	16.92	3.30	0.68	
TOTAL		**139.64**	**0.08**	**1.46**	**15.28**	**95.58**	**23.00**	**3.52**	**0.72**	

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Goa are given in Fig 10.

Water Resource Department (WRD), Goa is the main agency associated with the works of coastal management in Goa. Apart from WRD, River Navigation Department, Goa, State Agricultural Department and Directorate of Environment, Goa. Agencies and Organizations like CSIR-NIO, Goa, NIOT, Chennai, National Centre for Earth Science Studies, Trivandrum, Goa Coastal Zone Management Authority, Goa, National Institute of Hydrology, Roorkee, CWPRS, Pune and CWC (Coastal Management Dte.) are involved in managing the coastal issues of Goa state. The coastal protection structures are planned & implemented by WRD through State's fund as per their priority.

A total of 9 nos. of coastal protection works were implemented by Govt. of Goa costing nearly Rs 73.16 crore in the last 10 years thus protecting more than 9 km of coastal length. Govt of Goa has also proposed to implement 3 such projects in the next 5 years, amounting to nearly Rs 28 Crore.

Fig. 10 Hotspot locations for Goa

The details of all coastal protection measures adopted by Govt of Goa along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-III (a) and III (b)**.

2.4.4. Karnataka

The northern coast is rocky while the southern coast has long linear beaches. Coastal geomorphic features in Karnataka include beaches, rocky headlands, spits, estuaries, shallow lagoons, mudflats and mangroves at few places.

As per Shoreline Change Atlas of SAC, around 40 km of the state coastline is under erosion and 48 km of the coast is under accretion, while 231 km of the coast is stable in nature. Total area that have eroded between 2004-06 to 2014-16 is about 72 ha and around 111 ha of area have accreted (Fig. 11). Karnataka coast is divided into 2 sectors, the north and the south, where the northern sector consists of coastal region of the Uttara Kannada District and the southern sector consists of the Udupi and Dakshina Kannada District. The northern Karnataka coast largely comprises of rocky coast and around 144 km of the coast is in stable condition. Around 12 km of the coast is under erosion, while 26 km of the coast is accreting. Considerable stretch of coast is under erosion along the Sharavati River mouth, while erosion in other places is in discrete patches. The southern sector of the Karnataka coast is more dynamic compared to the north. Erosion is observed along 28 km, while accreting coast is along 22 km. About 87 km of the coast in the southern sector is stable in nature. Severe erosions are along the stretch of southern coast from Ullal to Someshwar.

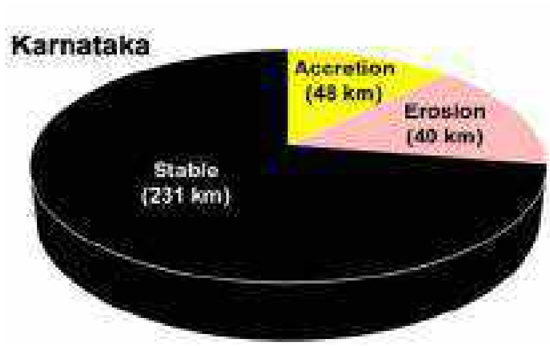

Fig. 11 Shoreline Change status for Karnataka

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of coastline affected by erosion and accretion. The list for Karnataka is given in Table 10 below.

Table 10 District-wise Length of Coastline of Karnataka

District-wise Length of Coastline of Karnataka Affected by Erosion/ Accretion/ Stable									
S. No	**District**	**Coast Length (in km)**	**Coast length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Dakshinna Kannada	36.66	1.08	2.36	13.18	7.72	12.08	0.22	0.02
2	Udupi	100.71	0.32	0.98	34.92	35.69	25.44	2.36	1.00
3	Uttara Kannada	175.65	0.80	1.12	15.26	107.75	44.12	5.54	1.06
TOTAL		**313.02**	**2.20**	**4.46**	**63.36**	**151.64**	**81.64**	**8.12**	**2.08**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Karnataka are given in Fig 12.

Infrastructure Development, Ports & Inland Water Transport Department and Karnataka Maritime Board are the main agency associated with the works of coastal management in Karnataka. Agencies and Organizations like CSIR-NIO, Goa and CWPRS, Pune are involved in managing the coastal issues of the state. The coastal protection structures are planned & implemented by Government either through State's fund or multilateral funding as per their priority. Karnataka was one of the State under Sustainable Coastal Protection and Management Investment Programme (SCP&MIP) which have implemented schemes with financial support from Asian Development Bank (ADB).

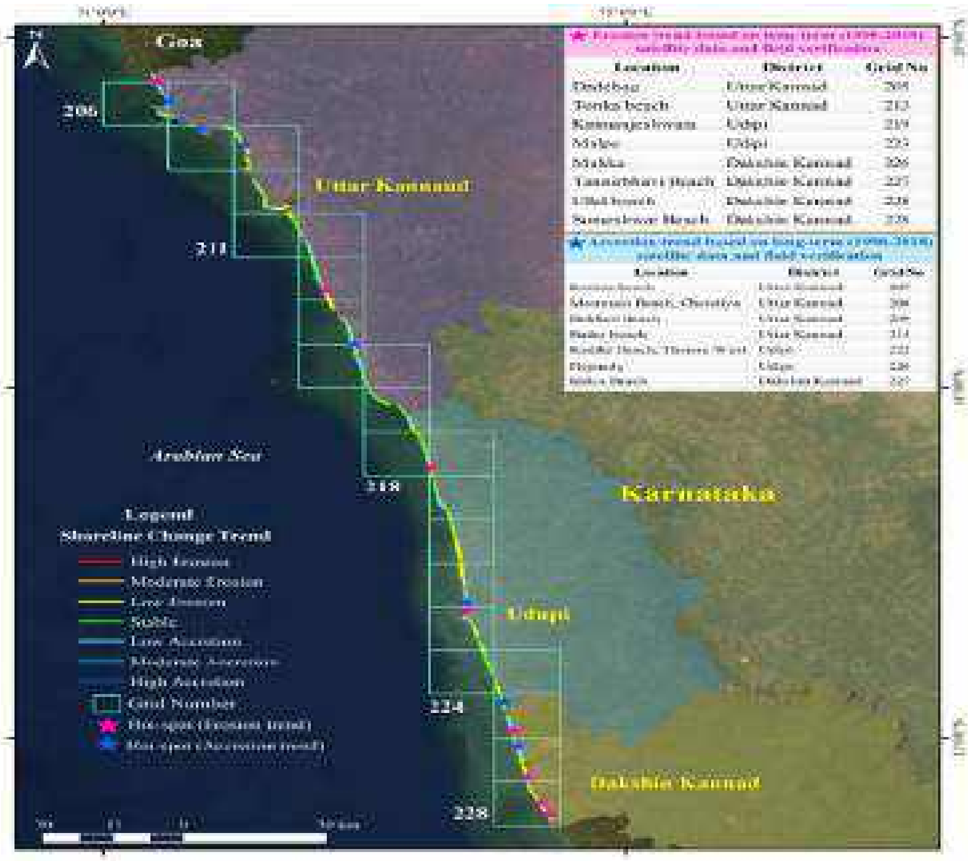

Fig. 12 Hotspot locations for Karnataka

A total of 60 nos. of coastal protection works were implemented by Govt. of Karnataka costing nearly Rs 872.63 crore in the last 10 years thus protecting more than 54 km of coastal length. Govt of Karnataka has also proposed to implement 170 such projects in the next 5 years, amounting to nearly Rs 556 Crore.

The details of all coastal protection measures adopted by Govt of Karnataka along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-IV (a) and (b)**.

2.4.5. Kerala

The Kerala coast is bestowed with rivers, lakes and is famous for its beautiful beaches and backwaters.

As per the Shoreline Change Atlas for timeframe 2004-06 and 2014-16, around 137 km of the coast is estimated to be under erosion and 121 km is observed to have accreted while 327 km of the coast is observed to be in stable condition (Fig.13). The total area accreted along the Kerala coast is 303 ha whereas 285 ha area of Kerala coast is estimated to have eroded. Kerala coast has been divided into three sectors based on the district boundaries. Along the northern sector, the coastal length under erosion and accretion is estimated to be around 40 km and 42 km respectively and 142 km stretch of the coast is stable in nature. Coastal erosion in the northern sector are mainly to the north of Mogral River, at Kottikulam, Kappad, Pudiyangadi, at north of Beypore and at Kadallundi. At the central sector, coastal length of about 51 km is estimated to be under erosion, accretion is along 45 km and 65 km of the coast is stable in nature. Along this coastal stretch, server erosion is observed at Ponnani, Putiyirutti, the mouth of Chettava Lake and at Vadanapalli. The erosion at the southern sector is estimated to be along 46 km of coastal length, while 34 km of the coast is accreting and 120 km of the coast is stable in nature. A large stretch of the coast is eroding at Panmana. The coastal stretch between Nirkunnam and Purakkad and the northern spit of the Kayamkulam Kayal are also observed to be under severe erosion. Due to the construction of coastal breakwater near Kottamkulangara, the southern coast has accreted while eroding the northern coast.

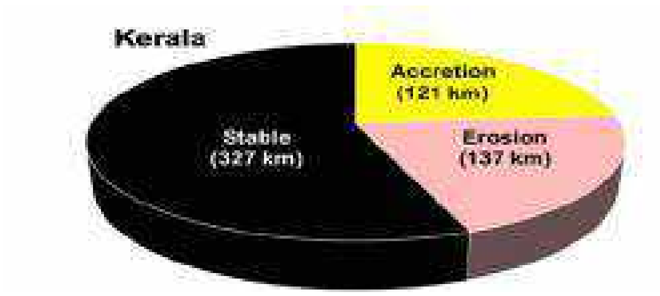

Fig. 13 Shoreline Change status for Kerala

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of coastline affected by erosion and accretion. The list for Kerala is given as per Table 11 below:

Table 11 District-wise Length of Coastline of Kerala

District-wise Length of Coastline of Kerala Affected by Erosion/ Accretion/ Stable									
S. No	**District**	**Coast Length (in km)**	**Coast Length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Kasaragod	83.60	0.02	0.18	28.48	40.20	12.64	0.44	1.64
2	kannur	69.05	0.04	0.14	28.04	27.85	9.92	2.60	0.46
3	Kozhikkode	78.03	0.46	084	47.56	24.93	3.74	0.24	0.26
4	Malappuram	50.85	0.22	1.06	23.70	18.45	7.10	0.18	0.14
5	Thrissur	61.50	0.00	0.34	17.58	12.76	18.72	6.08	6.02
6	Ernakulam	45.04	0.00	0.30	20.80	16.76	3.32	0.72	3.14
7	Alappuzha	83.56	2.12	5.08	40.66	15.84	13.08	2.68	4.10
8	Kollam	45.72	1.64	0.20	16.88	19.42	6.52	0.30	0.76
9	Thrivanantha puram	75.61	0.80	0.84	25.06	25.31	21.46	1.44	0.70
TOTAL		**592.96**	**5.30**	**8.98**	**248.76**	**201.52**	**96.50**	**14.68**	**17.22**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Kerala are given in Fig 14.

Fig. 14 Hotspot locations for Kerala

Irrigation Department of Kerala is the main agency in coastal protection which extends its traditional functions to engage in coastal engineering, exemplified by significant endeavors like the construction of anti-erosion sea works. Centre for Water Resources Development and Management (CWRDM), Department of Irrigation, conducts vital studies for identifying and mitigating coastal issues, including salinity intrusion analysis in prominent river basins. Harbour Engineering Department of Kerala, National Centre for Earth Science Studies (NCESS), and National Institute of Technology Calicut (NIT Calicut) significantly contribute to coastal management through their respective initiatives. National Centre for Coastal Research (NCCR), National Institute for Ocean Technology (NIOT), and National Institute of Technology Calicut (NIT Calicut) play indispensable roles in coastal management through their distinct contributions. The implementation of the Coastal Management Information System (CMIS) by Central Water Commission (CWC) serves as a pivotal platform for collecting, processing, and analysing near shore data vital for coastal protection measures. The coastal protection structures are planned & implemented by Government either through State's fund or multilateral funding (World Bank) as per their priority.

A total of 297 nos. of coastal protection works were implemented by Govt. of Kerala costing nearly Rs 657.88 crore in the last 10 years thus protecting more than 68 km of coastal length. Govt of Kerala has also proposed to implement 246 such projects in the next 5 years, amounting to nearly Rs 2974 Crore.

The details of all coastal protection measures adopted by Govt of Kerala along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-V (a) and (b).**

2.4.6. Tamil Nadu & Puducherry

Tamil Nadu is located on the southern part of the Indian peninsular coast. About 46 rivers, draining a total catchment of about 171 000, sq. km empty along this coastline. Kaveri delta forms the biggest sediment depository along the Tamil Nadu coast. The Gulf of Mannar and Palk Strait to the southern coast comprises of unique coastal features enriched with coral islands and mangrove habitats. Apart from this, there are a number of small lagoons along the Tamil Nadu coast.

Puducherry is a Union Territory scattered over two locations in Tamil Nadu: Puducherry and Karaikal.

As per the Shoreline Change Atlas for timeframe 2004-06 and 2014-16, around 189 km of the coast of Tamilnadu & Puducherry is accreting, while erosion happened along 129 km. The coast is stable in nature for around 532 km. Total areas that have eroded between 2004-06 to 2014-16 is about 358 ha and around 471 ha of area have accreted (Fig.15).

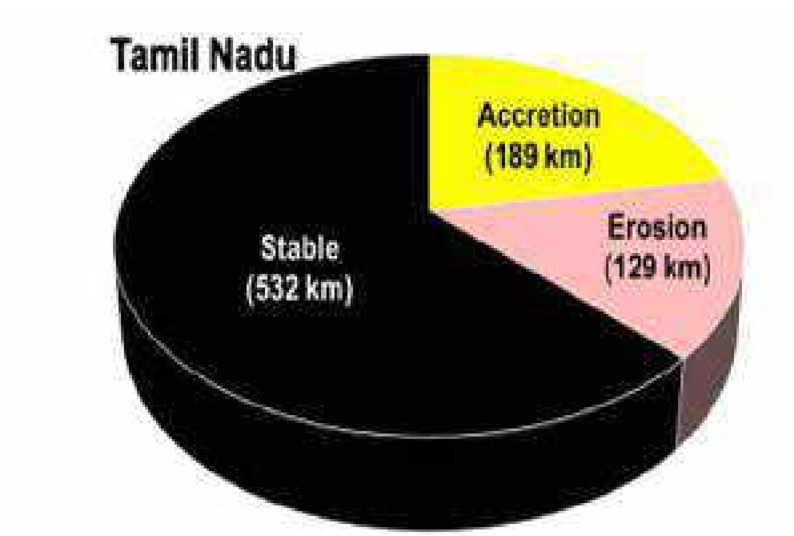

Fig. 15 Hotspot locations for Tamil Nadu

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of coastline affected by erosion and accretion. The list for Tamil Nadu is given in Table 12 below.

Table 12 District-wise Length of Coastline of Tamil Nadu

District-wise Length of Coastline of Tamil Nadu Affected by Erosion/ Accretion/ Stable									
S. No	**District**	**Coast Length (in km)**	**Coast length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Thiruvallur	40.97	1.66	3.12	9.22	17.22	6.54	0.61	2.60
2	Chennai	24.87	0.00	0.00	3.08	14.31	7.13	0.35	0.00
3	Kancheepuram	84.41	1.30	3.54	44.56	27.74	7.27	0.00	0.00
4	Villupuram	34.52	0.00	0.31	24.83	8.39	1.00	0.00	0.00
5	Cuddalore	43.35	2.47	2.21	12.06	9.93	12.08	3.60	0.00
6	Nagapattinam	125.65	3.48	14.46	43.84	17.70	33.92	8.65	3.60
7	Thiruvarur	24.39	3.08	0.99	11.01	6.84	2.38	0.06	0.02
8	Thanjavur	52.36	0.20	0.77	16.84	20.05	13.36	1.01	0.13
9	Pudukkottai	46.74	0.04	0.28	22.67	18.98	4.66	0.11	0.00
10	Ramanatha puram	272.01	1.27	3.48	99.55	125.95	37.81	1.97	1.99
11	Thothukudi	121.43	1.05	3.27	17.48	46.99	44.05	6.33	2.26
12	Thirunelveli	51.70	0.00	0.00	9.40	21.60	19.26	0.41	1.03
13	Kanyakumari	69.06	0.12	4.24	40.20	17.86	4.79	0.85	1.00
	TOTAL	**991.47**	**14.66**	**36.65**	**355.74**	**353.56**	**194.27**	**23.96**	**12.63**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Tamil Nadu are given in Fig 16.

Government of Tamil Nadu has demonstrated a proactive approach towards coastal protection and salinity ingress management in the state. Through the efforts of institutions like the Institute of Hydraulics and Hydrology (IHH) within the Water Resources Department (WRD), the government has actively engaged in understanding and addressing coastal challenges. To combat erosion and accretion, Tamil Nadu has implemented a mix of soft and hard measures, including beach nourishment, vegetation, and the construction of coastal protection structures like groynes and reinforced concrete walls. The ongoing TN-SHORE project underscores the commitment to restoring coastal resources and bolstering defences against erosion. Additionally, the government's collaboration with the Central Water Commission (CWC) and advocacy for a standardized SOP on coastal data collection reflects proactive steps towards effective coastal management.

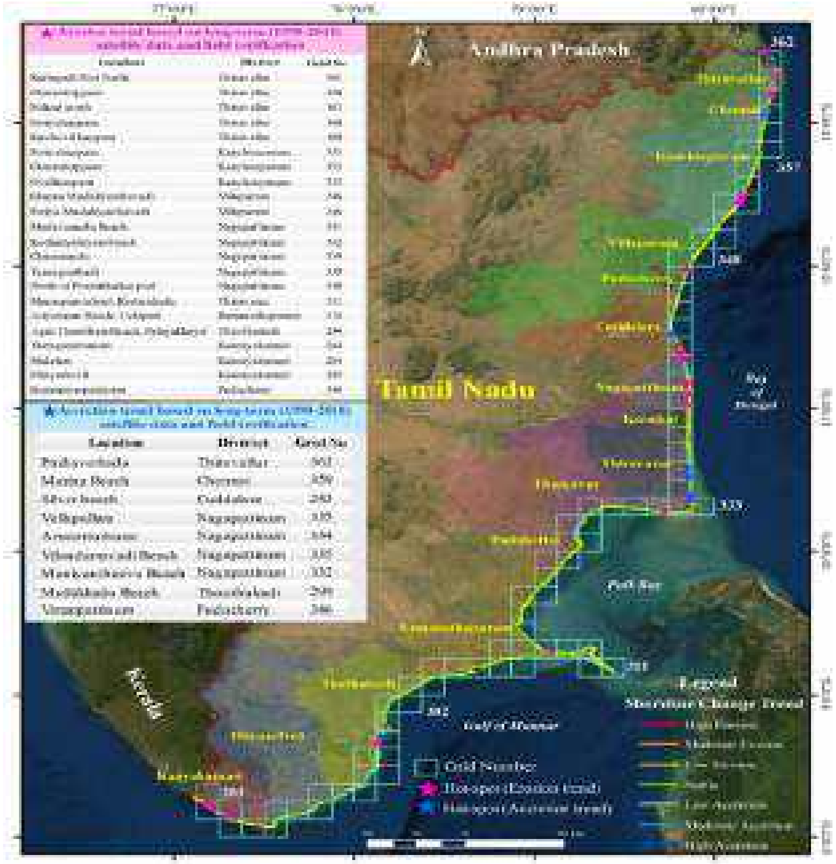

Fig. 16 Hotspot locations for Tamil Nadu

Department of Ocean Engineering, IIT Madras, has significantly contributed to coastal protection and salinity ingress management in Tamil Nadu & Puducherry. National Institute of Ocean Technology (NIOT) has played a crucial role in coastal protection and salinity ingress management in Tamil Nadu & Puducherry through a wide array of coastal engineering projects addressing various challenges while promoting sustainable coastal development. National Centre for Coastal Research (NCCR), under the Ministry of Earth Sciences, has also made substantial contributions, especially in preparation of Shoreline Management Plan (SMP). Central Ground Water Board (CGWB) has also played a pivotal role in addressing the concerning issue of groundwater depletion in Tamil Nadu and the Union Territory of Puducherry.

A total of 51 nos. of coastal protection works were implemented by Govt. of Tamil Nadu costing nearly Rs 302 crore in the last 10 years thus protecting more than 30 km of coastal length. Govt of Tamil Nadu has also proposed to implement 60 such projects in the next 5 years, amounting to nearly Rs 2127 Crore.

The details of all coastal protection measures adopted by Govt of Tamil Nadu along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-VI (a) & (b)**.

2.4.7. Andhra Pradesh

The Andhra Pradesh coast is located to the eastern coast of India facing the Bay of Bengal.

As per the Shoreline Change Atlas for timeframe between 2004-06 to 2014-16, accretion is observed along 208 km of the coastal length and coast of about 189 km is eroding, while 413 km of Andhra Pradesh shoreline is stable (Fig. 17). Total area of about 796 ha have eroded whereas 808 ha area of coastal land have formed as a result of accretion.

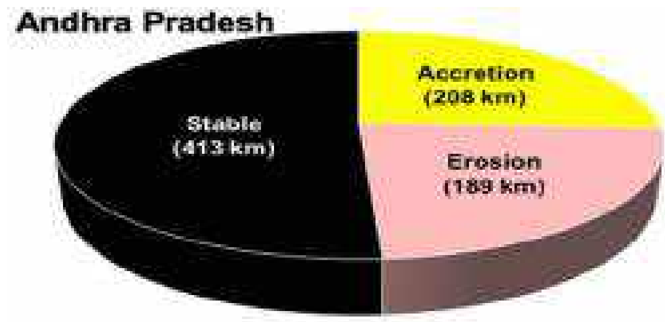

Fig. 17 Shoreline change status of Andhra Pradesh

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of Andhra Pradesh is given in Table 13 below:

Table 13 District-wise Length of Coastline of Andhra Pradesh

District-wise Length of Coastline of Andhra Pradesh Affected by Erosion/ Accretion/ Stable									
S. No	**District**	**Coast Length (in km)**	**Coast length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Nellore	172.10	5.36	3.16	41.72	50.36	62.22	7.14	2.14
2	Prakasam	107.18	3.20	4.72	15.38	19.70	53.64	7.18	3.36
3	Guntur	64.24	0.84	0.00	1.72	9.54	26.06	13.78	12.30
4	Krishna	133.36	40.30	6.18	8.64	17.86	21.02	10.18	29.18
5	West Godavari	17.98	5.52	0.72	0.98	1.04	2.74	1.98	5.00
6	East Godavari	189.84	45.92	13.84	19.54	25.60	33.10	18.22	33.62
7	Vishakhapatnam	136.98	0.34	2.24	12.36	102.74	17.78	1.34	0.18
8	Vizhianagaram	32.78	0.00	0.00	11.96	12.54	17.66	0.00	0.62
9	Srikakulam	173.12	0.02	1.92	25.76	81.60	49.36	7.36	7.10
TOTAL		**1027.58**	**101.50**	**32.78**	**138.06**	**320.98**	**273.58**	**67.18**	**93.50**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Andhra Pradesh are given in Fig.18.

As per the report received, Andhra Pradesh Coastal Zone Management Authority (APCZMA) has been constituted to appraise the projects/activities/building in the coastal zone of Andhra Pradesh. National Institute of Ocean Technology (NIOT), Chennai; National Centre for Coastal Research (NCCR), Chennai, Central Ground Water Board (CGWB) and CWPRS, Pune have played a crucial role in coastal protection and salinity ingress management in Andhra Pradesh through a wide array of coastal engineering projects addressing various challenges.

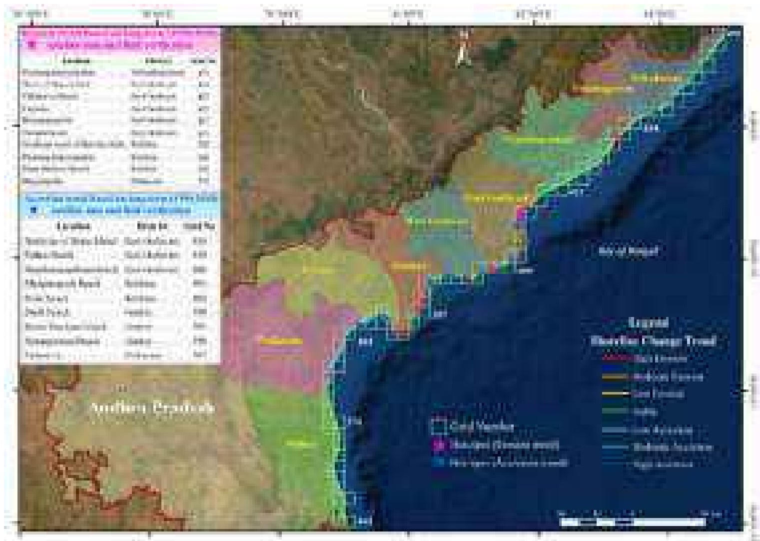

Fig. 18 Hotspot locations for Andhra Pradesh

Central Water Commission (CWC) has planned to establish one coastal site under Coastal Management Information System (CMIS) for collecting, processing, and analysing near shore data, vital for coastal protection measures.

The coastal protection structures are planned & implemented by Government through State's fund as per their priority. Though not much details have been provided by State Government in respect of project completed and planned, State Govt has completed i) construction of seawall by dumping the Granite boulders along the coast line of Uppada segment for an approximate length of 12 km in 2017, ii) constructed a Geo-Tube Sea wall of length 1.463 km along the Uppada seashore as a pilot project in the year 2011 as per recommendations CWPRS, Pune, which was, however, got damaged due to high waves and storm surges in Feb 2017 and in 2018. Further, NIOT, Chennai has conducted Case Study on Beach Restoration for Visakhapatnam, Andhra Pradesh. Some of the projects for coastal protection have been recommended for implementation; however, their cost has not been communicated by State Government.

2.4.8. Odisha

The Odisha coast extends along the eastern coast of India. The Odisha coast is mainly deltaic in nature, formed by the Mahanadi and the Brahmani- Baiterani rivers. The Chilka lagoon located on the southern parts of the Odisha coast is the largest natural water body in the country spread for around 830 sq km area. Sandy beaches are well marked along the shoreline from the Bahuda estuary near the Andhra Pradesh border to the Devi river mouth. The sandy beach of the southern coast of Odisha has its importance owing to the turtle nesting grounds. The delta region constitute major mangrove habitat at Bhitarkanika and Gahirmatha at the estuarine mouth of Brahmani-Baiterani confluence. Vast stretches of subtidal mudflats are observed from the Dhamra River to Chandipur along northern parts of the Odisha coast.

As per the Shoreline Change Atlas for timeframe between 2004-06 to 2014-16, erosion have occurred along 144 km of the coast while 99 km of the coast is under accretion (Fig. 19). Stable coast of Odisha is observed for around 208 km. A large area of around 831 ha of land have eroded during the time frame of analysis and nearly about 753 ha of area have been accreted due to deposition of sediment.

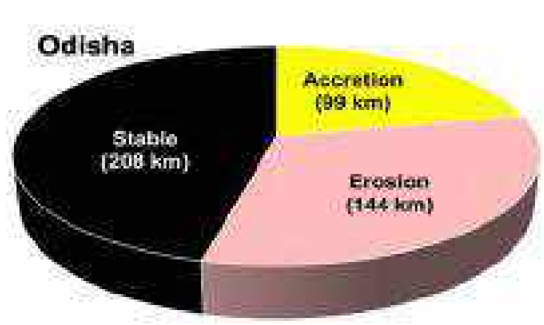

Fig. 19 Shoreline change status of Odisha

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of Odisha is given Table 14 below.

Table 14 District-wise Length of Coastline of Odisha

District-wise Length of Coastline of Odisha Affected by Erosion/ Accretion/ Stable									
S. No	**District**	**Coast Length (in km)**	**Coast length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	Ganjam	62.90	3.84	1.92	8.30	18.46	22.10	1.84	6.44
2	Puri	140.04	6.68	4.34	10.38	9.18	73.72	23.66	12.08
3	Jagatsinghpur	58.72	14.58	7.76	11.88	9.24	5.18	0.88	9.20
4	Kendrapara	135.82	31.02	8.72	9.22	54.26	11.26	5.02	16.32
5	Bhadrak	59.88	6.64	3.44	3.48	4.14	4.58	6.66	30.94
6	Baleshwar	92.14	5.50	4.32	11.78	18.24	22.10	7.54	22.66
TOTAL		**549.50**	**68.26**	**30.50**	**55.04**	**113.52**	**138.94**	**45.60**	**97.64**

Further, NCCR has identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for Odisha are given in Fig. 20.

Department of Water Resource, Govt of Odisha is the nodal department in the matter of coastal erosion and salinity ingress in coastal region. NCCR, Chennai; NIOT, Chennai; CWPRS, Pune; CGWB etc have played significant role in managing these issues in Odisha.

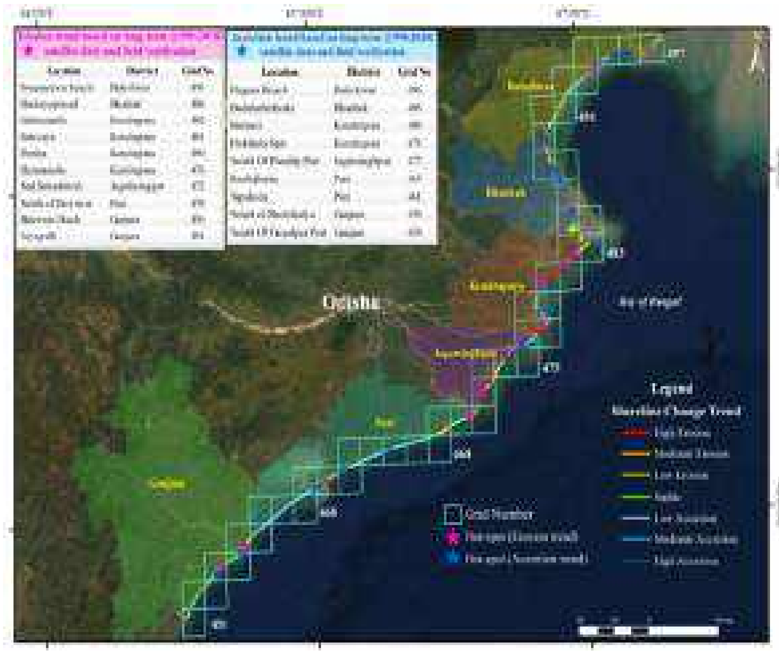

Fig. 20 Hotspot locations for Odisha

Under Coastal Management Information System (CMIS), Central Water Commission (CWC) has planned to establish one numbers of coastal site for collecting, processing, and analysing near shore data, vital for coastal protection measures. State of Odisha has implemented Integrated Coastal Zone Management Project (ICZMP) under which two stretches of Odisha coast i.e. Gopalpur to Chilka and Paradeep to Dhamara has been taken up with World Bank assistance. State has also utilized fund from National Cyclone Risk Mitigation Project (NCRMP), Asian Development Bank (ADB), Rural Infrastructure Development Fund (RIDF) in strengthening its coastal protection.

The coastal protection structures are planned & implemented by Government either through State's fund or multilateral funding (World Bank, ADB etc) as per their priority. A total of 6 nos. of coastal protection works were implemented by Govt. of Odisha costing nearly Rs.144.11 crore in the last 10 years. Govt of Odisha has also proposed to implement 4 such projects in the next 5 years, amounting to nearly Rs 260 Crore.

The details of all coastal protection measures adopted by Govt of Odisha along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-VII (a) and (b).**

2.4.9. West Bengal

The West Bengal coast extends from 21° 36' N to 21° 56' N and 87° 27' E to 89° 8' E. The Sundarban area is fed with numerous rivers, which form network of creeks. These are affected by the daily tides. Many small sandy islands and mudflats mark the river channels and the coast and most of them are completely inundated during high tide. The mangroves in the West Bengal coast have mainly colonies in the Sundarban area, which forms the largest single block of tidal halophytic mangroves of the world.

As per the Shoreline Change Atlas for timeframe between 2004-06 to 2014-16, the West Bengal coast is eroding along 56 km and accretion is along 34 km, while the shoreline is stable along 67 km (Fig. 21). An area of around 394 ha of the land have eroded and about 141 ha of area have been accreted due to deposition of sediment. Analysis has been carried out by dividing the shoreline into two based on the coastal geomorphology and district administrative boundary; the western part comprising of the Purba Medinipur District and the eastern part comprising the South 24 Parganas District. Coastal erosion happened along 26 km of the Purba Medinipur District. Accretion is along 20 km and 19 km of the coast is under stable condition. The coast at Jaldha is under severe erosion. Along this sector, the coast at Gadadhapur, the southern coast of Champa River mouth, a long stretch of coast at Dadanpatra, the coast near Masjidpur and small coastal segments at Alichak, Pachuria and Sastimall are under erosion. The coastal erosion at South 24 Parganas District is along 31 km while accretion is along 14 km and 48 km of the coast is stable in nature. Severe erosion happened at Rasrur, that have made the shoreline to shift around 200 m towards land.

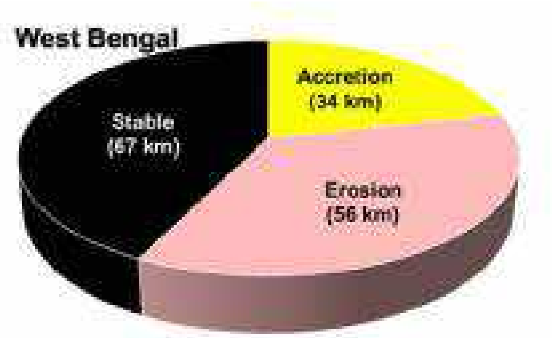

Fig. 21 Shoreline change status for West Bengal

NCCR in its National Assessment of Shoreline Changes along Indian Coast, published in 2018, has identified district-wise distribution of West Bengal is given Table 15 below.

Table 15 District-wise Length of Coastline of West Bengal

District-wise Length of Coastline of West Bengal Affected by Erosion/ Accretion/ Stable									
S. No	**District**	**Coast Length (in km)**	**Coast length (in km)**						
			Erosion			**Stable**	**Accretion**		
			High	**Moderate**	**Low**		**Low**	**Moderate**	**High**
1	East Midnapore	55.35	6.44	5.49	15.92	8.09	9.12	2.78	7.51
2	South 24 Parganas	332.93	98.74	28.26	66.84	44.22	39.98	15.94	38.94
3	Moderate Erosion	146.07	68.46	18.21	28.16	16.47	7.16	1.07	6.54
TOTAL		**534.35**	**173.64**	**51.96**	**110.92**	**68.78**	**56.26**	**19.80**	**53.99**

NCCR has, further, identified erosion/accretion hotspot locations based on the cumulative shoreline change results for the time period of 1990-2018 all along the coast, published in 2022. The hotspot locations for West Bengal are given in Fig. 22.

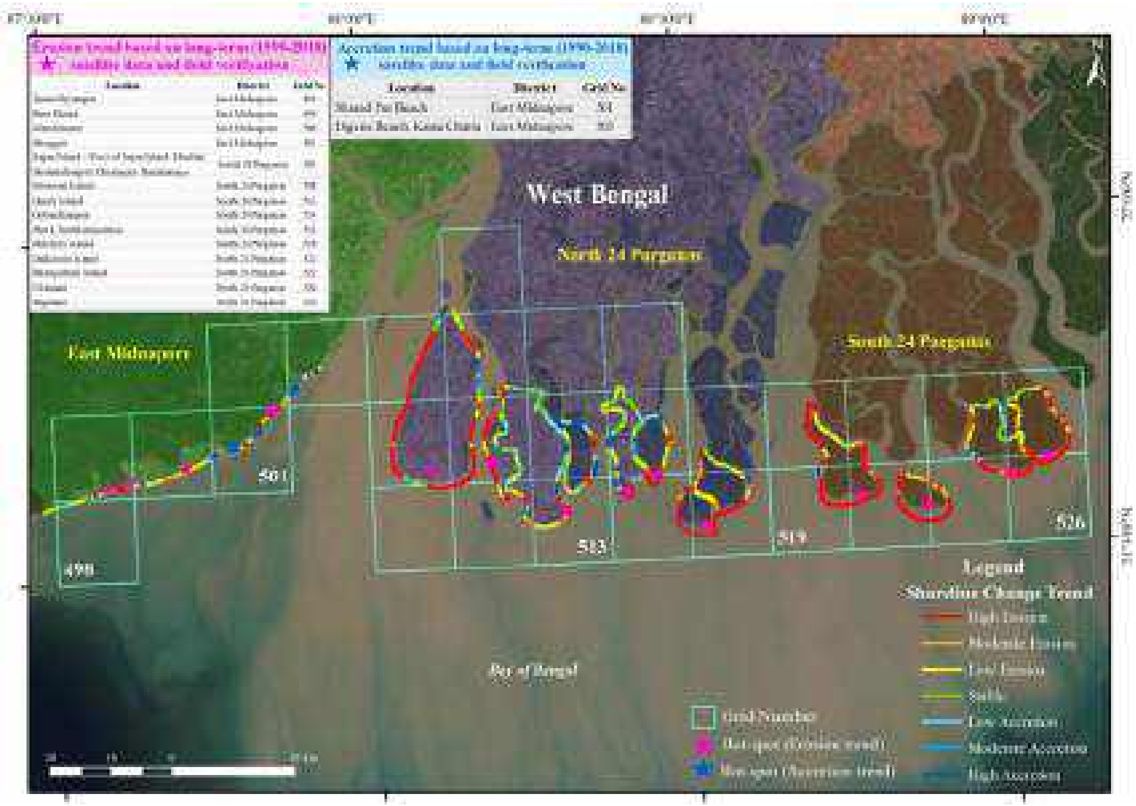

Fig. 22 Hotspot locations for West Bengal

Irrigation & Waterways Department, Govt of West Bengal is the main nodal agency in the matter of coastal erosion & salinity ingression in coastal areas. Integrated Coastal Zone Management Plan (ICZMP) was prepared by Institute of Environmental Studies & Wetland Management (IESWM) under World Bank assistance for two coastal stretches of Digha Sankarpur in Purba-Medinipur district and Sagar Island in South 24 Pargana district of west Bengal. The project also active involvement from National Centre for Sustainable Coastal Management (NCSCM). CWPRS, Pune; Jadavpur University, Kolkata; CGWB; Sundarvan Development Board are associated in the matter of coastal erosion & salinity ingression in coastal region of WB. Under Coastal Management Information System (CMIS), Central Water Commission (CWC) has planned to establish two numbers of coastal sites for collecting, processing, and analysing near shore data, vital for coastal protection measures.

The coastal protection structures are planned & implemented by Government either through State's fund or multilateral funding (World Bank, ADB etc) as per their priority. A total of 11 nos. of coastal protection works were implemented by Govt. of West Bengal costing nearly Rs 215 crore in the last 10 years thus protecting nearly 13 km of coastline. Govt of West Bengal has also proposed to implement 6 such projects in the next 5 years, amounting to nearly Rs 260 Crore.

The details of all coastal protection measures adopted by Govt of West Bengal along with expenditure incurred in the last 10 years and proposed coastal protection works or ongoing works are attached as **Annexure-VIII (a) and (b)**.

2.4.10. Andaman & Nicobar Islands

The Andaman and Nicobar islands group is the largest archipelago system in the Bay of Bengal, consisting of more than 350 islands. These groups of islands are the emerged part of a mountain chain and lie on a ridge extending southward from the Irrawady delta area of Burma. The Ten Degree Channel separates the Andaman group of islands from the Nicobar group of islands. On the Andaman and Nicobar islands, there are many small tidal estuaries, long inlets and lagoons, which support a dense and diverse mangrove flora. The tidal creeks of Andaman and Nicobar islands often form the outlets to the rain-fed stream that flow from the interior and carry silt to the shore to form muddy plains facilitating the spread and regeneration of mangroves. The islands alone account for about 18% of the country's total mangrove area.

A major part of the coastline is stable in nature accounting to about 77 %. Erosion happened along 231 km and 256 km of the coast have accreted (Fig.23). A large area of around 1004 ha has accreted along the AN Islands, while 480 ha of the area have lost due to erosion. Along the districts of North and Middle Andaman, the accreting coast is significantly more than the eroding coast. Accretion is along 73 km while the coast under erosion is 29 km. Around 620 km of the district is stable in nature. The South Andaman District have eroding and accreting coastal length of 79 and 72 km respectively, while 594 km of the coast is stable in nature. Erosions are observed along long coastal stretch to the east coast of Ross Island, near Beadanbad, to the east coast of Taramugli Island and to the coast of Cinque Islands. Along Nicobar Islands, around 123 km of the coast is under erosion, accretion is along 112 km and 455 km coast is under stable condition. A long stretch of coast at Pulloullo in Little Nicobar Island is under erosion. Erosion in Car Nicobar Islands are along Mus, Sawal and Tamalo.

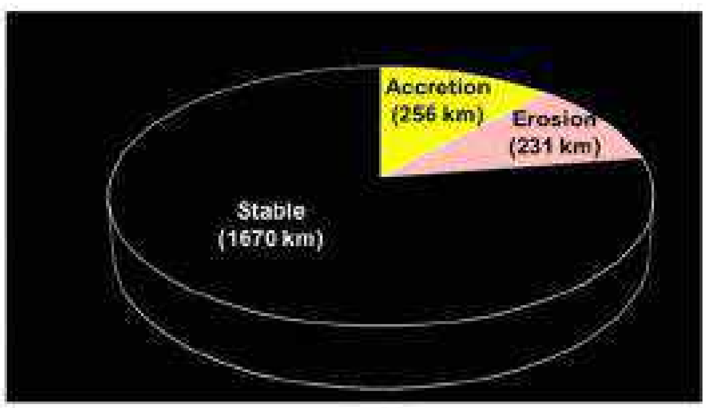

Fig. 23 Shoreline change status for Andaman & Nicobar islands

2.4.11. Lakshadweep Islands

The coral islands of Lakshadweep lie about 200 to 470 kilometres off the Kerala coast. The islands consist of a chain of well-developed coral reefs. There are about 36 islands, out of these only 10 are inhabited. The islands are flat, rising 3-9 meters above the sea. Chetlat is one of the northern most islands. The Minicoy Island is the southernmost island of this group, separated from the rest of islands by a stretch of a sea that is about 180 km wide. The corals occur as atolls in which the coral reef formation appears annular or ring shaped in its plan view. An atoll is often topped by low sand islands, enclosing a lagoon. These atolls are rich in biodiversity harbouring coral fauna over a hundred species. Sandy beach characteristically make up the coast of all the Lakshadweep islands.

Erosion in Lakshadweep Island is along 12 km and 13 km of the coast is under accretion. Around 116 km of the Lakshadweep Island is stable in nature. Fig. 24 shows the shoreline change status of Lakshadweep Islands. The erosion in Lakshadweep Island have caused a loss of 16.6 ha area of land while 18.4 ha area of land have accreted. The coastal erosion is observed for almost entire islands within the Lakshadweep Island group except for Chetlat, Amini and Kavaratti.

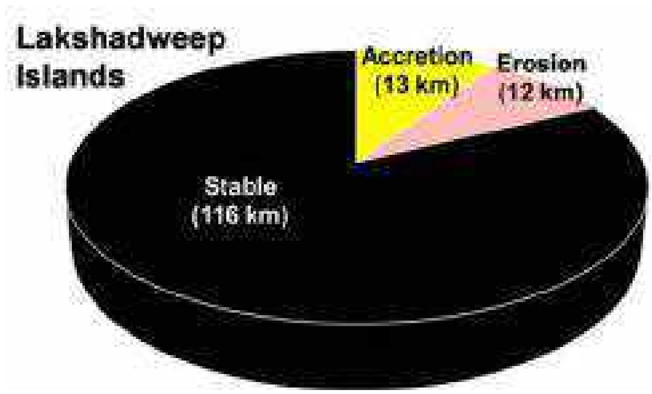

Fig. 24 Shoreline change status for Lakshadweep islands

2.5. Issue of Salinity Ingress and Remedial Measures

Salinity in coastal areas is a significant challenge and poses risks to sustainable development of Coastal regions. It is a national problem and requires detailed studies in all the coastal slates. If left unmanaged, salinity has serious implications for water quality, biodiversity, agricultural productivity, supply of water for critical human needs and industry and the longevity of infrastructure. The nature of salinity in different areas varies from State to State and from one region to another within the same state. This phenomenon is exacerbated by reduced freshwater flow from rivers, sea-level rise, unscientific agricultural practices and over-extraction of groundwater. Fig. 25 shows the Occurrence of Coastal Groundwater Salinity.

2.5.1. Causes of Salinity Ingress

- Groundwater Over-Extraction: (Fig 26 shows over extraction of ground water)
    - Aquifer Depletion: Over-pumping of groundwater for agriculture and urban use reduces the pressure in coastal aquifers, allowing seawater to enter and contaminate them.
    - Land Subsidence: Excessive extraction of groundwater can cause land subsidence, further exacerbating salinity ingress.

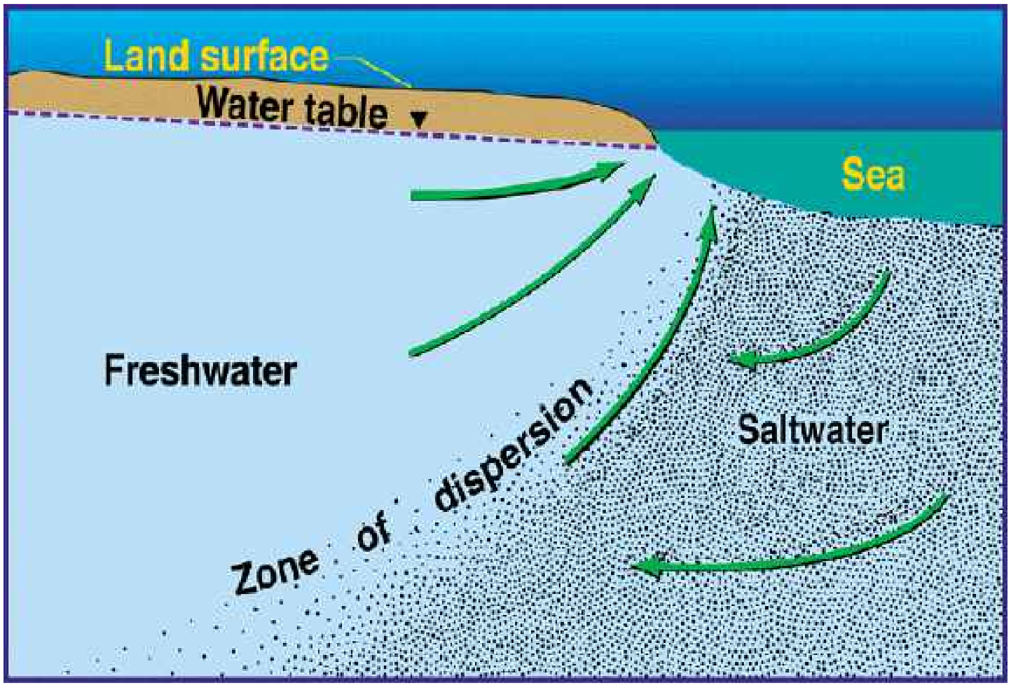

Fig. 25 Coastal Groundwater Salinity and Its Occurrence

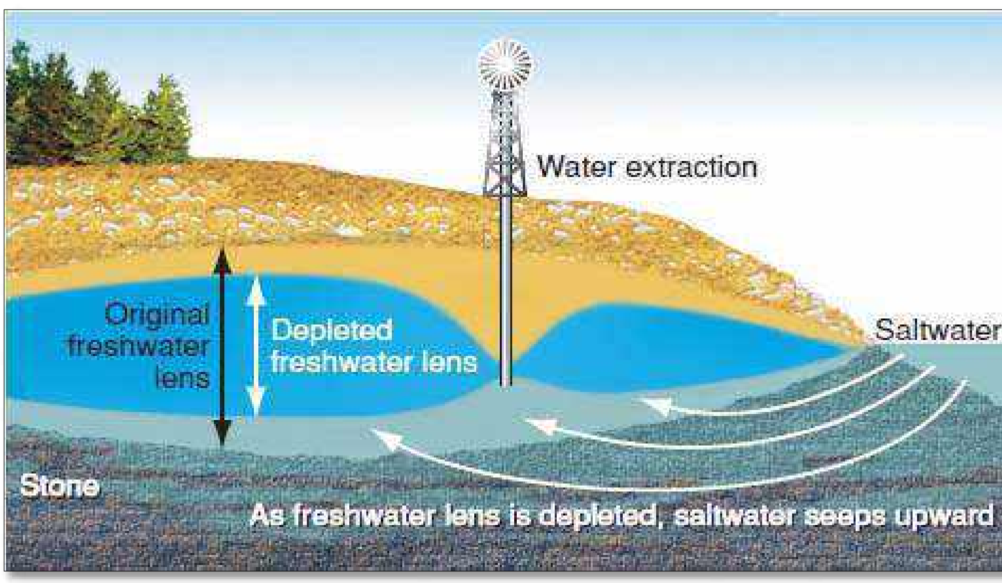

Fig. 26 Over extraction of groundwater

- Reduced River Flow:
  - Dams and Barrages: The construction of dams and barrages upstream reduces the freshwater flow that naturally pushes seawater back, allowing saline water to intrude further inland.
  - Over-Extraction of Water: Excessive withdrawal of river water for irrigation and industrial use further reduces the freshwater inflow to coastal areas.

- Sea-Level Rise:
  - Climate Change: Global warming is leading to rising sea levels, which increase the pressure on coastal aquifers and allow seawater to seep into freshwater zones.
  - Storm Surges: Increased frequency and intensity of storms and cyclones can push seawater further inland, especially during high tides.

Salinity processes are natural processes closely linked with landscape and soil formation processes; however, human activities can accelerate salinity processes, thereby further aggravating the land and water degradation of the affected region. Salt affected soils occur within a narrow strip of land adjacent to the coast and up to 50 km wide. These areas generally have an elevation of less than 10 m above mean sea level and include the low-lying land of river deltas, lacustrine fringes, lagoons, coastal marshes, and narrow coastal plain or terraces along the creeks. Table 14 shows the extend of coastal saline soil in India.

The problem occurs in varying degree in the States of West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Goa, Maharashtra, Gujarat and four Union Territories. While no factual data are available as to the extent of the area affected by salinity, the problem area is estimated to be about 30 to 40 thousand sq. kms. The important areas needing attention are the Sundarban of West Bengal, the delta areas of Krishna, Godavari and Cauveri, Kari soils in Kerala, Khar land of Maharashtra and coastal areas of Gujarat and Rann of Kutch.

Table 16 Extend of coastal saline soil in India.

Extent of coastal saline soils in India (Bandyopadhyay et al., 1988)

State	Area (thousand hectares)
West Bengal	820
Gujarat	714
Orissa	400
Andhra Pradesh	276
Tamil Nadu	100
Karnataka	86
Maharashtra	64
Kerala	26
Goa	18
Puducherry	1
Andaman & Nicobar Islands	15
Salt affected area under mangrove forests	574
Total	**3094**

Coastal land salinization and salt water ingress are major hazards encountered along the Indian coast which can hamper the rapid socio-economic growth of the coastal states and the economy of the country as a whole. In coastal regions, which are in close proximity to the sea, salinization may lead to changes in the chemical composition of natural water resources, degrading the quality of water supply to the domestic, agriculture and industrial sectors, loss of biodiversity, taxonomic replacement by halotolerant species, loss of fertile soil, collapse of agricultural and fishery industries, changes in local climatic conditions, and creating health problems; thus, affecting many aspects of human life and posing major hindrance to the economic development of the region.

2.5.2. Impacts of Salinity Ingress

- Agricultural Damage: Salinity ingress makes soil and water too saline for most crops, leading to reduced agricultural yields and, in some cases, complete loss of arable land.
- Freshwater Contamination: Coastal aquifers and surface water bodies become saline, leading to a shortage of potable water for drinking and irrigation.
- Biodiversity Loss: The intrusion of saltwater into freshwater ecosystems can lead to the loss of sensitive species and habitats, such as mangroves and freshwater wetlands.
- Economic Impact: The combined effect of reduced agricultural productivity, water scarcity, and environmental degradation can lead to significant economic losses for coastal communities.

2.5.3. Remedial Measures to control Salinity

Salinity water ingress problem is multi-disciplinary in nature involving hydrology, geology, ground water aquifer system, hydrogeology etc. The problem needs to be tackled in surface and ground water front also. Suitable Measures are to be taken to tackle the effect of salinity along the coast line and prevent the salinity ingression on to the inland areas. Due to different coastal conditions the remedial measures to be adopted varies differently along the coast.
Salinity control measures can be classified under the following categories:

1. Salinity Control Techniques
2. Recharge Techniques
3. Management Techniques/Land Reclamation

The tables 17, 18 and 19 show different measures adopted by the State Governments which have been grouped into the categories as discussed above.

Table 17 Salinity Control Techniques

Sl No	Measures Adopted	Sl No	Measures Adopted
1	Regulators (Tidal regulator, Tail end Regulator, Regulator cum Bridge, Lock cum Regulator, Inlet Sluice/Control Sluice)	5	Bunds
2	Bandharas	6	Vented Cross Bar
3	Kharland Schemes	7	Nalla Plugs
4	Salt Water Exclusion Dams		

Table 18 Recharge Techniques

Sl No	Measures Adopted	Sl No	Measures Adopted
1	Check Dams / Instream Structure	4	Recharge Reservoirs/ Spreading Channel
2	Recharge Tanks	5	Recharge Shaft
3	Recharge Wells	6	Afforestation

Table 19 Management Techniques/Land Reclamation

Sl No	Measures Adopted	Sl No	Measures Adopted
1	Cropping Pattern	4	Reclamation of Land
2	Minimum flow in rivers	5	Anti Sea Erosion Works
3	Regulation of Ground Water Extraction	6	Desiltation of lakes

2.5.4. Salinity ingression status in Coastal States of India

2.5.4.1. Gujarat

The Gujarat coast can be divided into five regions: Rann of Kachchh, Gulf of Kachchh, Saurashtra coast, Gulf of Khambat, and South Gujarat coast. Salinity ingression in Gujarat is a significant concern due to various factors, including seawater encroachment, inherent salinity of geological formations, tidal water incursion through creeks, and irrigation with saline water. The groundwater salinity along the coastal regions is exacerbated by the overdraft of groundwater, leading to the upcoming of underlying saline water. The Rann of Kachchh is a saline desert for most of the year and turns marshy during the monsoon season. Specific regions such as the Bhavnagar-Una section, the Una-Madhavpur section, and the Maliya-Lakhpat section exhibit different extents and causes of groundwater salinity. For instance, the Gulf of Khambat region is characterized by high salinity levels due to marine influences and the inherent salinity of formations.

To mitigate the salinity problem, the Gujarat government has implemented several remedial measures recommended by High Level Committees in the 1970s and 1980s. These measures include constructing structures to control surface and subsurface salinity, recharge underground aquifers, and promote agricultural activities. Techniques such as check dams, recharge tanks, spreading channels, and afforestation have been employed to augment groundwater recharge and prevent seawater intrusion. These interventions have led to significant benefits, including increased agricultural land, improved groundwater quality, reduced soil erosion, and better socio-economic conditions for the local communities.

During Quarterly Dialogue held on 25.04.2024, Central Ground Water Board (CGWB), Ahmedabad stated that NAQUIM 2.0 study has been taken up in Coastal parts of Gandevi Block, Navsari District on recommendation of GWRDC Ltd. around Devdha Tidal Regulator, to know the efficacy of the tidal regulator in mitigating Salinity in the area. It was also presented that CGWB has carried out field surveys which concluded that Tidal regulator is helping in improvement of Ground water quality and mitigating salinity of Ground Water. The Tidal regulator also augments the recharging process of phreatic aquifer and developing a blanket of Fresh water floating over saline water up to 10 m depth, which can be used for domestic purpose after primary treatment. Water Resources Department, Gujarat informed that the State Government is also in the process of constructing a Tidal Regulator at Kaveri River. The Tidal regulator Works are also under progress on other rivers. Chief Engineer, WRD presented that Salinity ingress is serious issue in 10.65 lacs ha coastline area of Saurashtra and Kachchh region where more than 13.3 lakh people live. He, further, added that controlling salinity and reclaiming saline land is an urgent priority matter for State for increasing productivity of existing land, making better use of irrigation and demonstrate that new irrigation areas can be managed in a sustainable manner. The reasons of salinity ingress in Gujarat are less and irregular rainfall, porous geographical formations, less natural water filling, weak land management, excessive lifting of ground water. Chief Engineer also informed about the initiatives and projects undertaken by Govt. of Gujarat on the issues of salinity ingress and coastal erosion.

The details of all Salinity ingression prevention measures adopted by Govt of Gujarat along with expenditure incurred in the last 10 years and proposed works or ongoing works are attached as **Annexure-IX (a) and IX (b)** respectively.

2.5.4.2. Maharashtra

Maharashtra's geological composition ranges from Pre-Cambrian to recent periods, with the Deccan Traps dominating the central region. This area faces frequent droughts due to limited rainfall (400-700 mm annually) and reliance on groundwater, with an annual recharge of 32.76 bcm and extractable resources at 30.95 bcm. The Konkan region, along Maharashtra's western coast, is a narrow strip between the coast and the Sahyadri ridgeline, featuring marine landforms like lagoons, creeks, mudflats, and sand beaches. The region receives plentiful rainfall from the south-west monsoon. Major rivers, including the Konkan, Pinjal, Vaitarna, and Ulhas, have short courses not exceeding 100 km. The Konkan coast has narrow beach sands and coastal alluvium that serve as moderate groundwater reservoirs, with aquifers formed by alluvial deposits. Groundwater levels vary seasonally, from 2-10 meters below ground level pre-monsoon to 2-5 meters post-monsoon. Groundwater quality varies, being fresh in elevated areas and brackish to saline in lowlands and tidal zones, influenced by natural and anthropogenic factors.

Coastal land salinity, particularly in the Konkan region's Khar/Khajan lands, poses significant management challenges. The Kharland Board, established in 1948 and later restructured under the Maharashtra Kharland Development Act-1979, implements schemes to reclaim saline lands through embankment construction, restricting tidal water intrusion, and promoting freshwater recharge. The remedial measures in Maharashtra provide environmental benefits, such as preventing salinity ingress, enhancing freshwater recharge, and maintaining ecological balance. Socio-economic benefits include improved agricultural yields, increased employment, reduced migration, and protection from floods, tsunamis and cyclones.

During Quarterly Dialogue held on 18.04.2024, CGWB, Nagpur presented outcome of NAQUIM studies in coastal districts of Maharashtra state viz., Sindhudurg (High salinity in SW parts in deeper aquifers), Ratnagiri, Raigad, Thane, Palghar. The highlights of CGWB Study:

- Hydrogeological characteristics of Maharashtra state reveal that the Deccan Trap Basalt constitutes 82% of the state's area, followed by Archeans (Granites, Gneisses, and Schists) at 11%, Alluvium at 5%, and Precambrians (Vindhyans, Cuddapahs, and Kaladgis) at 2%.
- Sindhudurg district faces major issues such as steep slopes, declining water level trends, low yield potential, and high salinity in the southwest parts in deeper aquifers. Groundwater utilization in the district is between 35-50%, categorized as safe.
- Ratnagiri district deals with major issues such as hilly terrain (38% area), water scarcity during non-monsoon months, and uneven behavior of joints/fractures. Groundwater utilization ranges between 11-30%, categorized as safe.

- Raigad district faces issues of limited yield potential and low utilization. Groundwater utilization ranges between 9-47%, categorized as safe.
- Thane district struggles with water scarcity during non-monsoon months, limited yield potential, and low utilization. Groundwater utilization ranges between 9-42%, categorized as safe.
- Palghar district experiences water scarcity during non-monsoon months, limited yield potential, and low utilization. Groundwater utilization ranges between 11-36%, categorized as safe.

The details of all Salinity ingression prevention proposed by Govt of Maharashtra are attached as **Annexure- X (b)**

2.5.4.3. Goa

Topographically, Goa consists of three sub-regions: coastal plains (22% of the area), intermediate uplands (35%), and interior hilly regions (43%). Goa's coastline is part of Konkan region. The state's warm, humid climate, influenced by the Arabian Sea, brings abundant rainfall, averaging 3000 mm annually, with higher precipitation towards the Western Ghats.

The coastal alluvium along Goa's coastal plains forms potential aquifers, yielding between 155 and 260 cubic meters per day. Goa's aquifer system is categorized into two primary types: a shallow weathered aquifer (Aquifer-I) and a deeper fractured aquifer (Aquifer-II). Both aquifers demonstrate limited yield potential, presenting considerable challenges for groundwater sustainability. Aquifer-I, located at depths ranging from 9 to 42 meters, is particularly susceptible to salinity, with many areas yielding less than 1 liter per second. This limited capacity intensifies the difficulties associated with effective water resource management in the region. The groundwater salinity is a significant concern, primarily due to marine depositional environments and tidal influences. In North Goa, areas around the Baga and Chapora rivers have brackish to saline groundwater, while South Goa's Marmugao taluka shows high salinity around creeks, especially during month of May when freshwater flow is minimal. Coastal land salinity, influenced by tidal activities in rivers and creeks, affects the flood plains of the Zuari and Mandovi rivers in North Goa and the Zuari, Sal, Saleri, Talpona, and Galjibagh rivers in South Goa. These saline soils are deep, poorly drained, and exhibit reduced permeability.

To address salinity, Goa has implemented remedial measures, including the construction and repair of earthen bunds (dykes) and sluice gates to protect Khazan lands. These lands are crucial for agriculture & pisciculture and support rice cultivation with salt-tolerant species and shrimp aquaculture. Additionally, Khazan lands act as storm water receptacles, preventing inland flooding, while mangrove vegetation serves as a natural anti-erosive barrier for the coastline.

During Quarterly dialogue held on 10.04.2024, CGWB presented an in-depth analysis of Coastal Zone Management from a groundwater perspective. Her presentation highlighted groundwater potential and salinity intrusion in key areas of Goa. The CGWB has installed Digital Water Level Recorders (DWLR) at various locations across the state, facilitating ongoing studies under the National Aquifer Mapping and Management (NAQUIM) program, specifically focusing on salinity ingress in groundwater. The findings indicate that groundwater salinity in Goa is significantly influenced by marine depositional environments and tidal effects. This results in brackish to saline conditions in several regions, particularly along the northern coastline. Areas surrounding the Baga and Chapora rivers are particularly affected by seawater intrusion, complicating water availability for local communities.

- CGWB continuously assesses various water quality parameters through its DWLR. Results indicate that many groundwater samples, particularly during the post-monsoon season, exhibit elevated salinity levels due to tidal influx, underscoring the necessity for ongoing surveillance of water quality. Seasonal variations further complicate the salinity dynamics in Goa. Groundwater quality often fluctuates significantly between pre-monsoon and post-monsoon periods, with the later frequently reflecting higher salinity levels due to reduced freshwater flow during dry months.
- Both geological and anthropogenic factors contribute to the salinity challenges faced by Goa. The region's geology, characterized by schists and laterites, affects groundwater levels and can lead to salinity issues in dug wells, particularly in coastal panchayats. Furthermore, human activities, in conjunction with seasonal influences, exacerbate salinity problems, impacting groundwater quality and availability throughout the state. To address these salinity issues effectively, several recommendations have been proposed. The implementation of tidal regulators and continuous monitoring systems is essential to gain a comprehensive understanding of the impacts of groundwater extraction and tidal influences. Additionally, artificial recharge methods are recommended to enhance groundwater levels and mitigate salinity in critical areas, ensuring sustainable management of water resources in Goa.

The details of all Salinity ingression prevention measures adopted by Govt of Goa along with expenditure incurred in the last 10 years and proposed works or ongoing works are attached as **Annexure-XI (a) and XI (b).**

2.5.4.4. Karnataka

Karnataka's coastline, stretching across Uttara Kannada, Dakshina Kannada, and Udupi districts, showcases a complex interplay of geological and hydrological features. The unique geological formations and climatic conditions have led to significant challenges, particularly concerning groundwater salinity, which affects agricultural sustainability and water quality across the state. Groundwater salinity in Karnataka's coastal plains is generally low, with electrical conductivity (EC) values typically below 1000 µS/cm. However, localized areas, such as Hangarkatta in Udupi district, experience elevated salinity levels primarily due to the marine depositional environment and tidal influences. The fresh-saline groundwater interface is notably close to the coastline, often within a kilometer in sandy regions and about 500 meters from estuaries. However, with retreat of Monsoon after October, interface between fresh and saline groundwater becomes more pronounced. In summer, reduced river flow allows seawater to intrude up to 5-15 km upstream during high tides, leading to the mixing of saline and freshwater. This intrusion exacerbates salinity levels, adversely impacting agricultural lands and water quality for local communities. The effects of increased salinity are profound, resulting in soil degradation, vegetation loss, and rendering water unsuitable for drinking and agricultural use. To address these challenges, Karnataka has implemented several remedial measures, including the construction of Salt Water Exclusion Dams (SWEDs) and Kharland Schemes. SWEDs are strategically built at river mouths to prevent seawater ingress, while Kharland Schemes utilize earthen bunds and sluices to protect cultivable lands from saline intrusion. These initiatives aim to mitigate salinity issues, ensuring the sustainability of coastal agriculture and the overall well-being of the region's inhabitants.

During Quarterly dialogue held on 23.04.2024, CGWB informed that the work of national aquifer mapping has been completed in Karnataka. It was stated that groundwater plays an important role in the management of coastal areas, where excess extraction of groundwater can cause a reversal of flow and salinity ingress issues. Salinity ingress in Karnataka's coastal areas is caused by both natural and human factors. Events like high tides and cyclones lead to seawater intruding into freshwater systems, particularly affecting regions like Ullal Beach in Mangalore and Baindur in Kundapura. Identifying and mapping vulnerable areas is urgently needed to understand the problem's scope. Despite state government efforts, more effective mitigation measures and evaluations of current strategies are required to address salinity ingress comprehensively. Indiscriminate groundwater pumping significantly contributes to salinity ingress in coastal regions. Excessive extraction reduces freshwater availability, facilitating seawater intrusion into aquifers. Additionally, sea-level rise exacerbates this issue by elevating coastal water levels, putting more pressure on freshwater systems and allowing seawater to infiltrate further inland. These challenges, combined with other human activities and climatic changes, threaten coastal ecosystems and communities in Karnataka. Sustainable water management practices and adaptation strategies are vital to mitigating salinity ingress and preserving freshwater resources. Collaborative efforts between state and central governments, supported by relevant institutions, are essential to implementing comprehensive strategies and safeguarding Karnataka's coastal regions.

2.5.4.5. Kerala

Kerala, on India's southwestern tip, has a coastline with nine coastal districts. These districts cover 65% of the state's area and hold 84% of its groundwater resources. The region has high population density and significant land for plantations, crops, and forests. Drained by 41 westward-flowing rivers from the Western Ghats, including Bharatapuzha, Periyar, and Pampa, the coastal plain faces limited groundwater utilization due to its geology, with 88% of the area underlain by low-porosity crystalline rocks, despite over 3000 mm of annual rainfall.

Salinity ingress in Kerala's coastal areas is a significant issue, driven by various factors. Shallow aquifers exhibit electrical conductivity (EC) ranging from 10 to 700 µS/cm, with some areas near tidal influences showing even higher levels. Salinity intrusion is particularly problematic during the summer months due to reduced freshwater flow. Seasonal tidal influences on rivers and lakes, construction of breakwaters that facilitate saline water entry, and urbanization and industrialization exacerbate salinity issues across all coastal districts. This salinity significantly impacts agricultural productivity and water supply, especially in the Kuttanad region, leading to substantial socio-economic challenges.

To mitigate salinity intrusion, Kerala has implemented various structural measures, including the construction of tidal regulators, bunds, and temporary barriers. These interventions have substantially reduced salinity intrusion, improving access to freshwater for agriculture, drinking, and industrial use, thereby supporting local livelihoods. However, the ongoing challenges of salinity ingress underscore the need for continuous monitoring and the implementation of sustainable water management practices to preserve Kerala's freshwater resources and support its coastal communities.

During Quarterly dialogue held on 29.04.2024, CGWB representative highlighted the urgent need to address challenges posed by climate change in Kerala's vulnerable coastal regions - coastal erosion and seawater ingress. Importance of vigilant monitoring and proactive measures to safeguard coastal regions against climate-induced sea level rise and uncertain aquifer recharge patterns was emphasized. Govt of Kerala has undertaken a study titled "Sea Water Intrusion in Coast of Kerala State," under National Hydrology Project. This study focused on the Anjarakkandi, Kadalundi, and Pallikal river basins, aiming to identify salinity extent, seasonal variations, barriers, circulation phenomena, and freshwater requirements for managing saltwater intrusion. The study revealed significant variations in tidal range and salinity intrusion across Kerala's river basins. Tidal range increases from the southern to northern coastal areas, with mean salinity occurring around 0.6-0.7 meters below the surface. Salinity intrusion patterns varied across the basins, with the Pallikkal River experiencing intrusion up to 21 km, the Kadalundi River showing 14-16 km variations influenced by seasonal showers, and the Anjarakandy River recording 21-24 km intrusion.

It was also highlighted during the meeting that salinity ingress in Kerala and Lakshadweep is a pressing issue driven by both natural and anthropogenic factors. There is urgent need for a comprehensive strategy to identify vulnerable areas, utilize advanced GIS mapping, and develop effective action plans to mitigate the impacts of salinity on coastal ecosystems and communities. To address these challenges, there is need for establishment of a dedicated nodal agency, the creation of a comprehensive database, and collaboration with relevant stakeholders. By leveraging available data and engaging communities, a sustainable coastal management framework can be developed to promote resilience and sustainable development in the region.

The details of all Salinity ingression prevention measures adopted by Govt of Kerala along with expenditure incurred in the last 10 years and proposed works or ongoing works are attached as **Annexure-XII (a) and XII (b)**.

2.5.4.6. Tamil Nadu

Tamil Nadu's coastal regions are grappling with profound challenges stemming from salinity ingress into its aquifers, exacerbated by a complex geological landscape and unsustainable groundwater extraction practices. The state's northern districts, including Tiruvallur, Kancheepuram, and Chennai, exhibit a diverse geological makeup comprising younger and older alluvial deposits, boulder beds, Quaternary coastal sands, and underlying Tertiary sandstones and Gondwana formations. This geological diversity significantly impacts groundwater availability and quality, particularly near the coastline where salinity levels pose a critical threat to water sustainability.

The state faces a critical water imbalance, with an annual groundwater extraction of 14.42 billion cubic meters against a recharge of 21.59 billion cubic meters, resulting in a high stage of extraction at 73.91%. Approximately 32% of assessment units are categorized as 'over-exploited,' underscoring the urgency of addressing groundwater sustainability issues. The extensive extraction of groundwater for various purposes amidst rapid urbanization and industrialization exacerbates salinity intrusion in Tamil Nadu. Notably, areas like Minjur and

Cuddalore bear witness to seawater encroachment, while districts such as Ramanathapuram and Tuticorin grapple with in-situ salinity issues.

The aquifers in Tamil Nadu operate under both water table and confined conditions, yet many Tertiary and Gondwana formations exhibit limited yield potential. This limitation intensifies salinity challenges, with areas like the Vaigai basin experiencing severe impacts from saline conditions, highlighting the vulnerability of these aquifers to seawater intrusion. The depth disparities within aquifers further exacerbate the situation, with shallow zones varying from 3 to 54 meters thick and deeper aquifers extending from 100 to 450 meters. As groundwater quality deteriorates closer to the coast, elevated salinity levels increasingly impact freshwater sources, particularly in regions characterized by intense industrial and agricultural activities. Despite ongoing efforts such as artificial recharge methods and check dam constructions, the persistent demand for water across sectors continues to drive seawater intrusion.

Effective groundwater management strategies are imperative to mitigate these challenges, safeguarding the long-term viability of Tamil Nadu's coastal aquifers amidst rising pressures on water resources. Focusing surveillance in sensitive areas (over exploited, urban exploitation, coastal ingress, industrial parks etc.,) and stressing importance of addressing overexploited areas at the block and panchayat levels, emphasizing convergence of policy making and effective ground-level policy implementation by state agencies are key in managing the ground water and thus preventing sea-water intrusion.

The details of all Salinity ingression prevention measures adopted by Govt of Tamil Nadu along with expenditure incurred in the last 10 years and proposed works or ongoing works are attached as **Annexure-XIII (a) and XIII (b).**

2.5.4.7. Andhra Pradesh

The complex interplay of geology and hydrology influences groundwater availability in Andhra Pradesh's coastal regions, particularly in the East and West Godavari districts. It impacts both shallow and deep aquifer conditions across the coastal landscape. Salinity ingress poses a significant challenge in Andhra Pradesh's coastal aquifers, driven by factors such as seawater intrusion and human activities. Instances of seawater intrusion have been observed, leading to elevated salinity levels in groundwater, especially in areas near tidal flats and mangrove swamps. The electrical conductivity (EC) in deeper aquifers can reach alarming levels, up to 46,000 µS/cm, indicating serious salinity issues. Approximately 2.74 lakh hectares within canal commands are affected by waterlogging and salinity, with over 1.15 lakh hectares exhibiting significant salinity problems, primarily due to groundwater withdrawal and surface channel intrusion during high tides.

The salinity issues are exacerbated by unsustainable groundwater extraction practices and the expansion of aquaculture, leading to further deterioration of freshwater quality. The degradation of aquifers, particularly around urban centers and river deltas, highlights the urgent need for effective groundwater management strategies to mitigate salinity and ensure sustainable water supply in Andhra Pradesh's coastal areas. Key issues affecting the coastal districts include water logging, limited fresh water availability, and salinity, exacerbated by rampant aquaculture. Groundwater exploration in the Godavari and Krishna deltas reveals thick saline clays and sediments, rendering wells beyond 20 meters depth saline and unusable. The geogenic nature of sediment deposition contributes to this salinity.

2.5.4.8. Odisha

The coastal region of Odisha is highly disaster-prone, frequently impacted by cyclones and severe sea-water flooding, which significantly affect both agricultural productivity and groundwater quality induced by salinity.

The geological formations in coastal Odisha, comprising alluvial deposits interspersed with Tertiary sediments, create isolated pockets of fresh aquifers situated above saline layers. Saline zones can extend up to 15 km inland, critically impacting freshwater availability, particularly in low-lying agricultural areas. Shallow phreatic aquifers, often composed of unconsolidated sediments, are especially susceptible to saline intrusion, with vulnerabilities heightened by coastal sand dunes and paleo channels formed in earlier geological periods. This salinity issue poses significant challenges for sustainable groundwater management and the accessibility of potable water for local communities.

Multiple factors contribute to the salinity challenges in coastal Odisha. Natural geological processes, excessive groundwater extraction, and coastal erosion, exacerbated by cyclonic disturbances, intensify the problem. Over-extraction, primarily through dug wells and shallow tube wells, leads to declining water table levels and facilitates the lateral movement of saline water into freshwater aquifers, particularly in areas where the hydraulic gradient favors intrusion.

To address these salinity challenges, various remedial measures have been implemented. Saline embankments have been constructed along the coastline to prevent saline ingress from tidal actions and storm surges. Control structures, such as sluices and check dams, are strategically placed to regulate tidal influences and reduce the risk of saltwater intrusion into freshwater aquifers. Additionally, sea walls are erected at vulnerable coastal points to protect against flooding and erosion during extreme weather events.

The implementation of these strategies has yielded significant benefits. Coastal erosion has been reduced, thereby preserving critical habitats and agricultural lands. Protective measures help safeguard farmland from saltwater intrusion, enhancing crop yields and ensuring food security. Furthermore, these efforts increase the resilience of coastal communities against flooding and cyclones while stabilizing sand dunes, which are crucial for local biodiversity, including nesting habitats for Olive Ridley Turtles. Regular monitoring of groundwater quality through electrical conductivity assessments and piezometric studies further supports the management and maintenance of these vital aquifer systems.

The details of all Salinity ingression prevention measures adopted by Govt of Odisha along with expenditure incurred in the last 10 years and proposed works or ongoing works are attached as **Annexure-XIV (a)** and **XIV (b).**

2.5.4.9. West Bengal

The coastal aquifers of four coastal districts of West Bengal viz. North 24 Parganas, South 24 Parganas, Haora, and Purba Medinipur are increasingly threatened by salinity intrusion. Studies indicate that over 48% of groundwater samples exhibit seawater mixing, with electrical conductivity (EC) levels exceeding safe limits for irrigation in more than 80% of analyzed samples. This increase in salinity can be attributed to various factors, including geological formations that consist of unconsolidated, porous sediments, which facilitate the movement of saline water into freshwater aquifers. These sediments, deposited during historical marine transgressions, often trap saline water underground, while limited groundwater flow leads to stagnant conditions that promote salinity buildup.

Anthropogenic factors further exacerbate the salinity issue. Overexploitation of groundwater creates pressure differences that draw saline water inland, while rising sea levels due to climate change push saltwater wedges deeper into aquifers. Additionally, cyclones and storm surges inundate coastal areas with saltwater, further contaminating freshwater sources. The consequences of this salinity crisis are profound, rendering previously fertile land unsuitable for crops, thereby impacting agricultural productivity and local livelihoods. Increased salinity disrupts coastal ecosystems, harming fish populations and plant life, while salinized groundwater becomes unfit for human consumption, leading to freshwater scarcity for communities.

Tackling salinity in West Bengal's coastal aquifers requires a multi-faceted approach that addresses both natural geological factors and human activities contributing to the problem. By adopting sustainable water management practices and investing in ongoing research, the state can work towards preserving this vital freshwater resource for future generations.

The State Water Investigation Directorate (SWID), under the Water Resources Investigation & Development Department, have installed Digital Water Level and Quality Recorders (DWLQRs) at 118 locations in salinity-affected blocks across the state. Each DWLQR is equipped with triple sensors installed at depths of approximately 100, 200, and 300 meters, recording both water level and electrical conductivity (EC) data every six hours, four times a day. Emerging trends from the data collected indicate some anomalous results that require on-site investigation for validation. The chemical wing of SWID has initiated a project to validate these data through on-site studies and calibration of the DWLQRs. Understanding the impact of elevated EC values is crucial, as high salinity can profoundly affect ecology, human health, agricultural productivity, and infrastructure. Through these efforts, we aim to safeguard our ecosystems, protect public health, and ensure the sustainability of our water resources for current and future generations.

The details of all Salinity ingression prevention measures adopted by Govt of West Bengal along with expenditure incurred in the last 10 years and proposed works or ongoing works are attached as **Annexure-XV (a)** and **XV (b).**

2.5.4.10. Summary of Measures taken by States

States/ UTs have been taking measures tackle the issue of salinity ingression into coastal areas as per their requirement & necessity either through their own fund. In some of the cases, States have used various schemes of Government of India in tackling salinization problem. The total expenditure incurred by these States for tackling the salt ingression in the last 10 years is Rs 457.103 crore and the total cost of planned schemes as well as ongoing works for the next 5 years is Rs 1572 crore.

Table 20 shows the salinity Ingress Prevention Works executed in the last 10 years and Table 21 shows the salinity Ingress Prevention Works to be executed in the next 5 years or ongoing:

Table 20 Salinity Ingress Prevention Works executed in the last 10 years

Sl. No.	**State**	**Project Cost (Rs Crore)**	**Source of Funding**
1	Maharashtra	No information provided	
2	Tamil Nadu	34.88	NABARD
3	Gujarat	15.037	State Government
4	Kerala	162.825	State Government
5	Goa	27.101	State Government
6	West Bengal	215.52	State Government
7	Odisha	1.74	State Government
8	Karnataka	No information provided	
9	Andhra Pradesh	No information provided	
	Total	**457.103**	

Table 21 Salinity Ingress Prevention Works to be executed in the next 5 years or ongoing

Sl. No.	**State**	**Project Cost (Rs Crore)**	**Source of Funding**
1	Maharashtra	16.12	State Government
2	Tamil Nadu	81.77	NABARD
3	Gujarat	355.682	State Government
4	Kerala	253.834	State Government
5	Goa	17.63	State Government
6	West Bengal	118.49	State Government
7	Odisha	728.57	State Government
8	Karnataka	No information provided	
9	Andhra Pradesh	No information provided	
	Total	**1572.0962**	

3. Coastal/ Shoreline Management Plan

Coastal Zone Management Plans (CZMP) – Coastal Zone Management Plan (CZMP) are designed to promote sustainable development within coastal zone environments. CZMP are an instrument to be implemented under an Integrated Coastal Zone Management (ICZM) approach which addresses the synergistic relationships of coastal activities and the interdependencies between terrestrial, marine, and coastal environments.

The coastal zone is an essential part of a river basin. The two areas are linked by numerous physical and socio-economic processes including, water quality and quantity, sediment transport, economic development, and livelihood. ICZM identifies the important linkages between the activities in the upstream river basins and the environmental conditions in the downstream coastal zones. The concept of ICZM is therefore aligned with the IWRM approach. As in IWRM planning, ICZM formulates actions necessary to develop an effective framework of policies, legislation, and capable institutions with clearly defined roles, and a set of management instruments, fitting to the countries or regions involved. ICZM approaches express a holistic view to achieve multi-sectoral development; addressing additional issues related to the diverging, and often competing, sectoral land-uses existing within coastal zones.

Integrated Coastal Zone management (ICZM) as a "dynamic, multidisciplinary, and iterative process to promote the sustainable management of coastal zones". ICZM guides action to secure a balance between economic, societal, cultural, and ecological objectives by integrating policy areas, sectors, administration etc. related to terrestrial, marine, and freshwater environments. A core principle of ICZM is the maintenance of ecosystem integrity (and its ability to deliver goods and services essential for human well-being). To achieve this, ICZM encourages an ecosystem-based approach to resource management, with environmental considerations at the forefront of decision-making for all sectoral activities. ICZM can be implemented in combination with other ecosystem-based practices e.g., Nature-based Solutions (NBS), and assessment tools which monitor the state and health of ecosystems and their services.

General Objective of ICZM

- Formulation of Integrated Coastal Zone Management Plan for the Territory/State
- Lessen the coastal erosion
- Reduce vulnerability to disaster
- Biodiversity conservation
- Livelihood security
- Pollution/ environmental quality management
- Improvement and conservation of cultural/ archaeological assets

CZMP are instruments employed under a ICZM approach, designed with the purpose of achieving sustainable development within coastal zone environments. Coastal zones are more commonly defined as dynamic interfaces, or transition areas, between the land and sea. They comprise of some of the most productive terrestrial, freshwater, and marine ecosystems on earth, and are therefore among the most complex systems to study and manage. These favourable environmental and climatic conditions provide humans with a variety of goods and services, resulting in coastal zones being home to a large majority of the world's population.

Purpose of CZM:

- Maximize the benefits provided by the coastal zone
- Minimize conflicts and harmful effects of activities upon each other, resources and the environment
- To dissipate tidal and wave energy & reduce risk from disasters
- To stabilise the adjoining land.
- Promote linkages between sectoral activities
- Guide coastal area development in an ecologically sustainable fashion.

The various steps involved in the prepatation of CZMPs are as shown in Fig. 27

Fig. 27 Various steps involved in the preparation of CZMPs

SHORELINE MANAGEMENT PLAN (SMP) - Shoreline Management Planning is a generic approach to the strategic management of the combined hazards of **erosion and flooding hazards** in coastal areas, which are key concerns under climate change and sea level rise. New approaches to shoreline management involves dividing the coast into a series of natural units (cells and sub-cells). Based on these units, a number of shoreline management plans are then developed which collectively cover the entire coastal length. Each shoreline management plan further divides the coast based on land use and selects a series of strategic options to be applied over the next 50 to 100 years: (1) advancing the line; (2) holding the line; (3) managed realignment; (4) limited intervention; and (5) no active intervention. The practical implementation of these options is not directly considered — this is considered at lower levels of planning. Various Coastal Management Strategies are as shown in Fig. 28

Fig. 28 Various Coastal Management Strategies

Coastal Management Plan (CMP) and Shoreline Management Plan (SMP) are crucial for tackling erosion in an effective way in coastal areas. As per the information available, the status of preparation of Shoreline Management Plan (SMP) by various Maritime States/ UTs are given in Table 22 below.

Table 22 The status of preparation of Shoreline Management Plan (SMP) by various Maritime States/ UTs

S. No	State	Activity	Agency involved	Status
1	Goa	Integrated River Basin and Shoreline Management Plan	National Institute of Ocean Technology (NIOT), Chennai.	Under Preparation. Stake holders meeting held in March 2024.
2	Karnataka	Shoreline Management Plan	National Centre of Sustainable Coastal Management (NCSCM)	Advanced stage of preparation.
3	Maharashtra	Shoreline Management Plan	National Centre of Sustainable Coastal Management (NCSCM)	Advanced stage of preparation.
4	Tamil Nadu	Shoreline Management Plan	National Centre for Coastal Research (NCCR)	Completed and submitted to State Government.
5	Puducherry	Shoreline Management Plan	National Centre for Coastal Research (NCCR)	Completed and submitted to State Government.
6	Andhra Pradesh	Shoreline Management Plan	National Centre for Coastal Research (NCCR)	Completed and submitted to State Government.

7	Kerala	Shoreline Management Plan	National Centre for Coastal Research (NCCR)	Likely to be submitted to State Govt soon.
8	West Bengal	Shoreline Management Plan	National Centre of Sustainable Coastal Management (NCSCM)	SMP prepared in 2020 under Integrated Coastal Zone Management Plan (ICZMP), identifying the highly eroding sites and providing conceptual shore protection measures for those areas.
9	Odisha	No information available		
10	Gujarat	During the Quarterly dialogue, Govt of Gujarat informed that there is no specific Coastal/ Shoreline Management Plan for Gujarat State.		

4. Role of CWC, DoWR, RD&GR in Coastal Area Management

As per the allocation of Business Rule 1961, Sea Erosion is one of the mandates of DoWR, RD&GR under Ministry of Jal Shakti.

4.1.Coastal Management Information System (CMIS)

All maritime states are experiencing problems of coastal erosion in varying magnitude. Some of the general problems along the Indian Coast which require engineering intervention are erosion of the coastline; flooding during storm surge; sand bar formation near river mouths and estuaries; silting up of entrance channels etc. The measures to control erosion include non-structural and structural or their combination. A combination of hard and soft options has become more popular recently for optimum results. For planning of coastal protection projects, the collection of systematic coastal data cannot be overemphasized. Identification of various coastal processes and causes of erosion is required for planning and design of Coastal Protection Works. Vast set of data on Sediment transport, wave, tides, bathymetry, geological data, satellite imageries etc. is required to analyze the problem. However, the site-specific coastal data was not available or was very limited with different agencies. In absence of such coastal data, coastal protection works were undertaken in an unscientific manner. Though agencies viz INCOIS, NCCR, NIOT under Ministry of Earth Sciences (MoES), NIO under CSIR, NHO under MOD, MoEF, etc have been collecting coastal data as per their mandate, those data are not directly usable for planning/design of coastal protection works as these agencies are collecting data as per their mandate & requirement. There was also lack of uniform data collection format and sharing within different agencies/stakeholders.

In view of lack of dedicated coastal data bank to tackle coastal erosion at National level/State level, DoWR,RD&GR, Government of India decided to create CMIS as one of the specific activities during 12th Plan. Under CMIS it was proposed to develop an integrated data bank at National Level to tackle coastal erosion in a scientific manner and keeping in view the long-term perspective and challenges of climate change. Analysis of data would be used for Identification of various coastal processes and causes of erosion which will be utilized for planning and design of Coastal Protection Works. Accordingly, Central Water Commission (CWC) initiated “Coastal Management Information System (CMIS)” under the Plan Scheme “Development of Water Resources Information System (DWRIS)”. The CMIS envisages setting up sites along the coast of the maritime States/UTs of India for collecting data of relevant coastal processes.

The objectives of CMIS are:

i. Collection, transmission, processing & analysis of near shore data for coastal protection measures: 9 Parameters i.e. Wave, Current, Tide, Riverine Data, Wind, Coastal Sediment, Beach Profile, Bathymetry and Shoreline Change to be observed under CMIS.
ii. To create an integrated data bank to tackle coastal engineering problems in a scientific manner along with challenges of climate change.
iii. Analysis of collected data and recommendation of suitable Coastal Protection method.

The prime objective of CMIS is to collect near shore parameters at vulnerable reaches of the entire east and west coast which will be used in the design, construction and maintenance of site-specific coastal protection structures whereas other agencies collect ocean parameter as a whole.

The CMIS data collected are being utilized for various purposes which are broadly indicated below:

- Determination of causes of erosion.
- Estimation of sediment transportation (Cross-shore and along shore) /sediment budget etc.
- Providing the Design input parameters for coastal protection works.
- Development & validation of Numerical models
- Providing the Design input parameters for Salt water Intrusion protection works.
- Development of Coastal Protection Plan (CPP) for short term measures.
- Coastal Management Plan (CMP) for entire coast as a long-term solution.
- Sharing of data with Stakeholders / State Govts for Coastal Studies on vulnerable location.
- For Research and Development projects.

The details of parameters, instruments and frequency of data collection at a CMIS site is as shown in Table 23 below.

Table 23 The details of parameters, instruments and frequency of data collection at a CMIS site

S.No	Parameters	CMIS Equipment	Frequency of Data Collection
1	Wave	Directional Wave Rider Buoy (DWRB)	Continuously
2	Offshore Ocean Current	Marine Acoustic Doppler Current Profiler (MADCP)	Continuously
3	Tide	Pressure Based Tide Gauge (PBTG)	Continuously
4	Wind Velocity & Direction, Relative Humidity, Temperature, Rainfall	Automatic Weather Station (AWS) – Land based	Continuously
5	River Discharge	ADCP	Thrice a day (during high tide, low tide and mid tide), twice in a month (once during the Spring Tide & once during Neap Tide), once during Pre-Monsoon, twice during the Monsoon and once again during Post Monsoon
	River Sediment Load	LISST	
	Salinity	CTD	
6	Bathymetry	Echo-Sounder with data logger & GPS	Pre-monsoon & Post Monsoon

7	Beach Sediment	Sieve Shaker	Monthly
	Offshore Suspended Sediment	Niskin Sampler	
	Sea bed sediment	Grab Sampler	
8	Beach Profile	Real Time Kinematic (RTK) GPS	Monthly
9	Shoreline Change		

The collected data is shared with State Govt. as and when requested.

Under CMIS, 8 nos. of sites have been established so far, as shown in Fig.29, for data collection activities. These include 2 sites in Maharashtra, 2 sites in Goa and one site each in Gujarat, Kerala, Tamilnadu & UT of Puducherry. Details of these are given below:

Considering expertise available with some of the institutions, it was decided to implement the scheme through Tripartite MoU between CWC as Project Implementer, Expert agency as Project Executor and the concerned State/UT Government as Project Facilitator. Accordingly, 3 separate tripartite MoUs were signed for establishment of 8 nos. of CMIS stations, details of which are as follows:

i. **IIT Madras, Chennai, participating states and CWC for sites Devaneri (TamilNadu), Ponnani (Kerala) and Karaikal (Puducherry)**

   The MoU was signed in 2016 for 3 years with an outlay of Rs 896.05 Lakh. The MOU was further extended for one more year in Feb, 2020 which ended in May, 2021 with an estimated cost of Rs 414.308 Lakh. The project with IITM as Project Executor came to an end on 31.05.2021 incurring an expenditure of 1310.36 lakh. Since, June 2021, regional office of CWC situated at Kochi, Kerala is performing the activities of coastal data collection and other allied activities at the 3 CMIS sites spread across Kerala, Tamil Nadu, and Puducherry with available manpower and expertise. Data collection is carried out as per the tidal prediction charts of Survey of India.

ii. **NIO, Goa, participating states and CWC for sites Baga-Anjuna & Benaulim-Mobor (Goa) and Malwan (Maharashtra)**

   The MoU among CWC, National Institute of Oceanography (NIO), Goa and respective Maritime State Govts was signed in March 2019 for three years at an estimated cost of **Rs.1376.60 lakh**. Establishment of three no. of coastal data collection sites (Tarkhali in Maharashtra, Benaulim in Southern Goa, Baga in Northern Goa) is completed and data collection activities for 9 coastal parameters are in under progress. The total expenditure till date is Rs 1063.05 lakh. Initially the duration of project was 36 months; however, due to COVID -19 pandemic during 2020-21, project could not be completed in stipulated duration. Therefore, project duration was extended up to November 2024. Recently, NIO, Goa has shown its willingness for extension of MoU within the stipulated cost.

iii. **CWPRS, Pune, participating states and CWC for sites Nanidanti-Motidanti (Gujarat), Satpati (Maharashtra)**

   The MoU was signed in January 2019 for three years with an outlay of **Rs 695.531 lakh**. Initially the duration of project was 36 months, however, due to COVID -19 pandemic and loss of equipment in Tauktae cyclone during 2021, project could not be completed in stipulated duration. In view of that, project duration was extended up to June 2024. The total expenditure till date is Rs 458.20 lakh. Proposal for further extension up to Dec. 2025 within the original cost has been received from CWPRS, which is under process.

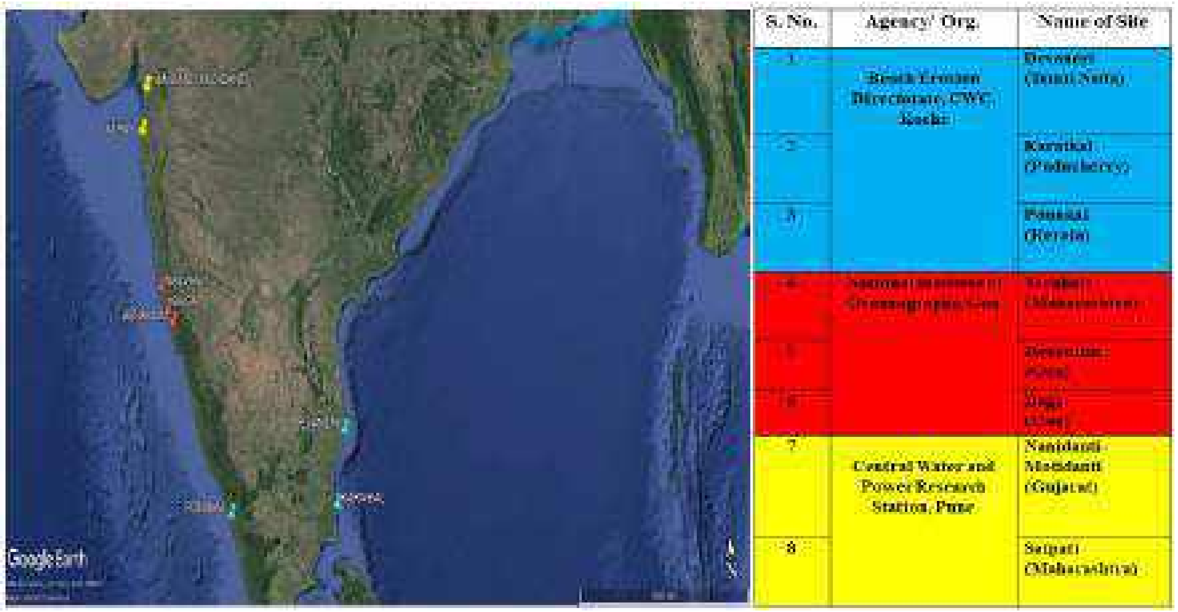

Fig. 29 Location of Current CMIS sites

For all these years, a data base has been created and is being maintained in CWC. CMIS envisages to bring all such data from various sources on single central platform viz. India-WRIS. It is also envisaged that coastal data available with States/UTs and various institutions would be integrated with this central portal for dissemination to stakeholders conforming to Data Dissemination Policy which is likely to be finalised soon. A website for CMIS is also being developed which will be hosted on India-WRIS portal.

The DWRIS EFC Memo (2021-26) proposes further expansion of CMIS sites with establishment of 12 new sites. Based on vulnerability assessment as per the reports of Shoreline Change Atlas of Indian coast prepared by National Centre for Coastal Research (NCCR) and Space Applications Centre, tentative locations of these 12 sites have been finalized in consultation with the respective State Governments. These 12 sites are tentatively located in Kerala (3 sites), Karnataka (1 site), Tamil Nadu (1 site), West Bengal (2 Sites), Andhra Pradesh (2 Nos) and Odisha (3 sites). Details of these sites are shown as per the Table 24 below.

Table 24 Details of proposed CMIS sites

S. No.	State	District	Location
1.	West Bengal	East Midnapore	Digha to Mandarmani sector
2.	West Bengal	South 24 Parganas	South east and west of sagar islands
3.	Andhra Pradesh	East Godaveri	Uppada coastal segment
4.	Andhra Pradesh	Prakasam	Binginapalli to Ullapalem sector

5.	Odisha	Ganjam	North of Gopalpur port
6.	Odisha	Kendrapara	Rajnagar City and nearly 50 km from Kendrapara Town (Pentha)
7.	Odisha	Puri	Near Lotus Eco Resort, Konark
8	Karnataka	Dakshina Kannada	Ullal to Thalapadi sector
9	Kerala	Ernakulam	Chellanam
10	Kerala	Alappuzha	Purakkad to Nirkunnam Sector
11	Kerala	Kozhikode	Kappad
12	Tamil Nadu	Villupuram	Chinamudaliar chavadi

DoWR,RD&GR decided to initiate action for opening of 4 sites in the first phase under CMIS. The proposal for opening of these sites is under consideration in DoWR,RD&GR. The details of these 4 sites are shown in Table 25 and also in Fig. 30.

Table 25 Details of the 4 CMIS sites in the advanced stage of approval

Sl. No.	**State**	**District**	**Location**	**Latitude**	**Longitude**
1.	West Bengal	East Midnapore	Digha to Mandarmani sector	21°39'25" N	87°39'47" E
2.	West Bengal	South 24 Parganas	South east and west of sagar islands	21°38'41"N	88°07'16"E
3.	Andhra Pradesh	East Godaveri	Uppada coastal segment	17°04'28"N	82°19'42"E
4.	Odisha	Puri	Near Lotus Eco Resort Konark	19°51'31"N	86°55'78"E

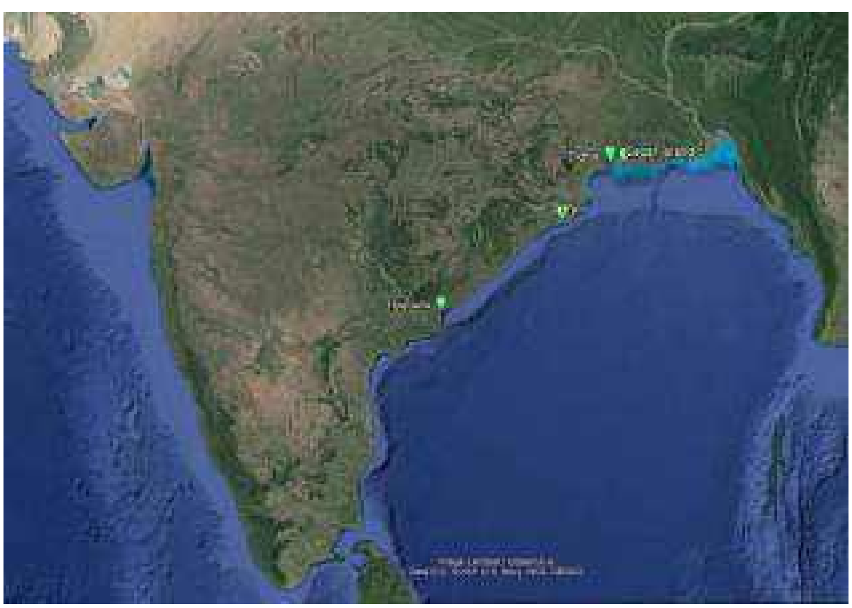

Fig. 30 Location of the 4 new proposed CMIS Sites

4.2. Data Collection by Maritime States/ UTs & other Institutions

To deal with the problem of coastal problem on localized level, various Maritime States / UTs were taking support from Central Institutions viz, CWPRS, Pune; NCCR, Chennai; NIO, Goa; NIOT, Chennai; NCSCM, Chennai; INCOIS, Hyderabad etc. These institutions have been collecting coastal related data for planning and design of coastal protection measures for those particular sites. In some cases, Maritime Boards of States are also collecting data. CMIS envisages to bring all such data from various sources on single platform viz. India-WRIS. A website for CMIS is also being developed which was hosted on India-WRIS portal as shown in the Fig. 31.

Fig. 31 India-WRIS portal for hosting the CMIS data

All the States/ UTs and institutions have been requested to share all the coastal related data to CWC so as to populate them on CMIS portal. During 19th meeting of CPDAC, recently held in June 2024 at Kolkata, all the States/ UTs and institutions were again requested to provide details of sites at which any type of coastal parameters have been observed/ are being observed and to share the data with CPDAC Secretariat.

4.3. Coastal Protection and Development Advisory Committee (CPDAC)

Realizing the need of overall planning and cost-effective solution to the coastal problems, the Govt. of India constituted Beach Erosion Board (BEB) in the year 1966 under the Chairmanship of Chairman, CWC (erstwhile CW&PC) to guide and implement the programme of anti-sea erosion works in Kerala. Chief Engineer In-charge of anti-sea erosion works of Kerala was appointed as Member-Secretary. Govt. of India reconstituted the Board in 1971 and further in 1989 extending its jurisdiction to the entire coastline of the country for comprehensive study of the coastal erosion processes and measures to tackle the problem in a scientific and coordinated manner. The Board has held 24 meetings so far and carried out advisory functions pertaining to design and construction of cost-effective seawalls. Construction materials and methods have also been recommended after experimental testing in selected stretches along the coast. Expert

Committees were constituted by the Board from time to time to study the problem of special nature on receipt of such a request from the maritime States.

As development surged in protected coastal zones and population pressures intensified in densely populated coastal areas, the BEB underwent further restructuring and was renamed the "Coastal Protection and Development Advisory Committee" (CPDAC) in April 1995 under the Chairmanship of Member (River Management), Central Water Commission. CPDAC was constituted to guide and implement the programme of anti-sea erosion works & to consider the development potential in the protected coastal zone. The committee, with its secretariat housed within the CWC, is a high-level inter-ministerial body comprising coastal engineering experts and representatives from Coastal States and relevant Central Departments to provide a common platform (total 27 Members) to discuss and solve the coastal erosion problems. All the leading Central Institutions viz. NCCR, Chennai; NIO, Goa; NIOT, Chennai; CWPRS, Pune; SAC, Ahmedabad; INCOIS, Hyderabad; NCESS, Thiruvananthapuram; IIT Madras etc. are associated with CPDAC. Its primary mandate is to identify and harness the diverse resource potential available within protected coastal areas for sustainable development.

4.3.1. Main Functions of CPDAC: -

i) To organise a coordinated programme of collection, compilation, evaluation and publication of data relating to various natural phenomena in coastal processes which affect the coastal line

ii) To organise general investigation, studies and research with the help of Central and Coastal Engineering Research Institutions

iii) To lay down principals in construction techniques of coastal protection measures for the guidance of State Authorities

iv) To review the performance of the works carried out by State and evolve improved design techniques based on such experience from time to time

v) To inter-act with International agencies engaged in the coastal protection technology transfer in the field of coastal protection

vi) To identify the coastal zone to be develop behind the coastal protection works with the help of State Governments

vii) To identify the development potential in various techno-economic activities and advise the concerned state Governments to prepare programmes for development

viii) To draw up long term and short-term plans for coastal protection and development of the coastal zones

ix) To appraise and recommend various coastal protection and development works for inclusion in State plans

x) To arrange effective and timely monitoring of the coastal protection and development projects.

xi) To review the action plan for rehabilitation and resettlement of the coastal development affected people and monitor the progress on rehabilitation and resettlement.

4.3.1.1. Status & Achievement of CPDAC

A total of 19 meetings of CPDAC have, so far, been held in various Maritime States. 19th meeting of CPDAC was held on 24th June 2024 at Kolkata, West Bengal.

Major Achievements of CPDAC are as enumerated below.

(a) CPDAC as a platform had been instrumental in the process of re-computing the Coastline length of India through the comprehensive exercise undertaken during the 11th meeting in collaboration with NHO, Dehradun. Re-calculation of coastline length has been successfully completed by NHO and the same already discussed & agreed by National Security Council Secretariat (NSCS), will be promulgated soon.

(b) CPDAC's strategic foresight and collaborative efforts materialized in the successful development and publication of the Shoreline Change Atlas of the Indian Coast. Initiated during earlier Committee meetings, CPDAC's decision to engage SAC, ISRO, resulted in the creation of a comprehensive atlas on a 1:25,000 scale, offering valuable insights into coastal changes for the 2004-06 and 2014-16 timeframes.

(c) As per the initiative of CPDAC, Government of India initiated Project Preparatory Technical Assistance (PPTA) in association with Asian Development Bank (ADB) to prepare an investment programme for Sustainable Coastal Protection and Management Project in the States of Goa, Maharashtra and Karnataka through Asian Development Bank (ADB).

(d) The Sub-committee on Performance Evaluation of Coastal Protection Works, operating within CPDAC, has made field visits to assess the efficacy of coastal protection measures implemented by various State governments. These on-site evaluations serve as invaluable benchmarks, offering practical insights and lessons for other States to adopt. The reports published by the Sub-committee not only highlight successful strategies but also pinpoint areas for improvement, facilitating a collaborative approach to coastal protection.

(e) Updating of Manual namely "Protection and Control of Coastal Erosion in India" by CWC in association with NIO, Goa.

4.4. Appraisal & Monitoring of Projects

Coastal Protection Projects are Planned & Executed by respective Maritime States/ UTs. Central govt. plays promotional, advisory & catalytic in nature. These projects are generally funded by States/ UTs from their own fund or from multilateral funding or through Central Assistance.

4.5. Flood Management and Border Areas Programme (FMBAP):

Though projects for flood management and control of flood & erosion are formulated and implemented by respective State Governments/Union Territories from their own resources and as per their priority, Central Government provides financial assistance to states/UTs for implementing some projects in critical areas under a State Sector Scheme namely FMBAP. Critical Anti-erosion Works in Coastal area are also eligible for funding under FMBAP. However, no projects for coastal protection have been funded under FMBAP so far since approval of the scheme in 2017-18.

The details of FMBAP under DoWR,RD&GR (MoJS) is as shown in Table 26.

Table 26 Details of the FMBAP under DoWR,RD&GR (MoJS)

Scheme for Central Assistance under DoWR,RD&GR (MoJS)		
Flood Management & Border Areas Program (FMBAP)	Total outlay of **Rs. 4100 Cr** for the period of 2021-26.	**90:10** for Special Category States **60:40** for General Category States

However, no projects to mitigate the coastal erosion have been received for funding under FMBAP.

4.6. National Coastal Protection Project (NCPP)

NCPP was initiated with a view to explore the possibility of funding coastal protection works through external assistance. Beach Erosion Board (now CPDAC), in its 23rd meeting held in July, 1994, requested Maritime States to formulate proposals for protection of vulnerable coastal reaches from sea erosion in their respective states and send the proposals to CWC who, in turn, will coordinate and prepare a consolidated National Coastal Protection Project (NCPP) for exploring external assistance. In July 2004, Ministry of Water Resources, after thorough examination of the proposal has directed to re-formulate NCCP after finalization of proposals of all the coastal States & UTs for protection of coastal areas from sea erosion with a view to explore possibilities of funding through external resources or other domestic resources. However, Funding for NCPP could not materialize. Subsequently, anti-sea erosion projects were made eligible for funding under State Sector – Flood Management Programme (FMP) since XI Plan. Anti-sea erosion projects are still eligible for funding under FMBAP.

4.7. Sustainable Coastal Protection and Management Investment Programme (SCP&MIP):

As an outcome of discussions between the Government of India and the Asian Development Bank (ADB), a Project Preparatory Technical Assistance (PPTA) programme for preparing a *Sustainable Coastal Protection and Management Project* for the states of *Maharashtra, Karnataka & Goa* was taken up. PPTA Final report was completed in May 2009. Under PPTA an investment programme estimating to $404.6 million USD (revised) including ADB loan of $250 million has been envisaged. Further, the multi-tranche facility (MFF) for project was approved by ADB on 29th September, 2010 for and amount of $250 million USD. ToR of PPTA also included preparation of one or two projects in each participating state for immediate implementation based on state's priority. Mirya Bay (Maharashtra), Coco and Colva Beach (Goa) and Ullal (Karnataka) projects were selected for implementation in first tranche and Feasibility Study and Design report for these projects were completed under PPTA. Later on State Govt. of Goa did not pursue for TAC approval for its projects.

The Sustainable Coastal Protection and Management Investment Program (SCP&MIP) aimed to address immediate coastal protection needs and coastal instability using environmentally and socially appropriate solutions, with a focus on softer options such as artificial reefs, beach nourishments, and dune management in the states of Karnataka and Maharashtra. It also developed institutional capacities to meet the long-term needs of sustainable coastal protection and management, and support initiatives to increase the participation of the private sector and communities in coastal protection and management. SCP&MIP was implemented in two tranches. The investment program had the following envisaged impact: improved income and reduced poverty of the coastal communities in the subproject areas of the coastal states of Karnataka and Maharashtra. The investment program had the following envisaged outcome: protected and managed shorelines in two states, meeting the needs of stakeholders and protecting the environment. The outcome was to be achieved through the following outputs: (i) sustainable plans and management for shorelines developed, (ii) coastal erosion and instability managed and reduced, and (iii) capacity for shoreline planning and development enhanced. The multi-tranche facility (MFF) for project was approved by ADB in 2010 for amount of $250 million to be implemented over a period of 8 years. Project Preparatory Technical Assistance (TA) broadly supports National Coastal Protection Project (NCPP). ADB has agreed for extension of Project Preparatory Technical Assistance (PPTA) to two more maritime States viz Tamil Nadu & Gujarat.

4.8. Climate Resilient Coastal Protection and Management Project (CRCPMP)

A Technical Assistance (TA) programme has been signed by Government of India for TA 8652-IND: Climate Resilient Coastal Protection and Management Project (CRCP&MP) to support mainstreaming of climate change consideration into coastal protection and management at the national level and in the two focal states (of Karnataka and Maharashtra) where the Sustainable Coastal Protection and Management Investment Programme (SCP&MIP) is already operational under external assistance from Asian Development Bank(ADB). The implementation of this TA will be financed by a grant amounting to Two Million USD ($) from Global Environment Facility (GEF) & administered by ADB. One of the major objectives of this TA is to analyze the climate change impacts into coastal areas and based on the same planning & design criteria and guidelines for coastal climate change adaptation are to be prepared.

A reference manual for climate change adaptation guidelines for coastal protection namely *"Reference manual on Climate Change Adaptation Guidelines for Coastal Protection and Management in India"* was prepared by a team of international and national experts under CRCPMP. CWC's *'Guidelines for Preparation of DPR for Coastal Management Projects under Climate Change Scenario 2020'* is based on this reference manual.

4.9. Procedure for Submission, Appraisal and Acceptance for Central Assistance/Externally aided projects;

- Preparation of DPR as per CWC Guidelines for Coastal management Projects.
- Submission of the Projects to field units of CWC after cleared by State TAC and other State/Central Agencies.
- Field units of CWC forward the DPR to Nodal office i.e. Coastal Management Directorate in CWC (HQ) for detailed examination after carrying out the preliminary investigation.
- The coastal protection projects are examined by nodal and specialized units in CWC (HQ).

- However, if the project is externally assisted then the DPR is to be submitted to Deputy Secretary, EA, Department of Water Resources, River Development and Ganga Rejuvenation (DoWR, RD & GR). DoWR, RD & GR forwards the DPR to CWC (HQ) for detailed examination.
- After examination by nodal and specialized units and compliance by Project authority and all the Statutory clearances having submitted by the Project Authority, an appraisal note will be prepared and put up to Advisory Committee of DoWR,RD&GR for consideration of techno-economic viability.
- The advisory Committee accepts or rejects the Proposal and if found acceptable recommends the Proposal for investment clearance.
- Proposal for investment clearance is to be submitted by Projects Authorities to CWC.
- The proposal is examined with reference to check list and guidelines issues by DoWR, RD &GR. If it is found acceptable, it is forwarded to DoWR, RD &GR with recommendations.
- The Ministry then considers the same in the Committee for accord of Investment clearance. If found acceptable, investment clearance for the same is issued by Ministry.

4.10. Salinity Ingression in Coastal Area

On Hon'ble Prime Minister's intervention that the Water Resource Ministry may examine the issues of salination of land along the coast in a scientific manner and suggest suitable remedial measures, a Technical Committee was constituted in 2014 under Chairman, Central Water Commission with members from CGWB, GSI, NIH, representative of coastal States/ UTs. Chief Engineer, HSO, CWC was the Member Secretary of the Committee. Committee has submitted its report titled "Problems of Salination of Land in Coastal Areas of India and Suitable Protection Measures" in July 2017.

Committee discussed the problems of sea salinity State-wise and measures being adopted in respective States/ UTs in threadbare manner. Report also included State-wise total schemes undertaken either completed/ ongoing/ planned for remedial measures for salinity ingression as shown in Table 27.

Table 27 State-wise total schemes undertaken either completed/ ongoing/ planned for remedial measures for salinity ingression

Sl. No.	State	Saline land in th. Ha	No. of structure completed/ ongoing	Area benefitted (ha)	Cost incurred (Rs in Cr)	Proposed Structures	Area to be benefitted (ha)	Proposed cost (Rs in Cr)
1	Gujarat	714	10829	281260	1072	2412		1090.19
2	Maharashtra	64	421	42192	64.65	148	5635	108.53
3	Goa	18			40.55	57		159.00
4	Karnataka	86	143	15836.45	55	326	15058	780.60
5	Kerala	26	91+bunds		294.58	26		344.20
6	Tamil Nadu	100	4			53		1255.63
7	Andhra Pradesh	276	Pilot studies conducted			Survey Proposed		14.29
8	Orissa	400	30	42252	88.51	20	20858	90.17

9	West Bengal	820	Drinking water purification		1667.69	Drinking water Purification		1500.00#
10	Puducherry	1	368 (approx)		130.71			125.00
11	Daman & Diu		No Data Received					
	Total		**22473**		**1599**	**2927**		**5467.61**

 # The salinity ingress component has not been separately indicated by the State Government.

Committee, in its finding, observed that the problem of coastal saline soil occurs in varying degrees in the states of Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha, West Bengal and the union territories of Daman & Diu and Puducherry. In most of the areas, lack of drainage system has been the main contributing factor; in some areas, overdraft of groundwater, ingress of saline sea water and unscientific agricultural practices are adding to the problem in a big way.

A brief of recommendation of the Committee area:

- Immediate need to protect the coastal lands which are most vulnerable to the problem of salinity intrusion.
- Minimum flow in rivers to ensure that sea water is prevented from entering inland if rainfall is abundant.
- There is a need to develop an effective mechanism to scientifically monitor salinity level in the ground water that helps adopting suitable protection measure for the particular location and scenario.
- For improving knowledge about salinity risks and suggesting remedial measures, a National Center for Scientific Study of Salinity Ingress in Delta Regions may be setup by CWC/ Ministry of Water Resource, River Development & Ganga Rejuvenation.
- Framing of scheme at the Central level: funding for sea-salinity scheme can be provided from the existing schemes of MoWR, RD & GR or a separate scheme may be created and necessary central assistance may be provided for execution of such projects.
- Necessary guidelines/ modalities etc. may be framed by CWC in consultation with CWPRS, CGWB and any other technical agency, as required.
- State will submit proposal for central funding to CWC after approval of State TAC
- Strengthening of Coastal Erosion Directorate at CWC HQ
- Community awareness about sea salinity, excessive drilling and usage of ground water

As per the recommendation of the Committee, CWC prepared the "Guidelines for preparation of Detailed Project Report (DPR) for Salinity Ingress Management Project in Coastal Areas" and submitted to DoWR,RD&GR in 2023. The same is under approval.

4.11. Capacity Building

Training: As part of the MoUs signed by CWC with IIT Madras; CWPRS, Pune and NIO, Goa, some basic trainings were imparted by these institutions. Higher level trainings on analysis, design, modelling etc including hands-on were also organized. NWA, Pune, in association with Coastal Management Dte has also organized training course on these matters. However, it has been observed that there is not much interest among CWC officials in opting for such training.

Officials involved in coastal matters are only generally opting for such training. After completion of respective tenure, Workshops are also planned.

Indian Institute of Technology, Madras is a leading academic and research center in India. Department of Ocean Engineering (DoOE), IIT Madras is dedicated to advancing knowledge and technology in the field of ocean engineering. Earlier, IIT Madras was one of the Project Executor for 3 nos. of CMIS sites (located in Tamil Nadu, Kerala & Puducherry) of CWC from 2016 to 2021.

DoOE, IITM has submitted a proposal for establishment of National Centre for Coasts and Coastal Water (NC3W) at IIT Madras in collaboration with CWC, DoWR,RD&GR. This initiative is aimed as a necessary response to the escalating global challenge of climate change, specifically its impact on coastal regions and water security. The proposal underscores the need for a collaborative and interdisciplinary approach, integrating engineering, humanities, social, and natural sciences to develop effective adaptation and mitigation strategies.

The NC^3W is envisioned as a national hub with a three-pronged approach: research, education, and knowledge transfer. It aims to consolidate existing networks and expertise of CWC field offices, creating a unified regional network. Central to the NC^3W's research agenda are three interconnected clusters:

"Coastal Water Security," addressing challenges like saltwater intrusion and erosion;

"Coastal Ecosystem Resilience and Nature-Based Adaptation Measures," emphasizing the role of ecosystems in adaptation; and

"Transfer Strategies for Climate Adaptation & Mitigation," focusing on integrating traditional knowledge and local economies into climate solutions.

The key aspects of the NC3W's methodology are:

a) Implementation of a "living lab" in Chennai: To facilitate real-world research, addressing the city's specific vulnerabilities, such as flooding and water scarcity, to develop practical solutions applicable to other coastal communities.
b) Capacity building: A new global M. Tech course on "Coastal Engineering" to nurture a new generation of environmental leaders.
c) International collaboration and knowledge exchange.

5. Role of various Central institutions

5.1. Central Water and Power Research Station (CWPRS)

The Central Water and Power Research Station (CWPRS) in Khadakwalsa, Pune, is a leading research institution under the Union Ministry of Jal Shakti. Specializing in hydraulic research, CWPRS focuses on water resources, energy, and water-borne transport. It conducts physical and mathematical model studies in areas such as river training, flood control, and coastal protection. Collaborations with various organizations and educational institutions bolster its research efforts. CWPRS provides expertise and consultancy services to central and state governments, addressing water-related challenges and disseminating research findings. Moreover, it builds technical databases and promotes research activities nationwide, significantly contributing to advancing knowledge and providing solutions for sustainable water resources management and development.

CWPRS activities encompass river engineering, reservoir systems modeling, coastal and offshore engineering, and calibration and testing services.

Activities of CWPRS on coastal matter:

- Comprehensive studies, including desk studies, wave flume tests, and field observations, to ensure hydraulic stability and effectiveness in mitigating coastal erosion.
- Undertakes coastal protection works, including the design and construction of seawalls, coastal protection works using stones and tetrapods, and measures to protect infrastructure such as natural gas pipelines from erosion.
- CMIS – Executing agency for 2 nos. of CMIS sites of CWC for collection, compilation and collation and analysis of coastal data for informed decision-making and long-term planning for coastal protection measures.

CWPRS, Pune was involved in designing of coastal erosion structures & prevention of sea-salinity structures in almost all the Maritime States. CWPRS is also involved in various studies in coastal matters including modelling. CWPRS is also one of the crucial partners in CPDAC.

5.2. Indian National Centre for Ocean Information Services (INCOIS)

INCOIS, operating under the Ministry of Earth Sciences (MoES), is at the forefront of managing the Indian Tsunami Early Warning Centre (ITEWC) and providing oceanic information and advisory services. Acknowledged as a Regional Tsunami Service Provider (RTSP) by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, ITEWC issues daily advisories and alerts, particularly benefiting fisherfolk and maritime industries. Alongside operational duties, ESSO-INCOIS conducts extensive research, operates ocean observing systems, and hosts training programs. Its active engagement in international collaborations and contributions to state-of-the-art initiatives significantly aids in the advancement of oceanic research and safety measures on a global scale.

ESSO-INCOIS delivers a comprehensive range of services, including Multi-Hazard Early Warning Services (such as Tsunami Early Warning Services, Storm Surge Early Warning Service, and Ocean State Forecast), Data Services (covering Operational Remote Sensing Data

Products, in-situ Data, and Digital Ocean), Applied Research, Ocean Observation Network, Ocean Modeling & Data Assimilation, and Research and Development efforts. These activities span various facets of oceanic research, forecasting, and service provision, enhancing safety measures and fostering a deeper understanding of oceanic phenomena. Additionally, INCOIS's assessment of shoreline change, conducted using satellite data between 1972 and 2000, plays a key role in determining the shoreline change rate, a crucial parameter for calculating the coastal vulnerability index along the Indian coast. This analysis, carried out from 2007 to 2009, provides invaluable insights into coastal dynamics and vulnerability, contributing significantly to coastal management strategies and decision-making processes.

INCOIS is member of CPDAC and also helping in framing the Data Dissemination Policy for coastal data.

5.3.National Centre for Coastal Research (NCCR)

National Centre for Coastal Research (NCCR) traces its origins to the Environment Management Capacity Building (EMCB) program initiated by the Government of India in 1997. Originally established under the Department of Ocean Development (DOD) as the Integrated Coastal and Marine Area Management (ICMAM-PD) project, one of the key mandates of NCCR was to address the multifaceted challenges facing India's coastal zones. Over time, the center evolved into a long-term research and development entity, ultimately designated as an attached office of the Ministry of Earth Sciences (MoES). This transformation underscores NCCR's role in advancing scientific understanding and promoting sustainable management practices in coastal regions.

The NCCR is mandated to provide best possible technological and scientific services / support for sustainable management of coastal areas by developing and improving capabilities related to coastal water quality, coastal processes, shoreline management, coastal hazards- vulnerability and coastal ecosystems through multi-disciplinary and integrated research programmes. And the vision of NCCR is to be a center of excellence for coastal research and offer scientific, advisory and outreach services to the coastal states and stakeholders for sustainable management of the coastal areas with a mission to carry out multi-disciplinary research related to coastal water quality, coastal process, shoreline management, coastal hazards-vulnerability and coastal ecosystems for the benefit of society and environment.

NCCR is involved in the Monitoring of beach morphology and impact of coastal structures on shoreline. This activity is being carried out at selected locations along east coast of India to develop a national data base. The survey includes Beach Profile survey, Littoral Environment Observation (LEO) observation, Wind & near shore measurements, Sediment collection (foreshore, bermline, and backshore), Geological observations (Rock types), Vegetation and shoreline. Monitoring the beach sediment characteristics, coastal geological and geomorphologic landforms feature with references to coastal /beach processes.

NCCR is also involved in Coastal Process and Sediment transport modelling (Fig. 32). It is being implemented at selected locations along the Indian coast by involving five premier research and academic institutions. The main focus of this activity is to understand the causes and intensity of shoreline changes and estimate the sediment transport rates through field data measurements and numerical modelling.

NCCR has also undertaken the study to understand the impact of sea level rise and climate change on coastline. A pilot study on shoreline retreat with sea level rise was carried out for Chennai coast Similar work is being extended for other priority locations along the coast.

Under its National Shoreline Assessment System (N-SAS), NCCR has published *National Assessment of Shoreline Changes along Indian Coast* in March, 2022.

Development of Web Application for Coastal Change System: A beta version of web applications is developed to provide required information related to coastal development, impact assessment of coastal hazards on the shoreline and its management aspects (Fig. 33). The application is to store, retrieve and produce the shoreline related information in interactive-integrated manner.

Fig. 32 Coastal Processes and Sediment transport sites under NCCR.

Fig. 33 Web application of Coastal Change System of NCCR.

NCCR is involved in preparation of Shoreline Management Plan (SMP) of Tamil Nadu, Andhra Pradesh, Kerala and Puducherry. NCCR is member of CPDAC. It has published many reports on coastal issues pertaining of almost all the Maritime States/ UTs.

5.4. National Hydrographic Office (NHO)

National Hydrographic Office (NHO), under the Indian Naval Hydrographic Department (INHD), is India's central agency for hydrographic surveys and nautical charting. Guided by the Chief Hydrographer to the Government of India, NHO ensures safe maritime navigation within Indian waters. It conducts detailed surveys to create and update nautical charts, publishes Notices to Mariners, and collaborates internationally while operating the National Institute of Hydrography for training and knowledge sharing. NHO's vision is to provide accurate hydrographic products and safety services for navigational safety in the region, aligning with international and national regulations.

The objectives of the Indian Naval Hydrographic Department (INHD) encompass a comprehensive range of goals aimed at enhancing hydrographic services and maritime safety, including conducting accurate hydrographic surveys, ensuring the availability of genuine, accurate, and up-to-date navigational products to mariners, providing hydrographic services to national and international agencies, as well as public and private sector undertakings, delivering quality training in the field of Hydrography, ensuring total satisfaction among users of hydrographic products, and extending cooperation in the field of Hydrography to maritime states in the region.

As per the decision taken by CPDAC, NHO has reviewed the coastal length of India. The verified coastal length by NHO, now, stands at 11098.81 km which is due for promulgation by Survey of India soon.

5.5. National Institute of Oceanography (NIO) Goa

The National Institute of Oceanography (NIO), headquartered in Goa and part of India's Council of Scientific and Industrial Research (CSIR), is a leading institute in oceanographic research. NIO utilizes multidisciplinary approaches including biology, chemistry, geology, physics, ocean engineering, marine instrumentation, and archaeology to explore the potential of the Indian Ocean. Its core objectives involve conducting fundamental and applied research to understand ocean processes, disseminating knowledge for informed decision-making on ocean resources and environmental conservation, and developing advanced oceanographic technologies to monitor the Indian Ocean's health and promote ocean literacy.

NIO's activities, as outlined in their latest annual report, encompass Marine Geology (including sedimentation patterns, geological features mapping, and coastal erosion studies), Marine Biology (biodiversity surveys, ecosystem research, and marine biotechnology exploration), Oceanography (monitoring physical parameters, studying ocean circulation, and developing numerical models), and Environmental Science (assessing water quality, monitoring pollution, studying climate change impacts, and developing coastal management strategies). Additionally, NIO, Goa has established an Integrated Coastal Observation Network (ICON), featuring Internet-accessible real/near-real-time reporting cellular-based sea-level, sea-state, and environmental data. Table 28 shows the coastal data collection activities of NIO Goa.

Table 28 Real-time data collection by NIO, Goa

Location	Weather Stations	Sea Level Gauges	Wave Rider Buoys
West Coast	Ratnagiri, Maharashtra	Ratnagiri , Maharashtra	Ratnagiri, Maharashtra
	Dona Paula, Goa	Dona Paula Radar Gauge, Goa	Okha, Gujarat
	Karwar, Karnataka	Karwar Radar Gauge, Karnataka	Karwar, Karnataka
	Trivandrum, Kerala		
East Coast	Gopalpur, Odisha	Gangavaram Radar Gauge, Andhra Pradesh	Gopalpur, Odisha
	Paradip, Odisha	Kakinada Radar Gauge, Andhra Pradesh	Vizag, Andhra Pradesh
	Vizag, Andhra Pradesh	Machilipatnam Radar Gauge, Andhra Pradesh	Pondicherry, UT of Pondicherry
	Gangavaram, Andhra Pradesh	Tuticorin Radar Gauge,Tamil Nadu	Tuticorin, Tamil Nadu
	Kakinada, Andhra Pradesh		
	Pondicherry, UT of Pondicherry		
	Tuticorin, Tamil Nadu		
Islands	Kavaratti, UT of Lakshadweep	Kavaratti Radar Gauge,UT of Lakshadweep	
	Port Blair, Andaman & Nicobar	Port Blair Radar Gauge, Andaman & Nicobar	

Activities of NIO, Goa on coastal matter:

- Research & Studies on oceanographic processes
- Developing advanced oceanographic technologies to monitor the Ocean's health & environmental related issues
- Monitoring physical parameters and developing numerical models.
- CMIS – Executing agency for 3 nos. of CMIS sites of CWC in Goa & Maharashtra for collection, compilation and collation and analysis of coastal data for informed decision-making and long-term planning for coastal protection measures
- Capacity building of all the stake holders

NIO, Goa has made significant contribution in various activities of CPDAC and is part of various sub-committees constituted by CPDAC.

5.6. National Institute of Ocean Technology (NIOT)

The National Institute of Ocean Technology (NIOT) is a prominent organization in India dedicated to oceanographic research and development. Established in 1993, it functions under the Ministry of Earth Sciences and plays a crucial role in harnessing the potential of the Indian Ocean. NIOT's primary mandate revolves around three key objectives of developing cutting-edge technologies, providing technical services and solutions and building knowledge and institutional capacity.

The National Institute of Ocean Technology (NIOT) gathers ocean data through various means: like Buoy network, Radar network, Wire-line drilling and Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) observational network.

Various activities of NIOT, Chennai:

- NIOT, in 2014, published a Wave Atlas for the Indian coast which will help design marine structure and serve as a major resource point to protect beaches and coastal environment in the country. The atlas is a reference for basic wave related information like wave height, wave approach and period.
- NIOT has been involved in preparation of Integrated River Basin and Shoreline Management plan for Goa & Gujarat under National Hydrology Project.
- NIOT has developed the in-house mobile App for N.I.O.T. (North Indian Ocean Tide) that provides predicted tides along Gulf of Khambhat. The database of N.I.O.T. App has been updated till June-2024.
- NIOT has played a crucial role in coastal protection and salinity ingress management in Tamil Nadu, Kerala and the Union Territory of Puducherry.
- NIOT has addressed various challenges while promoting sustainable coastal development. Their systematic approach, encompassing thorough reconnaissance, meticulous data collection, and advanced numerical model studies, has resulted in the implementation of effective solutions to mitigate erosion, enhance biodiversity, and promote ecological sustainability.
- NIOT has also developed wave atlas Version 2.0 including Lakshadweep and Andaman & Nicobar Island from 1995 to 2022.
- Development of decision support tool - Shoreline Response Evaluation System (ShoRES) for Tamil Nadu
- Involved with Govt of A.P. for coastal protection at multiple locations

5.7. National Center for Earth Sciences Studies (NCESS)

The National Centre for Earth Science Studies (NCESS), located at Thiruvananthapuram was established in 1967 under the Ministry of Earth Sciences, it pursues multidisciplinary research across various domains - land, sea, and atmosphere. NCESS delves into diverse areas like geodynamic evolution, coastal dynamics, hydrocarbon exploration, and slope stability. Its mission revolves around fostering cutting-edge research, translating knowledge into practical applications, and nurturing leadership in Earth sciences. NCESS continues to be a vital hub for scientific exploration and discovery.

NCESS's field team collects environmental data and field observations, including wind, waves, tides, currents, sedimentological characteristics, beach profiles, and visual observations. This data serves as input for models run and calibrated by the Modelling Laboratory (ML) at NCESS. Additionally, NCESS operates a Field Research Facility (FRF) in Valiathura, near Thiruvananthapuram equipped to gather coastal environmental data.

NCESS is also involved in "Coastal Monitoring for Indian Coast" and has developed Video Beach Monitoring System, CoastSnap - a smartphone-based application for citizen science programs, and CoastSat - a system for mapping shorelines using available satellite imagery. NCESS also addresses coastal management problems in India, including coastal flooding, increasing trends in coastal erosion, and the presence of rip currents. Fig. 34 shows coastal monitoring activities of NCESS.

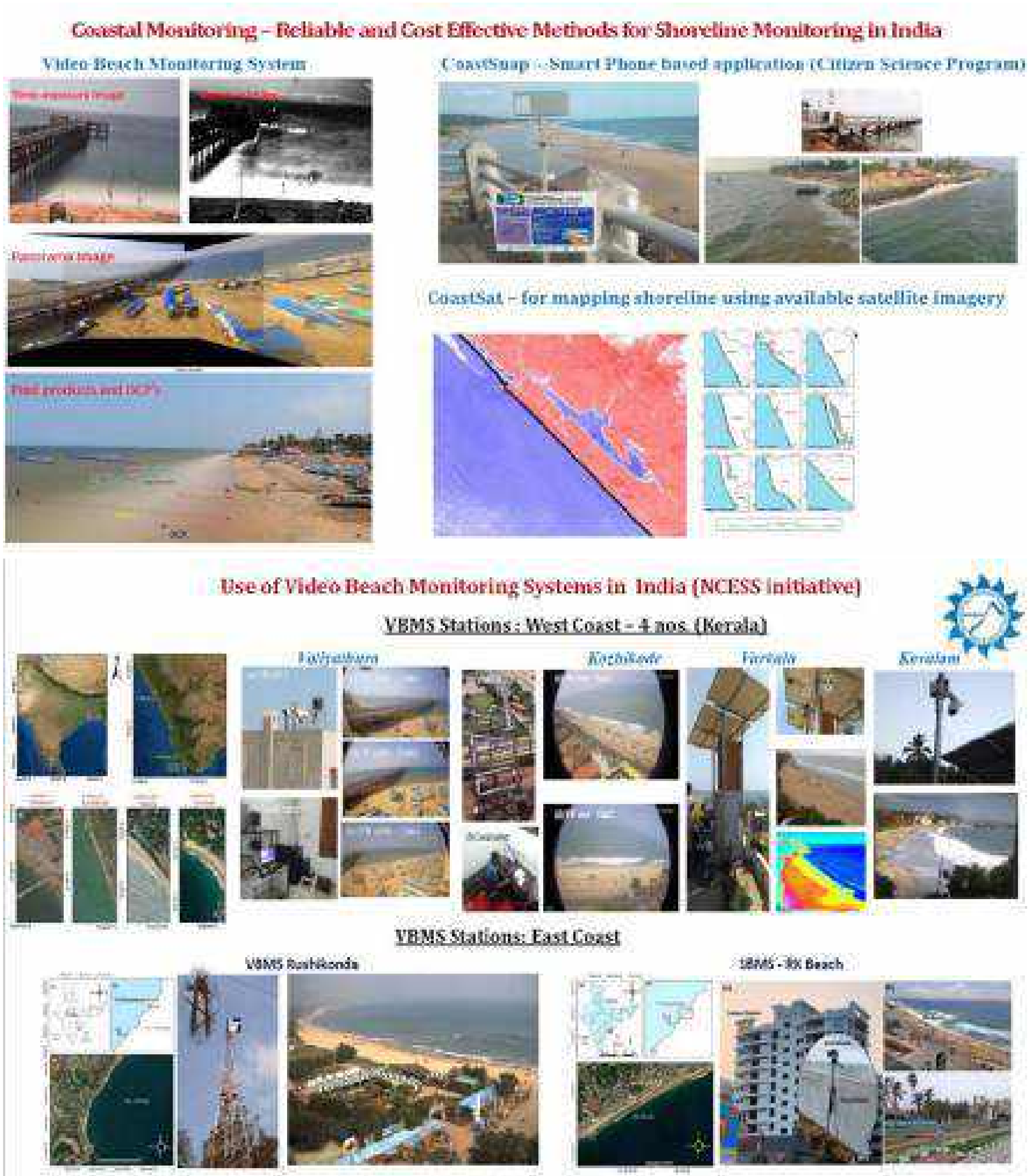

Fig. 34 Coastal monitoring activities of NCESS

NCESS was also involved in:

- Preparation of Integrated Coastal Zone Management Plan for Lakshadweep Islands
- Studies on shore protection structure in the Lakshadweep islands
- Impact of Tsunami on the Kerala coast and an initiative for development of management plan for the region.

5.8. Central Ground Water Board (CGWB)

The Central Ground Water Board (CGWB) is the nodal agency responsible for the scientific management and development of India's groundwater resources. The mandate of CGWB encompasses developing and disseminating technologies, monitoring, and implementing national policies for the scientific and sustainable development and management of groundwater resources. This includes their exploration, assessment, conservation, augmentation, protection from pollution, and distribution, based on principles of economic and ecological efficiency and equity.

The CGWB conducts scientific surveys and exploration of groundwater resources to assess groundwater availability and potential. This involves preparing detailed groundwater maps and atlases to provide a comprehensive understanding of groundwater distribution and characteristics. Continuous monitoring of groundwater levels and quality is another critical function. Based on these observations, the board develops and implements groundwater management plans. This includes promoting artificial recharge of groundwater to enhance aquifer storage and prevent groundwater pollution, ensuring sustainable use.

Regulating groundwater extraction through a system of permits and licenses is another vital responsibility of the CGWB, which helps control usage and prevent over-exploitation. The board enforces groundwater regulations and laws and plays a role in resolving disputes related to groundwater resources. Research on groundwater hydrology, hydrogeology, and related fields is also a key function. The CGWB works on developing new technologies for efficient groundwater management and disseminates knowledge and information to the public and professionals.

Additionally, the CGWB focuses on capacity building by training groundwater professionals and stakeholders, creating awareness about groundwater conservation and management to ensure best practices are followed at all levels. The board provides technical assistance to state governments and other agencies and collaborates with international organizations on groundwater issues, fostering global partnerships and sharing expertise. These functions and the overarching mandate highlight the comprehensive role of the CGWB in managing India's groundwater resources through scientific, regulatory, and educational efforts aimed at ensuring their sustainable and equitable use.

Under NAQUIM, CGWB has studied the groundwater salinity along coastal plains and effectiveness of various structures in reducing salinity. CGWB's hydrogeological assessments focused on the Deccan Trap Basalt and other geological formations, while their interventions included both supply-side measures, such as constructing recharge structures, and demand-side initiatives to improve groundwater conservation and irrigation. CGWB has implemented various remedial measures, including constructing seawater intrusion barriers and developing recharge structures such as check dams and recharge wells.

5.9. National Centre for Sustainable Coastal Management (NCSCM)

The National Centre for Sustainable Coastal Management (NCSCM) was established by the Ministry of Environment, Forest and Climate Change (MoEF&CC) in 2011, as an autonomous institution to support the protection, conservation, rehabilitation, management, and policy advice of the coast. NCSCM supports the nationwide adoption of the Integrated Coastal Zone Management (ICZM) approach by utilizing decision support systems based on cutting-edge science and knowledge and through networking with communities, government structures, and relevant reputable national and international institutes.

NCSCM's vision is to promote sustainable coasts through increased Partnerships, conservation practices, scientific research, and knowledge management for the benefit and wellbeing of current and future generations.

NCSCM's Mission is to support integrated management of the coastal and marine environment for livelihood security, sustainable development, and hazard risk management.

NCSCM is also committed to provide services in coastal and marine environmental impact assessment, coastal and marine microbial assessment, coastal and offshore water quality monitoring, coral reef health monitoring, ecosystem health reports, shoreline change assessment, coastal vulnerability assessment, mapping of coastal land use cover, preparation of coastal zone management plan and ICZM plans.

NCSCM is involved in preparation of Shoreline Management Plan (SMP) of Karnataka, Maharashtra & West Bengal.

6. Summary of Outcome of Quarterly Dialogue (State-wise)

Under the initiative of Chairman, CWC, quarterly dialogue on Coastal Area Management was organized by all the field offices of CWC with respective Maritime States/ UTs. A total of 9 such meetings were held in the month of April & May, 2024. The various Central Institutions involved in coastal matters along with CGWB and CWC HQ have also attended these quarterly dialogues.

6.1. Andhra Pradesh

The first such meeting was held on 05/04/2024 at Hyderabad. The meeting was chaired by Shri. Virendra Sharma, Chief Engineer, KGBO, CWC and it was attended by Central Water Commission (CWC), Andhra Pradesh Coastal Zone Management Authority (APCZMA), Govt. of A.P., Ground Water Department, Govt. of A.P., National Institute of Oceanography (NIO), Goa, Indian National Centre for Ocean Information Services (INCOIS), National Institute of Ocean Technology (NIOT), Central Ground Water Board (CGWB), Visakhapatnam.

6.1.1. Points of discussion

- Coastal Area Management Importance: The meeting emphasized the significance of coastal area management for economic development, sustaining livelihoods, and addressing commercial, strategic, and human dimensions. NIOT presented its work on coastal erosion mitigation, including projects across India and specific examples in Andhra Pradesh. INCOIS discussed its work on Coastal Vulnerability Atlases, highlighting the various factors contributing to coastal multi-hazard vulnerability. CGWB shared its findings on salinity ingress in Andhra Pradesh, explaining the challenges it poses to groundwater resources and the methods used to monitor it.
- Coastal Zone Management Authority (CZMA): The role of APCZMA in regulating activities harmful to coastal communities and the environment was outlined. The process of preparing and approving Coastal Regulation Zone (CRZ) maps was also discussed.
- Data Collection and CMIS: The Coastal Management Information System (CMIS) objective of collecting and analyzing coastal data was explained. The importance of this data for planning coastal protection measures was stressed, with concerns raised about the lack of site-specific data.
- Shoreline Erosion and Central Assistance: Discussions highlighted the Department of Water Resources' responsibility for 'sea erosion' and the availability of central assistance for Coastal Protection Schemes under the Flood Management & Border Area Programme.
- Shoreline Management Plan (SMP): Information was shared about the draft Shoreline Management Plan for Andhra Pradesh received in March 2024, with plans for further discussion.
- Collaboration and Data Sharing: The meeting concluded with a call for greater collaboration between central government departments, research institutes, and state government departments. A key recommendation was the creation of a centralized data platform to ensure data uniformity and informed decision-making on coastal management issues.

6.1.2. Way Forward

- The meeting concluded with a clear path forward emphasizing collaborative action and data sharing. A key takeaway was the need for a cooperative mechanism involving central government departments, research institutes like NCCR and NIO, and State government departments. This collaborative approach aims to leverage the expertise and resources of each stakeholder to address the multifaceted challenges of coastal management in Andhra Pradesh. The meeting underscored the importance of establishing a centralized data platform to consolidate information on coastal protection works, shoreline changes, salinity ingress, and other relevant factors. This platform would ensure data uniformity, facilitate informed decision-making, and promote transparency in coastal management efforts.

The Minutes of the quarterly dialogue is available at Annexure XVI.

6.2. Goa

The quarterly dialogue for Goa was held on 10/04/2024 at Panaji. The meeting was chaired by Shri Virendra Sharma, Chief Engineer, MSO, Bengaluru and it was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB), Belagavi; Water Resource Department (WRD), Govt. of Goa; National Institute of Ocean Technology (NIOT), Chennai; CSIR - National Institute of Oceanography (NIO), Goa and Central Water & Power Research Station (CWPRS), Pune.

6.2.1. Points of discussion

- Importance of Coastal Area Management: The meeting emphasized the crucial role of coastal area management, particularly for a state like Goa heavily reliant on tourism. It highlighted the need to balance economic development with environmental protection and sustainable tourism practices. The discussions highlighted significant challenges facing Goa's coastal areas. These include sea erosion impacting 19.2% of the coastline, salinity ingress affecting agricultural lands, and the pressures stemming from a substantial influx of tourists.
- Coastal Management Initiatives: Ongoing initiatives and research related to coastal management were discussed:
  - CWC's Coastal Management Information System (CMIS): The system's role in collecting data and addressing coastal issues through a systematic approach was explained, including the presence of two CMIS sites in Goa.
  - NIOT's Integrated River Basin and Shoreline Management Project: This project aims to develop a comprehensive management plan for Goa's coast, using satellite imagery and field measurements to identify erosion hotspots.
  - NIO's Coastal Monitoring Efforts: NIO shared its work on coastal monitoring using various methods, including physical monitoring, remote sensing, and community-based approaches.

6.2.2. Way Forward

The meeting involved discussions on potential solutions and recommendations for addressing Goa's coastal challenges. Some key suggestions included:

- Early Warning Systems: Participants discussed the need for early warning systems or decision support systems to alert authorities about potential coastal erosion, enabling timely intervention and mitigation measures.
- Soft Solutions for Erosion: Given local resistance to hard structures on beaches, the focus shifted to exploring soft solutions for mitigating erosion. These methods prioritize natural approaches and minimize environmental impact.
- Addressing Salinity Ingress: Concerns regarding salinity ingress in estuarine areas and agricultural lands were raised. Participants discussed the possibility of seeking central funding for constructing protective measures like outer marginal bunds.
- Ground Water Management: Discussions highlighted the importance of groundwater management in coastal areas, including the need to quantify groundwater discharge into the sea, optimize data collection frequency, and promote rainwater harvesting and groundwater recharge initiatives.

The Minutes of the quarterly dialogue is available at Annexure XVII.

6.3. Maharashtra

The quarterly dialogue for Maharashtra was held on 18/04/2024 at Nagpur. The meeting was chaired by Shri Neeraj Kumar Manglik, Chief Engineer, MCO, Nagpur and it was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); Maharashtra Maritime Board; CSIR - National Institute of Oceanography (NIO), Goa; Public Works Department (PWD), Government of Maharashtra and Central Water & Power Research Station (CWPRS), Pune.

6.3.1. Points of discussion

- Coastal Erosion and Accretion: The meeting started with a presentation on the changing coastline of India, focusing on erosion, accretion, and stability in Maharashtra. Case studies from other states were also discussed, highlighting effective solutions to coastal erosion. The discussion addressed various coastal protection strategies, discussing both "soft" solutions (e.g., beach nourishment, dune care) and "hard" solutions (e.g., sea walls, groynes) along with relevant policies like the Coastal Regulation Zone (CRZ) notification. Case studies from Maharashtra were presented to showcase site-specific solutions to coastal protection challenges.
- Coastal Management Information System (CMIS): The meeting focused on the CMIS initiative for creating a national database of coastal parameters. Discussions covered details about the CMIS sites in Maharashtra, data collection efforts, and the use of this data for disaster management and development. NIO Goa detailed their data collection processes and challenges at the Tarkhali site, while CWPRS Pune shared their experiences and lessons learned from implementing CMIS in Maharashtra and Gujarat. It was underscored the importance of inter-agency collaboration and data sharing.

Integrating data from state agencies and research institutions with INDIA-WRIS and CMIS was also discussed to improve coastal management efforts.

- CWPRS Pune discussed their ongoing work using satellite data for ocean profiling, a potentially quicker and more cost-effective method for gathering bathymetric data.
- Funding and Investment: The Maharashtra Maritime Board (MMB) presented on their Sustainable Climate Resilient Coastal protection and management investment program, which includes funding from the Asian Development Bank for projects like the installation of offshore geotextile reefs and dune construction.

6.3.2. Way Forward

- Establishing a collaborative National Shoreline Management Program
- Expanding the Coastal Management Information System (CMIS)
- Improving data sharing and integration
- Providing training for state government officials
- Implementing site-specific solutions for coastal protection
- Using a combination of hard and soft solutions for coastal protection
- Conducting regular monitoring and maintenance of coastal protection structures
- Developing and utilizing satellite-derived bathymetry

The Minutes of the quarterly dialogue is available at Annexure XVIII.

6.4.Karnataka

The meeting for State of Karnataka was held on 23/04/2024 at Bengaluru. The meeting was convened under Shri Virendra Sharma, Chief Engineer, MSO, Bengaluru and was attended by Dr. N. Manjula, IAS, Secretary, Infrastructure Development Ports & Inland Water Transport Department; Sh. Krishnamurthy B Kulkarni, Secretary, Water Resources Department; Sh. Jayaram Raipura, Chief Executive Officer, Karnataka Maritime Board besides representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); Water Resource Department (WRD), Karnataka; Karnataka Engineering Research Station (KERS); Fisheries Department, Karnataka; MI & GWI circle, Karnataka, National Institute of Ocean Technology (NIOT), Chennai; CSIR - National Institute of Oceanography (NIO), Goa and Central Water & Power Research Station (CWPRS), Pune.

6.4.1. Points of discussion:

- Data-Driven Decision Making: Participants emphasized the crucial role of robust data in effective coastal management. The CWC's CMIS initiative was highlighted as a valuable tool for collecting standardized coastal data. Secretary, Karnataka stressed for establishment of CMIS sites in Karnataka. The meeting also stressed the need for improved data sharing between agencies and research institutions for a holistic understanding of coastal processes.
- Addressing the Funding Gap: Securing adequate funding emerged as a significant challenge for implementing coastal protection measures. The meeting explored potential solutions like leveraging central government schemes and innovative financing mechanisms.

- Learning from Past Experiences: While acknowledging past efforts like the ADB-funded project involving hard solutions (groynes, sea walls), the meeting highlighted unintended consequences like altered erosion and accretion patterns. This emphasizes the importance of comprehensive impact assessments and adaptive management strategies.
- Balancing Protection with Sustainability: Participants explored the benefits of combining hard and soft coastal protection solutions. This approach aims to provide immediate protection while minimizing environmental impacts and promoting long-term ecological health.
- Salinity ingress: This emerged as a pressing problem, particularly impacting the Uttara Kannada district.
- Capacity Building and Knowledge Sharing: The meeting highlighted the importance of equipping state government officials with the knowledge and skills to effectively manage coastal projects. Training programs on coastal processes, data analysis, and sustainable construction practices were identified as crucial.

6.4.2. Way Forward

- Funding Constraints
- Enhancing Data Collection, central data platform for sharing of data and Utilization
- Comprehensive Shoreline Management Plan
- Prioritizing Salinity ingress issue
- Strengthening Capacity and Knowledge Sharing

The Minutes of the quarterly dialogue is available at Annexure XIX.

6.5. Gujarat

The quarterly dialogue for Gujarat was held on 25/04/2024 at Gandhinagar. The meeting was chaired by Shri K. A. Patel, Secretary, WRD, Govt. of Gujarat and Shri D. S. Chaskar, Chief Engineer, MTBO, CWC. Meeting was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); Gujarat Maritime Board, Maharashtra Maritime Board; CSIR - National Institute of Oceanography (NIO), Goa; Public Works Department (PWD), Gujarat; INCOIS, Hyderabad; IIT Bombay; NIOT, Chennai; PWD, Daman; Gujarat Water Resources Development Corporation (GWRDC), Gujarat and Central Water & Power Research Station (CWPRS), Pune.

6.5.1. Points of Discussion:

- Salinity Ingress: Gujarat faces a significant challenge with salinity ingress, impacting both groundwater and surface water. Meeting emphasized the need for more effective structures based on robust data.
- Coastal Erosion: Erosion is a widespread problem for Gujarat affecting various parts of the State, experiencing erosion along 27.6% of its coast.
- CMIS for Informed Decision Making: A key takeaway from the meeting was the need for a centralized and comprehensive CMIS and highlighted importance of collaboration and data sharing among various stakeholders, including government agencies, research institutions, and local communities, to address coastal challenges effectively. Lack of

adequate data for designing effective erosion and salinity ingress mitigation structures was also discussed.

- Capacity Building: The lack of technical expertise within the state government to address these complex coastal challenges was also acknowledged. The meeting discussed the need for capacity-building initiatives, including training programs on coastal processes, data analysis, and management techniques, to empower state officials to make informed decisions.

6.5.2. Way Forward

- Master Plan for Data Collection identifying data gaps, standardizing data collection protocols, and ensuring data accessibility to all stakeholders
- Expansion of CMIS with States willing to allocate State funds for setting up and operating these sites with technical support from central institutions including CWC
- Need for Capacity Building of State Government officials from NWA, Pune and other central institutions
- Inter-agency Coordination for addressing the multifaceted challenges of coastal management.
- Exploring Funding Sources either through public-private partnerships, external aid agencies, or dedicated budgetary allocations at the state level

The Minutes of the quarterly dialogue is available at Annexure XX.

6.6. Tamil Nadu, Puducherry and A&N Islands

The quarterly dialogue for Tamil Nadu, Puducherry and A&N Islands was held on 25/04/2024 at Chennai. The meeting was chaired by Shri T.K. Sivarajan, Chief Engineer, CSRO, CWC. Meeting was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); *Disaster Risk Reduction, Climate Change & Salinity Management (DRCS), Water Resources Department (WRD) & Institute of Hydraulics and Hydrology (IHH), Poondi, WRD, Govt of Tamil Nadu;* PWD, Government of Puducherry; IIT Madras; NIOT, Chennai; National Centre for Coastal Research (NCCR), Chennai; National Centre for Sustainable Coastal Management (NCSCM); Andaman Public Works Department (APWD), Port Blair and Central Water & Power Research Station (CWPRS), Pune.

6.6.1. Points of Discussion:

- Coastal Erosion: Discussion on the widespread problem of coastal erosion affecting Tamil Nadu, Puducherry, and the Andaman and Nicobar Islands were made. The discussions emphasized the dynamic nature of these coastlines, shaped by monsoons, wave action, and tidal variations. The devastating impact of the 2004 earthquake and tsunami on the Andaman and Nicobar Islands was also highlighted.
- Salinity Ingress: The increasing salinity of groundwater emerged as a major concern, particularly in Tamil Nadu and Puducherry. Factors like over-extraction of groundwater, industrial and agricultural activities, and seawater intrusion were identified as key contributors. Participants stressed the urgency of addressing this issue, which poses a threat to freshwater resources, agriculture, and coastal ecosystems.

- Data Collection and Management: A recurring theme throughout the dialogue was the critical need for robust and centralized coastal data. Meeting highlighted the CWC's Coastal Management Information System (CMIS), and reviewed the CMIS's progress, with two operational sites in Tamil Nadu (Devaneri) and Puducherry (Karaikal) out of eight sites nationwide. The need for expanding CMIS coverage, standardizing data collection protocols, and ensuring data accessibility for informed decision-making were also emphasized.
- Coastal Protection Measures: The dialogue reviewed the various coastal protection measures implemented in Tamil Nadu, including groynes, sea walls, and river mouth training works. Projects like the TN-SHORE initiative, focused on restoring coastal resources, and ongoing efforts to rehabilitate existing structures, were also discussed. The importance of adopting a mix of "soft" measures (beach nourishment, vegetation) and "hard" structures (groynes, seawalls) based on site-specific conditions was highlighted.
- Funding and Collaboration: The meeting acknowledged the financial implications of implementing coastal management plans. Flood Management & Border Area Program (FMBAP) as a potential funding source for coastal protection projects was also discussed. However, securing adequate funding for data collection, research, capacity building, and salinity ingress mitigation requires further exploration. The dialogue underscored the importance of collaboration between central agencies, state governments, research institutions, and local communities for developing sustainable solutions.
- Capacity Building: Recognizing the technical complexities of coastal management, participants stressed the need for capacity-building initiatives, particularly for state government officials. The potential for leveraging the expertise of institutions like IIT Madras, NIOT, and NCCR for training programs on coastal processes, data analysis, and management techniques were discussed.

6.6.2. Way Forward

- Identification and Survey of vulnerable Areas
- Creation of Comprehensive Centralized Database
- Development of a Comprehensive Action Plan for coastal protection, sea-salinity, ecosystem restoration, community resilience building, and policy interventions through Coastal Management Plan
- Central Government Support for financial and technical assistance to support coastal protection, management, and salinity ingress mitigation efforts
- GIS Mapping of Vulnerable Areas

The Minutes of the quarterly dialogue is available at Annexure XXI .

6.7. Kerala and Lakshadweep Islands

The quarterly dialogue for Kerala and Lakshadweep Islands was held on 29/04/2024 at Thiruvananthapuram. The meeting was chaired by Shri T.K. Sivarajan, Chief Engineer, CSRO, CWC. Meeting was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); NCCR, NIOT, NCESS, NIT- Calicut, Departments of Govt. of Kerala i.e. Water Resources Department (WRD); Harbour Engineering Department (HED); Ground Water Department; and PWD, Lakshadweep.

6.7.1. Points of Discussion:

- Coastal Erosion: The dialogue extensively discussed the issue of coastal erosion, a significant concern for Kerala's 570-kilometer coastline. Erosion, impacting approximately 40% of the shoreline, poses a threat to coastal communities, infrastructure, and ecosystems.
- Salinity Ingress: Another critical issue highlighted was salinity ingress, the intrusion of saltwater into freshwater sources, particularly in coastal aquifers and rivers. This phenomenon jeopardizes freshwater availability for drinking and agriculture, impacting livelihoods and ecosystems.
- Data Collection and Management: The importance of robust data collection, analysis, and sharing emerged as a crucial theme. The need for a centralized database integrating coastal information from various agencies was emphasized to support informed decision-making.
- Coastal Management Plans: The dialogue stressed the urgency of developing and implementing comprehensive coastal management plans for both Kerala and Lakshadweep. These plans should encompass strategies for coastal protection, erosion control, salinity management, ecosystem restoration, and community resilience.
- Collaboration and Funding: The dialogue underscored the importance of collaboration among different government departments, research institutions, and communities for effective coastal management. Additionally, the need for financial and technical support from the Central Government to aid Kerala's efforts in coastal protection and salinity ingress management was emphasized.

6.7.2. Way Forward

- Survey & Identification of Vulnerable Areas
- Development of Comprehensive Centralized Data Base
- Comprehensive Action Plan for shoreline protection, ecosystem restoration, sustainable land use practices, and community resilience-building measures.
- Preparation of Coastal Management Plan
- Support/Financial Assistance from Central Government and its Institutions

  The Minutes of the quarterly dialogue is available at Annexure XXII.

6.8. West Bengal

The quarterly dialogue for West Bengal was held on 09/05/2024 at Kolkata. The meeting was chaired by Shri. Subhrangshu Biswas, Chief Engineer, T&BDBO CWC and Shri. Sanjoy Kundu, Secretary, I&WD, Govt. of West Bengal. Meeting was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); Jadavpur University, Kolkata; Institute of Environmental Studies and Wetland Management (IESWM); Irrigation & Waterways Department, Govt. of West Bengal; State Water Investigation Directorate; Central Soil and Salinity Research Institute, Canning.

6.8.1. Points of Discussion:

- Coastal Management Plans: The importance of having robust coastal management plans was emphasized. The Institute of Wetland Studies & Wetland Management (IESWM) shared its progress in developing and updating Coastal Zone Management Plans (CZMPs) for West Bengal, based on CRZ Notifications 2011 and 2019. The dynamic nature of West Bengal's coastline was also discussed, with significant areas experiencing both erosion and accretion.

- Coastal Protection Measures: The dialogue included presentations on various coastal protection measures, including both soft solutions (e.g., vegetation, beach nourishment) and hard solutions (e.g., sea walls, groynes). The role of the Central Water Power Research Station (CWPRS) in studying and implementing such measures was also discussed.
- Salinity Ingress: The issue of salinity ingress and its impact on coastal areas was recognized as a significant concern. The need for appropriate action plans and guidelines for preparing Detailed Project Reports (DPRs) for salinity ingress management projects was highlighted.
- Coastal Management Information System (CMIS): The dialogue provided an overview of the CMIS, a crucial initiative for collecting and analyzing coastal data. The system's parameters, data collection frequency, and the role of CWC in its implementation were discussed.
- Role of Central Institutions: The dialogue highlighted the contributions of central institutions like the National Centre for Sustainable Coastal Management (NCSCM) and the Central Soil Salinity Research Institute (CSSRI) in supporting coastal management efforts in West Bengal.
- Case Studies and Experiences: Participants shared case studies of coastal protection works in areas like Digha, Mandarmani, and Old Digha, providing insights into the successes and challenges faced.

6.8.2. Way Forward

- Survey and Identification of Vulnerable Areas utilizing advanced GIS mapping techniques
- Centralized and comprehensive data collection strategy to fulfil data requirements
- Comprehensive Action Plan to address the complex challenges of coastal management
- Specialized Studies with focus on the impacts of coastal erosion and salinity ingress on biodiversity, agriculture, fisheries, and human settlements to frame targeted interventions and adaptation strategies
- Coastal Management Plan
- Financial/ technical assistance and policy guidance

The Minutes of the quarterly dialogue is available at Annexure XXIII.

6.9. Odisha

The quarterly dialogue for West Bengal was held on 29/05/2024 at Bhubaneshwar. The meeting was orgnaised by Shri. Ajay Pradhan, Chief Engineer, MERO, CWC and was chaired by Shri Ranjan Mohanty, Engineer-in-Chief, Water Resources Department (WRD), Govt. of Odisha. Meeting was attended by representatives from Central Water Commission (CWC), New Delhi; Central Ground Water Board (CGWB); Water Resources Department (WRD), Govt. of Odisha; Water and Power Consultancy Services (WAPCOS), Bhubaneswar; Central Water and Power

Research Station (CWPRS), Pune; ICAR- Indian Institute of Water Management, Bhubaneswar; Indian Institute of Technology (IIT), Bhubaneswar; National Institute of Ocean Technology (NIOT) Chennai; National Centre for Coastal Research (NCCR) Chennai; National Institute of Oceanography (NIO) Goa; Chilika Development Authority, Bhubaneswar.

6.9.1. Points of Discussion

- Coastal Erosion: Odisha's coastline is undergoing significant changes, with both erosion and accretion observed in different areas. While some coastal districts show accretion, others face severe erosion, jeopardizing coastal communities and ecosystems.
- Saline Ingress in Coastal Odisha: Saline ingress, or the intrusion of saltwater into coastal aquifers, is a significant problem in several districts of Odisha, including Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Cuttack, Puri, and Khorda. Odisha government is constructing saline embankments as part of National Cyclone Risk Mitigation Project (NCRMP) to mitigate the impacts of cyclones and saline ingress. The government is also exploring the feasibility of utilizing groundwater in salinity-affected areas, aiming to find alternative water sources, as a pilot project.
- Data Management: Effective coastal management requires robust and accessible data. The dialogue emphasized the need for a centralized system like the Coastal Management Information System (CMIS) to collect, analyze, and share data among stakeholders.
- Policy and Project Implementation: Discussions focused on the importance of coordinated efforts among different stakeholders to implement effective coastal protection measures. This includes developing and implementing comprehensive action plans that address erosion control, salinity mitigation, and ecosystem-based solutions.
- Integrated Coastal Zone Management Project (ICZMP): The status of the ICZMP was discussed, including completed shoreline management plans under this project for Gopalpur to Chilika and Paradeep to Dhamara.
- World Bank assistance: The state has secured funding from the World Bank for a project titled "Multisector Disaster Resilient Saline Embankment Project". This project aims to mitigate the impacts of cyclones and saline ingress by constructing saline embankments.
- Findings of research done on Odisha coast were presented by NIO & NCCR on coastal processes, erosion patterns, and the effectiveness of different management strategies.

6.9.2. Way Forward

- Expansion of Coastal Management Information System (CMIS) for more robust data collection, particularly regarding shoreline changes and sediment dynamics
- Continued Monitoring and Research in areas identified as vulnerable
- Action to address Groundwater Salinity utilising expertise of CGWB
- Develop and Implement Integrated Coastal Zone Management Plans
- Strengthen Collaboration and Knowledge Sharing

The Minutes of the quarterly dialogue is available at Annexure XXIV.

7. Conclusion & Way Forward

The Indian coastline, extending over 7,516 kilometers, serves as a crucial interface between the land and the sea, supporting a numerous ecological, economic, and social activities. Despite its importance, this coastline faces significant challenges, particularly in the form of coastal erosion and salinity ingression, both of which have been intensified by natural and human activities.

Coastal erosion is currently impacting large tracts of the Indian coast. Under the National Shoreline Assessment System (N-SAS), *National Assessment of Shoreline Changes along Indian Coast* in March, 2022 was done by NCCR from 1990 to 2018 revealing that 33.6% i.e. nearly one-third of India's coastline is susceptible to erosion. This implies that more than 3700 km of Indian shoreline is subjected to erosion in varying degree. Though erosion and accretion are natural phenomenon, the problems of coastal erosion faced by the Maritime States are posing significant challenges to both the environment and human settlements. It has also been noticed that certain coastal stretches are experiencing more severe impacts than others. Climate change and sea-level rise is exacerbating the problems. To arrest the adverse effects of coastal erosion, the States have implemented a range of mitigation strategies. These include both hard and soft engineering approaches. However, it has been observed during recently organized quarterly dialogue that to tackle the problem on short-term basis to assuage the suffering of the people affected, States are often resorting to hard measures to protect the area from erosion. These solutions are local in nature and offers localized solution without considering its long-term effect on coastal zone. Due to lack of sufficient requisite coastal data, measures are adopted without adopting proper scientific analysis. Coastal protection and management require a balanced approach that integrates both hard and soft engineering measures to address the complex and dynamic nature of coastal environments based upon coastal data and sound analysis, often backed by numerical modelling. Lately States have resorted to preparation of Shoreline Management Plan. Some States have prepared Integrated Coastal Zone Management Plan (ICZMP). However, implementation of these plans for conceptualizing coastal protection measures is yet to be taken. On the whole, an expenditure of nearly Rs 550 Crore have incurred by various States in coastal protection measures in the last 10 years, thus protecting nearly 230 km of coastal length. As a result, a significant portion of erosion-prone areas remains unprotected.

States have proposed schemes costing more than Rs 7000 Crore which can be taken up in the next 5 years to mitigate the problems of coastal erosion in the most vulnerable areas. This will protect nearly 630 km of coastal length (details are not available for Andhra Pradesh and UTs of Daman, Lakshadweep, A&N Islands and Puducherry). All these expenditures done by States are either through own funds or through multilateral funding from World Bank, Asian Development Bank etc). With the large section of Indian coast still undergoing erosion despite various coastal protection measures, there is need to have a comprehensive strategy to address the issue of coastal erosion from the piece-meal, reactive methods to the long-term approach. This strategy will provide long-term vision followed by necessary priorities, procedures, tools, and operation strategies to achieve the objectives. The objectives could be:

- Reducing consequences of coastal erosion on coastal communities, infrastructure, and environment

- Providing effective and sustained response to erosion by prioritizing investment in the most vulnerable areas
- Raising awareness and engaging people in response to coastal erosion and its mitigation measures
- Scientific Data collection for evaluation of effectiveness of measures in various time windows.

Salinity ingress in coastal India poses significant challenges, particularly in regions with a delicate balance between freshwater and seawater. This issue is prevalent in various parts of the country, including Gujarat, Maharashtra, Tamil Nadu, and other coastal States, where the intrusion of seawater into freshwater aquifers leads to the progressive degradation of groundwater quality. To combat these salinity and erosion challenges, affected Maritime States/UTs has implemented series of structural and non-structural measures. Key initiatives include the construction of gabion and stone walls to protect against coastal erosion, the installation of tidal regulators, bandharas, and check dams, as well as the development of recharge reservoirs and wells to enhance groundwater storage. These measures have yielded significant benefits, including improved groundwater quality, the reclamation of degraded lands, and the prevention of further deterioration of agricultural areas. Afforestation efforts and changes in cropping patterns have also been promoted to mitigate the impacts of salinity ingress. The total expenditure incurred by States for mitigation of salt ingression in the last 10 years is Rs 457.103 crore and the total cost of planned schemes as well as ongoing works for the next 5 years is Rs 1572 crore.

The matter of salinity ingress and its mitigation was discussed in details by a Committee constituted by DoWR,RD&GR under Chairman, CWC which has submitted its report titled "Problems of Salination of Land in Coastal Areas of India and Suitable Protection Measures" in July 2017. The issues discussed by the Committee and its recommendations (briefly mentioned under para 4.4) are very elaborate and are yet to be implemented. Mitigating sea salinity ingress in coastal India requires a comprehensive and coordinated approach that integrates both structural and non-structural measures. The efforts by the Central and State Governments should reflect a commitment to safeguard the quality of groundwater resources, ensuring the sustainability of coastal ecosystems, and protecting the livelihoods of communities dependent on these critical water resources.

7.1. Recommendations:

7.1.1. Data Collection

i. **Centralized and comprehensive data collection strategy**: To fill the data gap in coastal parameter, there is need to further expand the Coastal Management Information System (CMIS). States may also establish such data collection sites in their respective coastal areas and share the data with Central platform. Further, there should be a centralized data platform and data should be shared with all the respective States/ UTs conforming to Data Dissemination Policy, to be finalized soon. Such data collection arrangement may be on continuous basis for long-term.

ii. **Establishment of terminal stations:** There is need for establishment of terminal stations on major rivers near the confluences of such rivers with sea. These data will be very useful while designing protection measures near confluences of rivers.

iii. **Pooling of Data from Central Institutions**: The various central institutions are having large set of data related to set of coastal parameters which were collected for studies, conceptualizing projects on request of State Govts etc. There is need for pooling of such data from these institutions on central platform with access to all stakeholders conforming to Data Dissemination Policy, to be finalized soon.

7.1.2. Protection Strategy

i. **Brainstorming Session**: In continuance with State level dialogue, there is need to have a brain-storming session with all central institutions viz., NIO, NCCR, NIOT, NCESS, NCSCM, INCOIS, CWPRS, SAC, CWC, CGWB to discuss the issues of coastal erosion and salinity ingression to devise the suitable strategy to mitigate the problem and to decide how to move forward.

ii. **Comprehensive Action Plan**: Preparation of Integrated Coastal Zone Management Plan (ICZMP) and Shoreline Management Plan (SMP) should be taken up in right earnest by all the Maritime States/ UTs. Any mitigation measures conceptualized may be based on such plan.

iii. **Survey and Identification of Vulnerable Areas**: Based upon Atlas published by NCCR as well as SAC, survey & identification of vulnerable reaches to erosion and salinity ingress may be initiated by States/ UTs utilizing latest technology. Mitigation measures may be accordingly prioritized.

7.1.3. Action to be taken on Recommendations made by Committee under Chairman, CWC: -

There is need to consider the recommendations made by the Committee under Chairman, CWC on salinity ingress and its mitigation and actions to be initiated. Some of the major recommendations are reproduced below:

- Immediate need to protect the coastal lands which are most vulnerable to the problem of salinity intrusion.
- Minimum flow in rivers to ensure that sea water is prevented from entering inland if rainfall is abundant.
- There is a need to develop an effective mechanism to scientifically monitor salinity level in the ground water that helps adopting suitable protection measure for the particular location and scenario.
- For improving knowledge about salinity risks and suggesting remedial measures, a National Center for Scientific Study of Salinity Ingress in Delta Regions may be setup by CWC/ Ministry of Water Resource, River Development & Ganga Rejuvenation.
- Framing of scheme at the Central level: funding for sea-salinity scheme can be provided from the existing schemes of MoWR, RD & GR or a separate scheme may be created and necessary central assistance may be provided for execution of such projects.
- Necessary guidelines/ modalities etc. may be framed by CWC in consultation with CWPRS, CGWB and any other technical agency, as required.

- State will submit proposal for central funding to CWC after approval of State TAC
- Strengthening of Coastal Erosion Directorate at CWC HQ
- Community awareness about sea salinity, excessive drilling and usage of ground water

7.1.4. Role of CWC

i. **Enhanced role of CWC:** Being the nodal agency in the matter of sea erosion, Central Water Commission (CWC)/ DoWR,RD&GR needs to play bigger role in this domain.

ii. **Capacity Building:** Considering lack of expertise in this domain with Government, both Central and States, as mentioned during quarterly dialogue, extensive capacity building programmes need to be devised, national as well as international. There is urgent need for strengthening of CWC competency in this field especially in the designing of coastal structure, analysis of data & studies, development of numerical modelling etc. Though short-term courses are available with all the central institutions, there is need for longer course to develop the expertise in the field. To meet this objective, PG degree courses and diploma courses could be started at institutions of repute in line with courses started at IISc Bangalore & IIT Roorkee on Dam Safety. In this regard, the proposal received from IIT Madras could be considered.

iii. For expanding the horizon of CWC in coastal area, one office (at the level of Director) can be opened in both East and West coast for data collection activity as well as monitoring of erosion & salinity project.

iv. Proposal for establishment of National Centre for Coastal Salinity Studies, as recommended by Committee under Chairman, CWC, could be pursed with DoWR,RD&GR.

7.1.5. Monitoring & Post Evaluation

i. **Evaluation of completed projects:** Under CPDAC, a sub-committee usually do the evaluation of completed projects. However, only one or two projects are getting evaluated on annual basis. Therefore, evaluation of completed projects may be undertaken by respective States/ UTs on regular basis so as to inculcate learning through peer interaction. Representative of CWC/ CGWB may also be involved in this exercise.

ii. **Monitoring and maintenance of existing structures**: A robust plan may be undertaken by States/ UTs for monitoring of existing structures and maintenance works may be carried out regularly. All such structures may be GIS mapped. CWC may take lead in this direction.

7.1.6. Funding Mechanism

i. Considering the vulnerability of coastal areas, in terms of erosion and salinity ingress, most of the States/ UTs have taken up schemes for mitigation of these problems from either through own fund or multilateral funding without resorting to sound technical & scientific analysis. Though schemes for protection of coastal erosion are eligible for funding under FMBAP, no States/UTs have proposed any project for funding due to meagre allocation for new projects under FMBAP. Therefore, there is a need for an exclusive Central Scheme to fund the schemes for mitigation of coastal erosion and sea-salinity ingress considering vulnerability of coastal region from erosion and sea-salinity ingress, as pointed out in the studies by SAC, Ahmedabad and NCCR, Chennai as well as reported by States/UTs. Widespread sea-salinity ingression has also been mentioned by the Committee constituted under Chairman, CWC. Almost all States/ UTs have raised the issue of central support, both financial & technical, during the quarterly dialogue. In the 19th meeting of CPDAC too, some of State's representative requested for central funding on this count.

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8. Report on The Quarterly Dialogue held with State Govt. of Goa and other stakeholders on the subject of Coastal Area Management
9. Report on The Quarterly Dialogue held with State Govt. of Gujarat and other stakeholders on the subject of Coastal Area Management
10. Report on The Quarterly Dialogue held with State/UT Govt. of Kerala and Lakshadweep other stakeholders on the subject of Coastal Area Management
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Annexures

Annexure I (a)

The details of coastal protection measures adopted by Govt. of Gujarat along with expenditure incurred in the last 10 years

S. No	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State / Loan)	Remarks/ Year of completion
1	Dwarka	0.067	Coastal Protection	1.31	Deposit work	Completed
2	Dwarka	0.46	Coastal Protection	10.69	Deposit work	Completed
3	SaiyadRajpara/ Una/ GirSomnath	0.05	Coastal protection work	0.46	State	Completed
4	Porbandar	0.7	Sea Wall + Tetrapod work	11.35	State	Completed
5	Gopniath/ talaja / Bhavnagar	0.27	Providing Costal Protection wall to combat erosion at GopinathBunglow	2.35	state	Completed
6	Khera/ Rajula/ Amreli	0.63	Tetropod as a Armour Layer	6.05	State	Completed
7	Tithal/ Valsad/ Valsad	0.675	Anti-Sea Erosion Works	7.45	State	Completed
8	Bhagdavada/ Valsad/ Valsad	0.455	Heavy Stone 1.00 to 1.50 T	4.44	State	Completed
9	Udwada/ Pardi/ Valsad	0.53	Heavy Stone 1.00 to 1.50 T	5.39	State	Completed
10	Maroli-dandi/ Umargam/ Valsad	0.8	Heavy Stone 0.40 to 0.60 T	3	State	Completed
11	Kalay/ Umargam/ Valsad	0.78	Heavy Stone 0.40 to 0.60 T	3.61	State	Completed
12	Tithal/ Valsad/ Valsad	0.93	Heavy Stone 1.00 to 1.50 T	9.61	State	Completed
13	Tithalsurwada/ Valsad/ Valsad	1.025	Heavy Stone 1.00 to 1.50 T	11	State	Completed
14	Umarsadi/ Pardi/ Valsad	1.55	Heavy Stone 1.00 to 1.50 T	4.72	State	Completed
15	Bhadelijagalala/ Valsad/ Valsad	0.54	Geofabric, core & Heavy Stone	7.32	State	Completed
16	Nanidanti-motiDanti/ Valsa/	0.57	Anti-Sea Erosion Works	9.78	State	Completed
17	Umarsadi-mangelwad/ Pardi/ Valsad	0.422	Earthen bund with 45 cm thk. Panel pitching	1.29	State	Completed

S. No	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State / Loan)	Remarks/ Year of completion
18	Bhathikarambeli/ Umargam/ Valsad	0.25	Gabion Protection Work	1.1	State	Completed
19	Nargol/ Umargam/ Valsad	0.3	Earthen bund with 60 cm thk. Panel pitching	0.31	State	Completed
20	Maroli(Dandi)/ Umargam/ Valsad	0.8	Heavy Stone 0.40 to 0.60 T	3.15	State	Completed
21	Nargol/ Umargam/ Valsad	0.19	Armour layer of Heavy Stone	2.92	State	Completed
22	Nargol/ Umargam/ Valsad	0.15	Armour layer of Heavy Stone			
23	Nargol/ Umargam/ Valsad	0.2	Armour layer of Heavy Stone			
24	Kosamba/ Valsad/ Valsad	1.03	Anti-Sea Erosion Works	4.08	State	Completed
25	Khatalwada/ Umargam/ Valsad	1.5	Earthen bund with 45 cm thk. Panel pitching	2.44	State	Completed
26	BorsiMachhivad/ Jalalpore/ Navsari	1.2	Rising the height of existing pro. wall	3.8126	State	Completed
27	BorsiMachhivad/ Jalalpore/ Navsari	1.72	Protection wall	24.1405	State	Completed
28	Danti/ Jalalpore/ Navsari	1.26	Protection wall and flood erosion	3.796	State	Completed
29	OnjalMachhivad/ Jalalpore/ Navsari	0.51	Restoration of Protection wall	3.537	State	Completed
30	OnjalMachhivad/ Jalalpore/ Navsari	0.432	Restoration of Protection wall	10.4	State	Completed
31	Dholai/ Gandevi/ Navsari	0.61	Earth work, Toe wall, Pitching, C.D. work and Flap Gate	3.301	State	Completed
32	DandiSamapor/ Jalalpore/ Navsari	1.485	Geofabric, core & Heavy Stone in Armor layer	18.2242	State	Completed

S. No	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State / Loan)	Remarks/ Year of completion
33	BorsiMachhivad/ Jalalpore/ Navsari	1.2	Protection wall	3.8126	State	Completed
34	OnjalMachhivad/ Jalalpore/ Navsari	0.432	Restoration of Protection wall	2.8078	State	Completed
35	Bhat/ Gandevi/ Navsari	0.6	Restoration of Protection wall	3.8991	State	Completed
36	BorsiMachhivad/ Jalalpore/ Navsari	0.6	Protection wall	3.6661	State	Completed
37	Vill. Kharbhasi, Ta.Palsana, . Surat	0.12	Paccaa rubble pitching Protection Wall	0.1	State	Completed
38	Vill. Veluk, Ta. Olpad, . Surat	0.121	Protection Wall	0.11	State	Completed
39	Vill. Sandhiyer, Ta. Olpad, . Surat	0.135	Protection Wall	0.13	State	Completed
40	Vill. Kansad, Ta. Choryasi, . Surat	0.75	Protection Wall	0.18	State	Completed
41	Vill. Veluk, Ta. Olpad, . Surat	0.12	Protection Wall	0.13	State	Completed
42	Dumas – Sulatnabad/Choyasi / Surat	0.32	M & R work to strengthening existing rubble	5.41	State	Completed

Annexure I (b)

The details of the proposed or on-going coastal protection works of Govt. of Gujarat

S. No.	Name of Village/Taluka/	Length of Coastline to be protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)
1	Sutrapada(Bandar)/	0.9	Anti Sea Erosion	18
2	Hirakot / Sutrapada / Gir	0.841	Anti Sea Erosion	16
3	SaiyadRajpara/	0.83	Anti Sea Erosion	2.61
4	SaiyadRajpara(Port)/	0.3	Anti Sea Erosion	3
5	CHANCH/ RAJULA/ AMRELI	3	TETRAPOD AS A ARMOUR LAYER	60
6	KHERA PHASE-2/ RAJULA/ AMRELI	1.6	TETRAPOD AS A ARMOUR LAYER	32
7	Katpar/ Mahuva/	0.35	Bhavani sea Erosion	4.1
8	kosamba/ Valsad/ Valsad	0.4	Anti-Sea Erosion	4.114
9	Magoddungri/ Valsad/ Valsad	1.5	Anti-Sea Erosion	18.841
10	Survada/ Valsad/ Valsad	0.8	Anti-Sea Erosion	14.915
11	Bhagadakhurd/ Valsad/ Valsad	0.5	Anti-Sea Erosion	1.773
12	Nani Danti -Moti Danti/ Valsad/ Valsad	1.49	Anti-Sea Erosion	51.690
13	Bhagal/ Valsad/ Valsad	2.5	Anti-Sea Erosion	30.000
14	Umargam/ Umargam/ Valsad	0.84	Armour layer of Heavy Stone	9.110
15	Tadgam/ Umargam/ Valsad	0.83	Armour layer of Heavy Stone	4.915
16	Kamalwad/ Umargam/ Valsad	0.7	Armour layer of Heavy Stone	6.602
17	Dehri (Ramwadifaliya)/ Umargam/ Valsad	0.89	Design Under Process	6.151
18	Dehri/ Umargam/ Valsad	1.4	Armour layer of Heavy Stone	
19	Govada/ Umargam/ Valsad	0.645	Armour layer of Heavy Stone(under design)	4.507
20	Nargol/ Umargam/ Valsad	1.2	Armour layer of Heavy Stone(1.5 to 2 tone)	17.858
21	Maroli/ Umargam/ Valsad	0.8	Armour layer of Heavy Stone(under design)	10.500
22	Fansa/ Umargam/ Valsad	0.8	Armour layer of Heavy Stone(under design)	10.500

S. No.	Name of Village/Taluka/	Length of Coastline to be protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)
23	Fansa/ Umargam/ Valsad	1.2	Armour layer of Heavy Stone(under design)	15.000
24	Kalgam/ Umargam/ Valsad	1.5	Armour layer of Heavy Stone	20.000
25	Pardi/ Udwada/ Valsad	1.66	Armour layer of Heavy Stone	27.923
26	Kolak/ pardi/ Valsad	0.125	Armour layer of Heavy Stone	2.037
27	Ubhrat / Jalalpore/ Navsari	2.21	Protection wall	17.4
28	Krishnpur/ Jalalpore/ Navsari	2	Protection work	7
29	Vansi Borsi/ Jalalpore/ Navsari	3.99	Protection wall	80
30	DandiSamapore/ Jalalpore/ Navsari	-	Protection wall	39.6
31	Bhat/ Gandevi/ Navsari	-	Protection wall	4
32	Vill. Bulkash, Ta. Olpad, . Surat	0.105	Protection Wall	0.19
33	Vill. Bulkash, Ta. Olpad, . Surat	0.8	Protection Wall	0.19
34	Vill.Gola, Ta. Olpad, . Surat	0.65	Protection Wall	0.15
35	Vill. Narthan, Ta. Olpad, . Surat	0.92	Protection Wall	0.19
36	Vill. Asnad, Ta. Olpad, . Surat	0.85	Protection Wall	0.19
37	Vill. Kansad, Ta. Choryasi, . Surat	3	Gabian Protection Work	20
38	Vill. Dabhari, Ta. Olpad, . Surat	0.85	Rubble Pitching	50
39	Vill. Lajpor, Ta. Choryasi, . Surat	3	Gabian Protection Work	15
40	Vill. Sandhiyer, Ta. Olpad, . Surat	0.7	Gabian Protection Work	0.29
41	Dumas – Sulatnabad/Choyasi/Surat	0.43	M & R work to strengthening existing	11.77
42	Dariya Ganesh Temple-Dumas/Choyasi/Surat	2.15	Rubble wall	39

Annexure-II (a)

The details of coastal protection measures adopted by Govt. of Maharashtra along with expenditure incurred in the last 10 years

Sr. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
1	GeetanagarBrekawater, Colaba . Mumbai.	0.25	Rubble bund	1.50	State	Completed
2	Kalikamata/ Premnagar Slum, Walkeshwar, . Mumbai.	0.11	Rubble bund	1.50	State	Completed
3	Priyadarshani Park, Nepean Sea Road, Malbar Hill, . Mumbai	0.08	Rubble bund	1.50	State	Completed
4	Citizen Apartment to Hinduja Hospital, Mahim, . Mumbai	0.09	Rubble bund	2.00	State	Completed
5	DaryanagarMahalakshmiMandir Reva House SevaSundarBhulabhai Desai Road, . Mumbai	0.12	Rubble bund	1.80	State	Completed
6	Backside of ManoraAmdarNiwas, Colaba, . Mumbai	0.12	Rubble bund	1.40	State	Completed
7	Daimond Nagar Slum, Mata Parvati Nagar Slum, Shivaji Nagar Darabasha Lane, Nepean Sea Road, . Mumbai	0.20	Rubble bund	2.00	State	Completed
8	Magdum Sea Palace Society, Mahim, Mumbai	0.10	Rubble bund	2.00	State	Completed
9	Rajbhavan, Dis.t. Mumbai (Part-1)	0.78	Rubble bund	19.45	State	Completed
10	RamtekBunglow, Malbar Hill, Mumbai	0.10	Rubble bund	1.40	State	Completed
11	Priyadarshani Park, Malbar Hill, . Mumbai	0.07	Rubble bund	1.50	State	Completed
12	DandepadachinchaniTal.Dahanu, . Palghar	0.144	ASE bund	1.50	State	Completed
13	TadiyaleTal.Dahanu . Palghar	0.150	ASE bund	2.00	State	Completed

Sr. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
14	Satpati, . Palghar	1.258	Anti-sea erosion bund	16.51	State	Completed
15	Edvan, . Palghar	0.115	ASE bund	1.00	State	Completed
16	Navapur, . Palghar	0.330	ASE bund	3.00	State	Completed
17	TarapurTal.Dahanu, . Palghar	0.350	ASE bund	2.50	State	Completed
18	NarpadTal.Dahanu, . Palghar	0.150	ASE bund	1.50	State	Completed
19	GungwadaTal.Dahanu, . Palghar	0.126	ASE bund	1.50	State	Completed
20	Varor, . Palghar	0.100	ASE bund	1.00	State	Completed
21	DandiUchcheli, . Palghar	0.330	ASE bund	4.50	State	Completed
22	Shirgaon, . Palghar	0.281	ASE bund	4.00	State	Completed
23	ArnalakillaTal.Vasai, . Palghar	0.420	ASE bund	5.70	State	Completed
24	KalambTal.Vasai, . Palghar	0.298	ASE bund	2.50	State	Completed
25	BhuigaonTal.Vasai, . Palghar	0.110	ASE bund	1.00	State	Completed
26	RangaonTal.Vasai . Palghar	0.630	ASE bund	6.00	State	Completed
27	Bhati,	0.450	Rubble bund	2.50	13th FC	Completed
28	Danapani (near Aksa Beach)	0.180	Rubble bund	2.50	State	Completed
29	ManoriKabrastan	0.150	Rubble bund with	1.50	State	Completed
30	Khardanda	0.150	Rubble bund with	1.50	State	Completed
31	Diveagar Part-I, Tal. Shrivardhan, . Raigad	0.24	ASE bund	2.50	State	Completed
32	Korlai, Tal. Murud, . Raigad	0.196	ASE bund	3.00	State	Completed

Sr. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
33	Borli, Tal. Murud, . Raigad	0.34	ASE bund	5.00	State	Completed
34	Bharadkhol, Tal. Shrivardhan, . Raigad	0.13	ASE bund	0.50	State	Completed
35	Murud, Tal. Murud, . Raigad	0.15	ASE bund	0.50	State	Completed
36	Mandwa, Tal- Alibag, - Raigad	0.225	ASE bund	1.50	State	Completed
37	Alibag, Tal- Alibag, - Raigad	0.095	ASE bund	1.00	State	Completed
38	Sasawne, Tal- Alibag, - Raigad	0.095	ASE bund	1.00	State	Completed
39	Nevedarnavagaon, Tal- Alibag, - Raigad	0.260	ASE bund	3.00	State	Completed
40	Theronda, Tal- Alibag, - Raigad	0.300	ASE bund	3.23	State	Completed
41	Nagaonpirwadi -1, Tal- Uran, - Raigad	0.277	ASE bund	4.00	State	Completed
42	Nagaonpirwadi -2, Tal- Uran, - Raigad	0.263	ASE bund	4.00	State	Completed
43	Awas, Tal- Alibag, - Raigad	0.200	ASE bund	2.00	State	Completed
44	Hindale	0.141	ASE Bund	1	State	Completed
45	Mithmumbari	0.13	ASE Bund	1	State	Completed
46	Munage	0.42	ASE Bund	2	State	Completed
47	Bagmalagaon	0.107	ASE Bund	1	State	Completed
48	MasurkarJuva	0.345	ASE Bund	1.5	State	Completed
49	MasurkarKhotjuva	0.537	ASE Bund	1.5	State	Completed
50	DevbagTarkarli	2.6	ASE Bund	3	State	Completed
51	Sagareshwarkurlewadi	0.135	ASE Bund	1.5	State	Completed
52	Bhogave Last Stop	0.133	ASE Bund	1.5	State	Completed
53	Newale fort to Bhogave	0.135	ASE Bund	1.5	State	Completed
54	Talashil Seaside	0.223	ASE Bund	1.8	State	Completed

Sr. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
55	SarjekotPirwadi	0.2	ASE Bund	1.75	State	Completed
56	Shrikrishna Temple to Moreshwar Temple	0.15	ASE Bund	1.45	State	Completed
57	Devbag Part-1	0.51	ASE Bund	4	State	Completed
58	Talashil Seaside SavalaramDhaku	0.39	ASE Bund	3	State	Completed
59	Talashil Seaside RajanChandrakantKocharekar	0.195	ASE Bund	1.5	State	Completed
60	DandiMoreshwar	0.225	ASE Bund	2	State	Completed
61	Medha Rajkot	0.22	ASE Bund	2	State	Completed
62	ShirodaKerwada	0.5	ASE Bund	2	State	Completed
63	NivatiKochara	0.11	ASE Bund	1	State	Completed
64	Bhogave	0.125	ASE Bund	1	State	Completed
65	Navabag	0.19	ASE Bund	1.5	State	Completed
66	Sagareshwar Remaining	0.125	ASE Bund	1	State	Completed
67	MasurkarJuva	0.88	ASE Bund	3.48	State	Completed
68	AcharaKaranja Bandar	0.19	ASE Bund	2	State	Completed

Annexure- II (b)

The details of the proposed or on-going coastal protection works of Govt. of Maharashtra

S. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
1.	Walkeshwar Bandstand to Walkeshwar Road . Mumbai	0.28	ASE bund	5.50	State	Work in Progress
2.	Strengthening and Beautification of existing ASE bund at Dadar Chowpatty, . Mumabi	0.14	ASE bund	13.60	State	Work in Progress
3.	Girgaon Chowpatty North end to Bandstand Mumbai, . Mumbai	0.14	ASE bund	4.30	State	Work in Progress
4.	Mahim Shioposwadi to Anath Ashram, Mahim, . Mumbai	0.19	ASE bund	2.50	State	Work in Progress
5.	Ratnakar Soceity, Mahim, . Mumbai	0.06	ASE bund	1.50	State	Work in Progress
6.	Sarvodaya Macchimar Society, Badhwar Park, Cuff Parade, . Mumbai.	0.25	ASE bund	4.50	State	Work in Progress
7.	Geetanagar Approach Road, Mumbai	0.14	ASE bund	3.00	State	Work in Progress
8.	Mahim Relewadi, Mahim, . Mumbai	0.14	ASE bund	2.25	State	Work in Progress
9.	Strengthening of Existing ASE bund at Mahim, . Mumbai	0.14	ASE bund	2.25	State	Work in Progress
1(	Rajbhavan, . Mumbai. (Part-II)	0.16	ASE bund	3.00	State	Work in Progress
1	Rajbhavan, . Mumbai. (Part-III)	1.00	ASE bund	25.00	State	Work in Progress
1	Geetanagar slum to Breakwater Mumbai	2.50	ASE bund	62.50	State	Work in Progress
1	Bordi Tal. Dahanu, . Palghar	0.101	ASE bund	3.00	State	Work in Progress
1	Chikhala Tal.Dahanu . Palghar	0.184	ASE bund	1.80	State	Work in Progress
1	Dahanu gaon Tal.Dahanu . Palghar	0.210	ASE bund	4.50	State	Work in Progress
1(	Dahanu parnaka to forest office Tal.Dahanu . Palghar	0.293	ASE bund	3.48	State	Work in Progress
1	Usarni Tal, -Palghar	0.161	ASE bund	2.99	State	Work in Progress
1	Navapur Tal, -Palghar	0.177	ASE bund	3.00	State	Work in Progress
1	Arnala killa Kalika mata temple Tal-Vasai ,	0.195	ASE bund	5.22	State	Work in Progress

S. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
	Palghar					
20	Arnala Gaon Tal-Vasai , Palghar	0.132	ASE bund	2.50	State	Work in Progress
21	Lagebandar Tal-Vasai , Palghar	0.240	ASE bund	2.99	State	Work in Progress
22	UttanTal. Bhayandar, .Thane	0.190	ASE bund	5.00	State	Work in Progress
23	Kongaon, Tal.Bhivandi, Thane.	1.028	ASE bund	14.39	State	Work in Progress
24	Versova	1.20	Rubble bund with tetrapods and concrete protection wall	65.00		
25	Gorai	0.45	Rubble bund	6.00	4711, State Fund	(Yet to be started)
26	Madh	0.24	Rubble bund with concrete protection wall	7.50	4711, State Fund	(Yet to be started)
27	Juhu Mora Gaon	0.07	Rubble bund with tetrapods	2.40	4711, State Fund	(CRZ not granted yet)
28	Madh Patwadi	0.30	Rubble bund with concrete protection wall	6.00	4711, State Fund	(Propose d)
29	Maral Part-I, Tal. Shrivardhan, . Palghar	0.27	ASE bund	2.50	State	In Progress
30	Maral Part-II, Tal. Shrivardhan, . Palghar	0.12	ASE bund	1.00	State	In Progress
31	Maral Part-III, Tal. Shrivardhan, . Palghar	0.31	ASE bund	3.60	State	In Progress
32	Diveagar, Part-II, Tal. Shrivardhan, . Raigad	0.135	ASE bund	1.50	State	In Progress
33	Diveagar, Part-III, Tal. Shrivardhan, . Raigad	0.33	ASE bund	4.00	State	In Progress
34	Dagiwala Bunder, Tal. Shrivardhan, . Raigad	0.60	ASE bund	0.50	State	In Progress
35	Velas Agar, Tal. Shrivardhan, . Raigad	0.32	ASE bund	3.50	State	In Progress
36	Adgaon, Part-I, Tal. Shrivardhan, . Raigad	0.18	ASE bund	1.50	State	In Progress
37	Adgaon, Part-II, Tal. Shrivardhan, . Raigad	0.60	ASE bund	6.00	State	In Progress

S. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
38	Murud, Tal. Murud, . Raigad	0.38	ASE bund	4.00	State	In Progress
39	Nagaon pirwadi -3, Tal. Uran, . Raigad	0.246	ASE bund	4.00	State	In Progress
40	Alibag, Tal. Alibag, . Raigad	0.420	ASE bund	5.50	State	In Progress
41	Nagaon pirwadi, Kegaon-I, Tal. Uran, . Raigad	0.147	ASE bund	2.55	State	
42	Saswane, Tal. Uran, . Raigad	0.390	ASE bund	4.50	State	
43	Nagaon pirwadi, Kegaon-2, Tal. Uran, . Raigad	0.250	ASE bund	4.37	State	
44	Kegaon-1, Tal. Uran, . Raigad	0.200	ASE bund	3.00	State	
45.	Shri Dev dandeshwar	0.19	ASE Bund	2	State	
46.	Devbag Creek Side	1.289	ASE Bund	7	State	
47.	Ranjnala	0.513	ASE Bund	2.01	State	
48.	KalaseBagwadi	0.328	ASE Bund	2.015	State	
49.	Revandi	0.354	ASE Bund	1.98	State	
50.	Achara Pirwadi	0.1	ASE Bund	2	State	
51.	Kavathi	0.293	ASE Bund	1.02	State	
52.	Bhangsal	0.2	ASE Bund	2.015	State	
53.	SarambalBhatiwadi	0.133	ASE Bund	2.01	State	
54.	Kavathani	0.195	ASE Bund	1	State	
55.	Satarda	0.46	ASE Bund	1.5	State	
56.	Mochemad	0.177	ASE Bund	3	State	
57.	Ubhadanda	0.26	ASE Bund	3.5	State	
58.	Sagartirth	0.632	ASE Bund	3.99	State	
59.	GryeTarbandar	0.478	ASE Bund	1.1	State	
60.	Devbag Part-2	0.472	ASE Bund	5	State	
61.	Devbag Vithal Mandir	0.474	ASE Bund	5	State	
62.	DevbagShrikrishnawadi	0.282	ASE Bund	3	State	
63.	TalashilTondavali	0.483	ASE Bund	5	State	
64.	SarjekotSuvarnkada	0.476	ASE Bund	5	State	
65.	WayariBhutnath	0.415	ASE Bund	5	State	
66.	MalvanNagarparishad	0.484	ASE Bund	5	State	
67.	WayariBhutnath Teli Panand	0.164	ASE Bund	2	State	
68.	Masurkar Khot Juva	0.569	ASE Bund	3.5	State	

S. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
69.	Nishankathi	0.289	ASE Bund	3.5	State	
70.	VengurlaKalavi Bandar	0.196	ASE Bund	2	State	
71.	Banda Sherle	0.34	ASE Bund	2	State	
72.	Kelus Part-2	0.208	ASE Bund	2.12	State	
73.	Killenivati Part-2	0.22	ASE Bund	2.24	State	
74.	Sherle Creek Side	0.082	ASE Bund	1.32	State	
75.	Aronda Kharbhumi No-2	0.08	ASE Bund	2	State	
76.	Satarda	0.2 0.15	ASE Bund	1.5	State	
77.	Aronda Creek Side	0.2 0.1	ASE Bund	1	State	
78.	Sherle	0.04	ASE Bund	1	State	
79.	Sagartirth	0.098	ASE Bund	0.7	State	
80.	Redi Yashwant	0.496	ASE Bund	5	State	
81.	ShirodaVelagar	0.496	ASE Bund	5	State	
82.	BhogaveKillenivati	0.171	ASE Bund	1.75	State	
83.	Karli Creek Hotel Krishnasagar	0.2 0.1	ASE Bund	1.5	State	
84.	Karli Creek Hotel Gulmohar	0.25	ASE Bund	1	State	
85.	Karli Creek Bibavane	0.175	ASE Bund	2	State	
	BibavaneKandechiGalavi	0.087	ASE Bund	1	State	
86.	ChendvanKharicha Bandh	0.215	ASE Bund	2.5	State	
87.	ChendvanSanekar	0.215	ASE Bund	2.5	State	
	TambaldegDakshinwada	0.914	ASE Bund	8	State	
88.	Mithmumbari	0.109	ASE Bund	1	State	
89.	Taramumbari	0.558	ASE Bund	5	State	
	Hindale	0.292	ASE Bund	2.5	State	
90.	Tirlot Mohul Bhatwadi	0.125	ASE Bund	1	State	
91.	MoujeTembavali	0.109	ASE Bund	1	State	
92.	MoujeBaparde	0.125	ASE Bund	1.08	State	
93.	Vadatar Wadis	0.245	ASE Bund	2.3	State	
94.	Construction of Anti Erosion Bund At-Bhogave Tal-Vengurla -Sindhudurg	0.1375	ASE Bund	15.18	State	
95.	Construction of Anti Erosion Bund At-ShirodaVelagar	0.45	ASE Bund	5.03	State	

S. No	Name of village/ Taluka/	Length of Coastline protected by Protection Work (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)	Remarks
96.	Costruction of Anti Erosion Bund At-Redi Tal-Vengurla -Sindhudurg	0.4	ASE Bund	4.48	State	
97.	Construction of Anti Erosion Bund At-Nivati Medha Tal-Vengurla -Sindhudurg	0.47	ASE Bund	5.25	State	
98.	Construction of Anti Erosion Bund At-UbhadandaSukhatanbag to Kurlewadi Tal-Vengurla -Sindhudurg	0.27	ASE Bund	3.66	State	
99.	Construction of Anti Erosion Bund At-Kavathani Tal-Vengurla -Sindhudurg	0.15	ASE Bund	1.7	State	
100.	Construction of ASE bund At-Devbag Tal-Malvan -Sindhudurg	2.3	ASE Bund	22.34	State	
101.	Construction of ASE bund At-Dandi Tal-Malvan -Sindhudurg	1	ASE Bund	9.72	State	
102.	Construction of ASE bund At-Tondavali Tal-Malvan -Sindhudurg	0.75	ASE Bund	7.3	State	
103.	Construction of ASE bund At-Talashil Tal-Malvan -Sindhudurg	0.15	ASE Bund	1.55	State	
104.	Construction of ASE bund at KolambSomavati Vel Tal-Malvan -Sindhudurg	0.7	ASE Bund	6.86	State	
105.	Construction of ASE bund At-Masure Hadkar Girkar Tal-Malvan -Sindhudurg	0.15	ASE Bund	1.47	State	
106.	Construction of ASE bund at Hindale Tal-Deogad -Sindhudurg	0.125	ASE Bund	1.19	State	
107.	Construction of ASE bund at Jamdul Tal-Deogad -Sindhudurg	0.6	ASE Bund	5.33	State	
108.	Construction of ASE bund at Tambaldeg Tal-Deogad -Sindhudurg	1.35	ASE Bund	11.87	State	
109.	Construction of ASE bund AtMithmumbari Tal-Deogad -Sindhudurg	0.6	ASE Bund	5.33	State	
110.	Construction of ASE bund at Aachara Tal-Deogad -Sindhudurg	1	ASE Bund	8.8	State	
111.	ASEBund at Taramumbari Tal-Deogad -Sindhudurg	0.6	ASE Bund	5.31	State	

Annexure-III (a)

The details of coastal protection measures adopted by Govt. of Goa along with expenditure incurred in the last 10 years

SI No.	Name of Village/Taluka/	Length of coastline protected by Protection Work (KM)	Type of Protection work	Project Cost (Rs. In Crore)	Source of Fund(Central/State/Loan)
1	Keri Pernem 1 Phase	1.00 km	Tetra pods	32.00	State
2	Anjuna-Bardez	0.50 km	Concrete block	9.00	State
3	Colva Creek	1.483 km	PCC wall	9.07	State
4	Sunset Beach-Betalbatim	0.50 km	Tetra pods	4.30	State
5	Anti ErosionFlood Protection wall-AzossimMandur	1.50 km	Concrete Wall	3.90	State
6	Anti-Ses Erosion-Siridao	3.20 km	GodiereneWal	11.86	State
7	Anti sea erosion wall Chapora	0.700 km	PCC Wall	1.96	State
8	Construction of retainish wall Dandosiolim	0.210 km	PCC Wall	0.472	State
9	Anti sea Erosion, Verem, Rois Magos	0.10 km	PCC Wall	0.598	State

Annexure-III (b)

The details of the proposed or on-going coastal protection works of Govt. of Goa

SI No.	Name of Village/Taluka/	Length of coastline protected by Protection Work (KM)	Type of Protection work	Project Cost (Rs. In Crore)	Source of Fund(Central/State/Loan)
1	Bank of Coco beach-Dandorim	0.39	Concrete block	4.38	State
2	Quepem-KhanginiKhola	0.180	Concrete protection wall/blocks	5.87	State
3	Keri-Pemem 2nd Phase	0.40	Tetra pods	17.80	State

Annexure-IV(a)

The details of coastal protection measures adopted by Govt. of Karnataka along with expenditure incurred in the last 10 years

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
1	BhavikeriGaneshbag/ Ankola/ Uttara Kannada	0.045	Sea Wall	0.396	State	Completed
2	Devbhag/ Karwar/ Uttara Kannada	0.0085	Sea Wall	0.38	State	Completed
3	HarwadaGabitwada/ Ankola/ Uttara Kannada	0.105	Sea Wall	1.12	State	Completed
4	BhavikeriGaneshbag/ Ankola/ Uttara Kannada	0.06	Sea Wall	0.685	State	Completed
5	Belambar/ Ankola/ Uttara Kannada	0.115	Sea Wall	1.38	State	Completed
6	Harwada / Ankola/ Uttara Kannada	0.3	Sea Wall	2.75	State	Completed
7	Majali Dandebag/ Karwar/ Uttara Kannada	0.075	Sea Wall	1.06	State	Completed
8	KodibagAlvewada/ Karwar/	0.06	Sea Wall	0.41	State	Completed
9	Majali Dandebag/ Karwar/ Uttara Kannada	0.235	Sea Wall	1.06	State	Completed
10	Keni /Ankola/ Uttara Kannada	0.47	Sea Wall	3.52	State	Completed
11	Keni /Ankola/ Uttara Kannada	0.26	Sea Wall	2.09	State	Completed
12	NadibagBobruwada/ Ankola/ Uttara Kannada	0.29	Sea Wall	1.89	State	Completed
13	Berkodi in Kagal Village/ Kumta Taluk/ Uttar Kannada	0.145	Sea Wall	0.99	State	Completed
14	Berkodi in Kagal Village/ Kumta Taluk/ Uttar Kannada	0.065	Sea Wall	0.37	State	Completed
15	Dhareshwar Village/ Kumta Taluk/ Uttar	0.035	Sea Wall	0.25	State	Completed
16	Kalbhag Village/ Kumta Taluk/ Uttar Kannada .	0.15	Sea Wall	0.99	State	Completed
17	Kalbhag Village/ Kumta Taluk/ Uttar Kannada .	0.15	Sea Wall	0.99	State	Completed
18	Kadle in Holanagadde Village/Kumta Taluk/ Uttar Kannada .	0.024	Sea Wall	0.1	State	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
19	Kadle in Holanagadde Village/ Kumta Taluk/ Uttar Kannada	0.024	Sea Wall	0.1	State	Completed
20	Kadle in Holanagadde Village/ Kumta Taluk/ Uttar Kannada	0.024	Sea Wall	0.1	State	Completed
21	BadaVillage/ Kumta Taluk/ Uttar Kannada .	0.024	Sea Wall	0.1	State	Completed
22	BadaVillage/ Kumta Taluk/ Uttar Kannada	0.024	Sea Wall	0.1	State	Completed
23	Gangekolla in Nadumaskeri Village/ Kumta Taluk/ Uttar Kannada .	0.082	Sea Wall	0.024	State	Completed
24	Gangekolla in Nadumaskeri Village/ Kumta Taluk/ Uttar Kannada	0.108	Sea Wall	0.082	State	Completed
25	Dhareshwar Village/ Kumta Taluk/ Uttar Kannada .	0.07	Sea Wall	0.108	State	Completed
26	BadaVillage/ Kumta Taluk/ Uttar Kannada .	0.065	Sea Wall	0.07	State	Completed
27	Gangekolla in Nadumaskeri Village/ Kumta Taluk/ Uttar Kannada .	0.038	Sea Wall	0.065	State	Completed
28	Hubbanageri in BadaVillage/ Kumta Taluk/ Uttar Kannada	0.255	Sea Wall	0.038	State	Completed
29	Hubbanageri in BadaVillage/ Kumta Taluk/ Uttar Kannada	0.105	Sea Wall	2.7	State	Completed
30	Ramanagindi in Divgiri Village/ Kumta Taluk/ Uttar Kannada .	0.128	Sea Wall	1	State	Completed
31	Hireoni in Bada &Holanagadde Village/ Kumta Taluk/ Uttar	0.077	Sea Wall	0.5	State	Completed
32	Vannalli Village/ Kumta Taluk/ Uttar Kannada	0.13	Sea Wall	0.3	State	Completed
33	Karikal in Aghanashini Village/ Kumta Taluk/ Uttar Kannada .	0.24	Sea Wall	0.4	State	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
34	Dubbanashashi in Gokarna Village &Gangekolla / Kumta Taluk/ Uttar Kannada .	0.9	Sea Wall	2	State	Completed
35	Rudrapada in Gokarna Village / Kumta Taluk/ Uttar Kannada	0.4	Sea Wall	10	State	Completed
36	Belekan in Tadadi Village / Kumta Taluk/ Uttar Kannada	0.34	Sea Wall	5	State	Completed
37	MankiDoddagunda/Honnavar/Uttra Kannada	0.6	Sea Wall	1.75	State	Completed
38	Kasarkod/Honnavar/Uttara Kannada	0.23	Sea Wall	1.75	State	Completed
39	Kasarkod/Honnavar/Uttara Kannada	0.11	Sea Wall	0.513	State	Completed
40	Kasarkod, Ramangara/Honnavar/ UttraKannand	0.08	Sea Wall	1.12	State	Completed
41	Kasarkod/Honnavar/Uttara Kannada	0.6	Sea Wall	0.8	State	Completed
42	Pavinakurve/Honnavar/Uttara Kannada	0.9	Sea Wall	0.3	State	Completed
43	Kasarkod/Honnavar/Uttara Kannada	0.1	Sea Wall	0.106	State	Completed
44	Talgod/Bhatkal/Uttara Kannada	0.3	Sea Wall	0.103	State	Completed
45	Hadinsudigadde/Bhatkal/ Uttara	0.1	Sea Wall	0.3	State	Completed
46	Hebale/Bhatkal/Uttara Kannada	0.06	Sea Wall	0.51	State	Completed
47	Hirekeri/Bhatkla/Uttara Kannada	0.6	Sea Wall	0.3	State	Completed
48	Honnegadde/Bhatkal	0.105	Sea Wall	0.3	State	Completed
49	Karikal/Bhatkal/Uttara Kannada	0.3	Sea Wall	0.85	State	Completed
50	Honnegadde/Bhatkal	0.105	Sea Wall	3.75	State	Completed
51	Karikal Bhatkal/Uttara Kannada	0.322	Sea Wall	0.145	State	Completed
52	Toppalakeri/Honnavar	0.1	Sea Wall	0.03	State	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
53	Tudalli/Bhatkal/Uttara Kannada	0.1	Sea Wall	0.535	State	Completed
54	Mavalli/ Bhatkal/Uttara Kannada	0.1	Sea Wall		State	Completed
55	Shirali/Bhatkal/Uttara Kannada	0.1	Sea Wall		State	Completed
56	Jaalikodi/Bhatkal/ Uttara Kannada	0.25	Sea Wall	1.15	State	Completed
57	Jaali Dodmne/Karwar/Uttara	0.16	Sea Wall	3.11	State	Completed
58	Jaali Dodmne/Karwar/Uttara	0.03	Sea Wall		State	Completed
59	Jaali Hotkani/Karwar/	0.09	Sea Wall		State	Completed
60	Talgod/Karwar	0.3	Sea Wall	0.22	State	Completed
61	Hoode, Udupi	0.050	Sea Wall	0.94	STATE	Completed
62	Beejadi, Udupi	0.025	Sea Wall	0.25	STATE	Completed
63	Shiroorkalihitlu, Byndoor	0.100	Sea Wall	0.20	STATE	Completed
64	Tenka Ermal, Udupi	0.400	Sea Wall	0.20	STATE	Completed
65	Tenka Ermal, Udupi	0.060	Sea Wall	0.05	STATE	Completed
66	Adragoli, Byndoor	0.170	Sea Wall	0.58	STATE	Completed
67	Manoor, Kundapura	0.152	Sea Wall	0.70	STATE	Completed
68	Tenka Ermal, Udupi	0.038	Sea Wall	0.07	STATE	Completed
69	Manoor, Kundapura	0.018	Sea Wall	0.34	STATE	Completed
70	Trasi Beach, Kundapura	0.148	Sea Wall	0.22	STATE	Completed
71	Shiroor, Byndoor	0.228	Sea Wall	0.49	STATE	Completed
72	Hosad, Byndoor	0.135	Sea Wall	0.15	STATE	Completed
73	Kota Padukere, Udupi	0.118	Sea Wall	0.18	STATE	Completed
74	Kodi Kanyana,Udupi	0.089	Sea Wall	0.13	STATE	Completed
75	Tenka Ermal, Kaup	0.300	Sea Wall	0.40	STATE	Completed
76	Bada Ermal, Kaup	0.055	Sea Wall	0.10	STATE	Completed
77	Bada Ermal, Kaup	0.075	Sea Wall	0.40	STATE	Completed
78	Kaipunjalu	0.048	Sea Wall	0.12	STATE	Completed
79	UdyavaraPadukere	0.120	Sea Wall	0.15	STATE	Completed
80	Shiroor, Byndoor	0.390	Sea Wall	0.17	STATE	Completed
81	Hosahitlu, Byndoor	0.096	Sea Wall	0.13	STATE	Completed
82	Tenka Ermal, Kaup	0.031	Sea Wall	0.05	STATE	Completed
83	Udyavara, Padukere	0.172	Sea Wall	0.14	STATE	Completed
84	Kidiyur, Padukere	0.087	Sea Wall	1.01	STATE	Completed
85	Hoode, Udupi	0.087	Sea Wall	1.01	STATE	Completed
86	Shiroor - Kalihitlu,	0.870	Sea Wall	1.00	STATE	Completed
87	Hosad, Kundapur	0.040	Sea Wall	0.55	STATE	Completed
88	Tenka Ermal, Kaup	0.182	Sea Wall	0.53	STATE	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
89	UdyavaraPadukere	0.070	Sea Wall	0.40	STATE	Completed
90	Adragoli, Byndoor	0.087	Sea Wall	0.50	STATE	Completed
91	Tenka Ermal, Kaup	0.060	Sea Wall	0.04	STATE	Completed
92	Paduwari, Byndoor	0.082	Sea Wall	0.98	STATE	Completed
93	Kota Padukere	0.084	Sea Wall	0.25	STATE	Completed
94	UdyavaraPadukere, Kaup	0.110	Sea Wall	0.09	STATE	Completed
95	Paduvari, Byndoor		Sea Wall	0.50	STATE	Completed
96	ShiroorKalihitlu, Byndoor	0.170	Sea Wall	0.74	STATE	Completed
97	KirimanjeshwaraAdragoli,	0.086	Sea Wall	0.52	STATE	Completed
98	ShiroorDombe, Byndoor	0.443	Sea Wall	4.17	STATE	Completed
99	Beejadi, kundapura	0.030	Sea Wall	0.03	STATE	Completed
100	Katapadi Mattu, Kaup	0.030	Sea Wall	0.04	STATE	Completed
101	Katapadi Mattu, Kaup	0.030	Sea Wall	0.04	STATE	Completed
102	Tenka Ermal, Kaup	0.025	Sea Wall	0.03	STATE	Completed
103	KidiyurPadukere	0.087	Sea Wall	0.01	STATE	Completed
104	Bada Ermal &Tenka	0.561	Sea Wall	2.16	STATE	Completed
105	Tenka Ermal, Kaup	0.250	Sea Wall	0.05	STATE	Completed
106	KutpadiPadukere, Udupi	0.160	Sea Wall	0.76	STATE	Completed
107	PadekarPadukere, Udupi	0.200	Sea Wall	0.92	STATE	Completed
108	Kodi Kanyana, Kundapura	0.215	Sea Wall	0.80	STATE	Completed
109	ManurPadukere,	0.311	Sea Wall	0.91	STATE	Completed
110	HosahitluKoderi, Byndoor	0.095	Sea Wall	0.47	STATE	Completed
111	Hosahitlu, Byndoor	0.155	Sea Wall	0.77	STATE	Completed
112	Kodi, Kundapura	0.081	Sea Wall	0.88	STATE	Completed
113	Kota Padukere, Kundapura	0.084	Sea Wall	0.69	STATE	Completed
114	Paduvari, Kundapura	0.050	Sea Wall	0.11	STATE	Completed
115	Hoode, Udupi	0.025	Sea Wall	0.01	STATE	Completed
116	Hoode, Udupi	0.125	Sea Wall	0.60	STATE	Completed
117	TenkaYermal, Kaup	0.098	Sea Wall	0.72	STATE	Completed
118	Tottam, Kaup	0.098	Sea Wall	0.24	STATE	Completed
119	Bada Yermal, Kaup	0.980	Sea Wall	0.72	STATE	Completed
120	Hosahitlu, Kundapura	0.900	Sea Wall	1.00	STATE	Completed
121	Kodi, Kundapura	0.121	Sea Wall	0.51	STATE	Completed
122	Trasi, Kundapura	0.025	Sea Wall	0.04	STATE	Completed
123	UdyavaraPadukere, Kaup	0.024	Sea Wall	0.10	STATE	Completed
124	Bengre, Kundapura	0.022	Sea Wall	0.09	STATE	Completed
125	Muloor Tottam, Udupi	0.661	Sea Wall	0.93	STATE	Completed
126	TenkaYermal, Udupi	0.050	Sea Wall	0.05	STATE	Completed
127	Tenkanidiyur, Udupi	0.272	Sea Wall	1.55	STATE	Completed
128	Malpe, Udupi	0.198	Sea Wall	1.20	STATE	Completed
129	Tenkanidiyur, Udupi	0.084	Sea Wall	0.50	STATE	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protecte d Work (Km)	Type of Protectio n Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/St ate/Loan)	Remarks
130	Tenkanidiyur, Udupi	0.070	Sea Wall	0.04	STATE	Completed
131	Malpe, Udupi	0.035	Sea Wall	0.21	STATE	Completed
132	Malpe Tottam, Udupi	0.035	Sea Wall	0.21	STATE	Completed
133	Malpe Beach, Udupi	0.035	Sea Wall	0.21	STATE	Completed
134	ManoorPadukere, Udupi	0.100	Sea Wall	0.49	STATE	Completed
135	ManoorPadukere, Udupi	0.070	Sea Wall	0.26	STATE	Completed
136	ManoorPadukere, Udupi	0.080	Sea Wall	0.29	STATE	Completed
137	Navunda Maski,	0.055	Sea Wall	0.37	STATE	Completed
138	GangolliBelikeri,	0.055	Sea Wall	0.37	STATE	Completed
139	Hosahitlu, Kundapura	0.055	Sea Wall	0.37	STATE	Completed
140	Shiroor, Kundapura	0.115	Sea Wall	1.71	STATE	Completed
141	Malpe Tottam, Udupi	0.980	Sea Wall	0.47	STATE	Completed
142	Trasi, Kundapura	0.150	Sea Wall	0.21	STATE	Completed
143	Gangolli Madi, Udupi	0.025	Sea Wall	0.26	STATE	Completed
144	KidiyurPadukere, Udupi	0.470	Sea Wall	5.74	STATE	Completed
145	Kodi Bengre, Kundapur	0.502	Sea Wall	3.83	STATE	Completed
146	GangolliBelikeri,	0.300	Sea Wall	2.38	STATE	Completed
147	GangolliKharvikeri,	0.215	Sea Wall	2.95	STATE	Completed
148	Navunda Maski, Byndoor	0.086	Sea Wall	1.10	STATE	Completed
149	PaduvariTarapati,	0.157	Sea Wall	0.92	STATE	Completed
150	Navunda Maski, Byndoor	0.260	Sea Wall	3.34	STATE	Completed
151	Muloor Tottam, Udupi	0.099	Sea Wall	0.55	STATE	Completed
152	Muloor Tottam, Udupi	0.130	Sea Wall	0.72	STATE	Completed
153	KadekarPadukere, Udupi	0.100	Sea Wall	0.44	STATE	Completed
154	KutpadiPadukere, Udupi	0.050	Sea Wall	0.44	STATE	Completed
155	KutpadiPadukere, Udupi	0.100	Sea Wall	0.44	STATE	Completed
156	KutpadiPadukere, Udupi	0.190	Sea Wall	0.73	STATE	Completed
157	UdyavaraPadukere, Udupi	0.207	Sea Wall	1.00	STATE	Completed
158	Koteshwara, Kundapura	0.100	Sea Wall	1.08	STATE	Completed
159	Maski, Byndoor	0.077	Sea Wall	0.51	STATE	Completed
160	Maski, Byndoor	0.070	Sea Wall	0.49	STATE	Completed
161	Maski, Byndoor	0.095	Sea Wall	0.63	STATE	Completed
162	ShiroorDoddahitlu,	0.150	Sea Wall	1.00	STATE	Completed
163	ShiroorDoddahitlu,	0.098	Sea Wall	0.65	STATE	Completed
164	Hosahiltu, Byndoor	0.150	Sea Wall	0.89	STATE	Completed
165	Hosahiltu, Byndoor	0.083	Sea Wall	0.47	STATE	Completed
166	KirimanjeshwaraAdragoli,	0.990	Sea Wall	0.57	STATE	Completed
167	PaduvariDombe, Byndoor	0.082	Sea Wall	0.55	STATE	Completed
168	PaduvariDombe, Byndoor	0.084	Sea Wall	0.56	STATE	Completed
169	PaduvariDombe, Byndoor	0.084	Sea Wall	0.56	STATE	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
170	Koteshwara, Kundapura	0.264	Sea Wall	0.32	STATE	Completed
171	UdyavaraPadukere,	0.090	Sea Wall	0.35	STATE	Completed
172	Kodi, Kundapura	0.050	Sea Wall	0.17	STATE	Completed
173	UdyavaraPadukere, Udupi	0.100	Sea Wall	0.36	STATE	Completed
174	Nadipatna, Kaup	0.325	Sea Wall	2.15	STATE	Completed
175	KidiyurPadukere, Udupi	0.470	Sea Wall	4.97	STATE	Completed
176	GangolliBelikeri, Kundapura	0.425	Sea Wall	2.33	STATE	Completed
177	Navunda Maski, Byndoor	0.085	Sea Wall	0.03	STATE	Completed
178	Maravathe Shoreline Protection and Management Project - Construction of Groynes and sand Re ribution – 3.50 Km	3.500	Groynes and sand Re ribution	92.23	ADB Loan	Completed
179	Kodi Bengre shoreline Protection and Management Project – Construction of Rock Revetment- 4.00 Km	4.000	Rock Reventment	78.88	ADB Loan	Completed
180	Udyavara Shoreline Protection and Management Project - Construction of Rock Groynes and Beach Nourishment- 5.00 Km	5.000	Roch Groynes and Beach Nourishment	98.85	ADB Loan	Completed
181	YermalThenka; Construction of Rock Revetment for Shoreline Protection and Management – 3.34 Km	3.340	Sea Wall	53.22	ADB Loan	Completed
182	KirimanjeshwaraByndore	0.345		4.50	STATE	Completed
183	NavundaByndore	0.310		4.50	STATE	Completed
184	Maravanth, Byale in Kundapura	0.217		2.50	STATE	Completed
185	ManooruPadukere, Kundapura	0.400		5.00	STATE	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
186	KirimanjeshwaraAdragoli, Byndore	0.124		1.00	STATE	Completed
187	KirimanjeshwaraHosahitlu, Byndore	0.130		0.90	STATE	Completed
188	Gujjarabettu Malpe, Udupi	0.228		2.50	STATE	Completed
189	Kundapura Kodi (Higoli temple)	0.400		4.97	STATE	Completed
190	Kota PadukereParampalli	0.640		6.40	STATE	Completed
191	KirimanjeswaraKoderi	0.128		0.80	STATE	Completed
192	ShirooruDoddahitlu	0.014		0.12	STATE	Completed
193	Badanidiyooru, Udupi	0.247		2.50	STATE	Completed
194	Hejamadi, Kaup, Kaipunjalu	1.600		17.25	STATE	Completed
195	GangolliKarvikereByndor	0.250		4.00	STATE	Completed
196	Kundapura Kodi (Higoli temple) in Kundapura	0.400		4.90	STATE	Completed
197	Kundapura Kodi Hotel Kinara right side	0.475		4.50	STATE	Completed
198	Battappadi- Someshara		Groyne 01	23.58	ADB	Completed
199	Battappadi- Someshara		Groyne 02		ADB	Completed
200	Battappadi- Someshara		Groyne 03		ADB	Completed
201	Battappadi- Someshara		Groyne 04		ADB	Completed
202	Uchila - Someshwara		Groyne 05		ADB	Completed
203	Uchila - Someshwara		Groyne 06		ADB	Completed
204	Uchila - Someshwara		Groyne 07		ADB	Completed
205	Feribail - Someshwara		Groyne 08		ADB	Completed
206	Feribail - Someshwara		Groyne 09		ADB	Completed
207	Feribail - Someshwara		Groyne 10		ADB	Completed
208	Someshwara - Off Shore Reef		Reef 01	104.69	ADB	Completed
209	Someshwara - Off Shore Reef		Reef 02		ADB	Completed
210	Someshwara	0.180	Sea wall	2.90	STATE	Completed
211	Someshwara	0.135	Sea wall	2.10	STATE	Completed
212	Subhasnagar - Ullala	0.350	Sea wall	24.72	STATE	Completed
213	Ullala Beach		Groyne 01	36.25	ADB	Completed
214	Ullala Beach		Groyne 02		ADB	Completed

S.No	Name of Village/Taluka/	Lengh of Coastline protected Work (Km)	Type of Protection Work	Project Cost (Rs.in Crore)	Souce of Fund (Central/State/Loan)	Remarks
215	Ullala Beach		Groyne 03		ADB	Completed
216	Mogaveera Patna		Groyne 04		ADB	Completed
217	Mogaveera Patna		Groyne 05		ADB	Completed
218	Mogaveera Patna		Groyne 06		ADB	Completed
219	Kodi - Ullala		Groyne 07		ADB	Completed
220	Kotepura - Ullala		Groyne 08		ADB	Completed
221	Ullala - Off Shore Reef		Reef 01	107.63	ADB	Completed
222	Ullala - Off Shore Reef		Reef 02		ADB	Completed
223	Bengre Area	0.225	Sea wall	2.75	STATE	Completed
224	Meenakaliya	0.180	Sea wall	1.50	STATE	Completed
225	Chitrapura -Kulai	0.800	Sea wall	10.00	STATE	Completed
226	Hosabettu Area	0.350	Sea wall	4.00	STATE	Completed
227	Sasihithlu Area	0.140	Sea wall	1.65	STATE	Completed
228	Sasihithlu Area	0.885	Sea wall	11.00	STATE	Completed
229	Sasihithlu Area	0.220	Sea wall	2.50	STATE	Completed

Annexure-IV (b)

The details of the proposed or on-going coastal protection works of Govt. of Karnataka

S.No.	Name of Village/ Taluka/ ricrt	Lengh of Coastline protected by Protection Work(Km)	Type of Protection Work	Project Coas (Rs. In Crore	Source of Fund(Central/ State/Loan)
1	Baval–Dand ebag-Majali /Karwar /Uttara Kannada	0.515	Coastal Protection work (Sea wall)	3.75	State
2	Baval –Ramapur - Majali / Karwar / Uttara Kannada	0.585	Coastal Protection work (Sea wall)	3.58	State
3	Devbagh –Ambigwada / Karwar / Uttara Kannada	0.320	Coastal Protection work (Sea wall)	2.42	State
4	Keni Gabitwada/ Ankola/ Uttara Kannada	0.145	Coastal Protection work (Sea wall)	1.04	State
5	Baval – Majali / Karwar / Uttara Kannada	0.493	Coastal Protection work (Sea wall)	6.70	ADB Loan/State

Annexure-V (a)

The details of coastal protection measures adopted by Govt. of Kerala along with expenditure incurred in the last 10 years

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
1	Varkala	0.134	Seawall	0.65	State	
2	Varkala	0.36	Geobag	0.38	State	
3	Chirayinkeezhu	0.938	Sea wall	2.3	State	
4	TvpmTaluk, Thiruvananthapuram	1.25	Groynes	16.7	Budget – Plan	
5	TvpmTaluk, Thiruvananthapuram	1.14	Sea wall	7.67	State & MLA ADS	Beemapally
6	TvpmTaluk, Thiruvananthapuram	0.17	Gabbion Sea wall	1.4	State& MLA ADS	
7	TvpmTaluk, Thiruvananthapuram	0.28	Sea wall	1.19	State & MLA ADS	Valiyathura
8	Kulathoor Village, NeyyattinkaraTaluk, Thiruvananthapuram	0.356	Sea wall	2.93	State & Central	
9	Thiruvallam Village, TvpmTaluk, Tvpm .	3.0	Sea wall	0.45	State	
11	Chavara/Karunagappally	0.03	Gabion Box, Rubble	0.45	State	
12	Chavara/Karungappally	0.085	Reformation of Seawall	0.289	13th FC	
	Chavara/Karunagappally	0.04	Reformation of seawall	0.15	State	
	Chavara/Karunagappally	0.04	Reformation of seawall	0.15	State	Completed
13	Chavara/Karunagappally	0.085	Reformation of seawall	0.3	13th FC	Completed
14	Chavara/Karunagappally	0.055	Reformation of seawall	0.15	State	Completed
	Chavara/Karunagappally	0.055	Reformation of seawall	0.15	State	Completed
	Chavara/Karunagappally	0.04	Reformation of seawall	0.15	State	Completed
15	Chavara/Karunagappally	0.055	Reformation of seawall	0.15	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
16	Shakthikulangara	0.07	Reformation of seawall	0.21	13th FC	Completed
	Neendakara/Karunagappally	0.103	Reformation of seawall	0.44	State	Completed
	Neendakara/Karunagappally	0.065	Reformation of seawall	0.3	State	Completed
17	Chavara/Karunagappally	0.04	Reformation of seawall	0.15	State	Completed
18	Chavara/Karunagappally	0.085	Reformation of seawall	0.265	State	Completed
	Shakthikulangara/	0.095	Protection work of sea coast using	0.095	State	Completed
	Neendakara/Karunagappally	0.03	Constructed core wall	0.0618	State	Completed
19	Alappad Village	3.588	Groyne with Sea wall	10.37 crore	State	Completed
20	Kollam	0.29	Seawall	0.46	State	Completed
	Kollam	0.06	Seawall	0.21	State	Completed
	Kollam	0.06	Reformation of damageed sea wall	0.11	State	Completed
21	Kollam	0.038	Reformation of damageed sea wall	0.16	State	Completed
22	Kollam	0.0435	Seawall	0.07	State	Completed
	Kollam	0.005	Sea wall- gabion box	0.05	State	Completed
	Kollam	0.02	Gabion wall	0.47	State	Completed
23	Kollam	0.056	Sea wall - geobags	0.08	State	Completed
24	Kollam	0.72	Groins	0.12	State	Completed
	Kollam	0.065	sea wall	0.18	State	Completed
	Kollam	0.11	sea wall	0.825	State	Completed
25	Kollam	0.079	sea wall	0.22	State	Completed
26	Kollam	0.034	sea wall	0.4	State	Completed
	Kollam	0.129	sea wall	0.36	State	Completed
	Kollam	0.06	Sea wall	0.16	State	Completed
27	Kollam	0.075	Sea wall	0.1	State	Completed
28	Kollam	0.047	Sea wall	0.1	State	Completed
	Kollam	0.045	Sea wall	0.095	State	Completed
	Kollam	0.045	Sea wall	0.1	State	Completed
29	Kollam	0.047	Sea wall	0.14	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
30	Kollam	0.047	Sea wall	0.1	State	Completed
31	Thrikkunnappuzha Panchayath	0.432	Sea wall using granite stone	2.98	State	Completed
32	Thrikkunnappuzha Panchayath	0.053	Sea wall using granite stone	0.218	State	Completed
33	Thrikkunnappuzha Panchayath	0.7	Sea wall using granite stone	2.78	State	Completed
34	Thrikkunnappuzha Panchayath	0.112	Sea wall using granite stone	0.147	State	Completed
35	Thrikkunnappuzha Panchayath	0.15	Sea wall using geobag	0.199	State	Completed
36	Thrikkunnappuzha Panchayath	0.035	Sea wall using granite stone	0.005	State	Completed
37	Thrikkunnappuzha Panchayath	0.11	Sea wall using geobag	0.15	State	Completed
38	Arattupuzha /Karthikappally /Alappuzha	0.3	ASE -2023- Urgentprotection worksusingGeobags in betweenCESCP No.516&518in PerumpallyinArattup	0.388	State	Completed
39	EdavanakkadGramapanchayath,Kochitaluk	0.75	4nos bulb groynes between CP stones 1136 and 1139	3.7	State	Completed
40	Edavanakkad GP Ernakulam	0.2	(30m) bulb groyne between CP stone 1128 & 1124	0.825	State	Completed
41	Edavanakkad GP Ernakulam	1	sand bund at Pazhangad	0.38	State	Completed
42	Edavanakkad GP Ernakulam	1.5	sanadbund at Aniyil	0.57	State	Completed
43	Nayarambala GP, Ernakulam	1	sand bund at Veliyathamparambu	0.19	State	Completed
44	Nayarambala GP, Ernakulam	0.5	sand bund at Nayarambalam	0.19	State	Completed
45	Edavanakkad GP Ernakulam	0.8	sandbund using Geo bags in between CP Stones 1136 &1132 at Pazhangad beach	0.1	State	Completed
46	Edavanakkad GP Ernakulam	1.4	sandbund using Geo bags in between CP Stones 1132 &1125 [illegible]	0.18	State	Completed
47	Nayarambala GP, Ernakulam	0.21	damaged seawall between CP Stone 1113 and 1114	0.1	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
48	Nayarambalam GP of Ernakulam	0.66	Geo bags in between CP Stones 1112 &1115 at Veliyathamparambu	0.2	State	Completed
49	Edavanakkad GP of Ernakulam	0.804	Geo bags atPazhangadu beach	0.2	State	Completed
50	PallipuramGramapanchayath,Kochitaluk	0.15	Geobags at southside of Cherai beach between CESCP stone 1159 and 1160	0.176	State	Completed
51	PallipuramGramapanchayath,Kochitaluk	0.2	Geobags atRakteswary beach in between CP stones 1156 &1157	0.3	State	Completed
52	Njarakkal GP of Ernakulam	0.102	GeO bags at ICAR	0.05	State	Completed
53	Edavanakkad GP of Ernakulam	0.051	Geobags in between CP stone 1127 & 1128, fishing landing centre at Aniyil	0.05	State	Completed
54	Edavanakkad GP of Ernakulam	1.6	formation of sand bund at Pazhangad Beach	0.0225	State	Completed
55	Nayarambalam GP of Ernakulam	2.412	formation of Sand Bund at Puthenkadappuram	0.032	State	Completed
56	Njarakkal/ Ernakulam	1.5	formation of Sand Bund in between CP Stone 1104 to 1110	0.045	State	Completed
57	NayarambalamGramapanchayath,Kochitaluk	0.066	Geo bag in between CP stone 1114& 1116 at Veliyathamparambhu	0.0496	State	Completed
58	EdavanakkadGramapanchayath,Kochitaluk	0.05	Geobag in Between CP Stone 1132 and 1137 at Pazhangad	0.0378	State	Completed
59	NjarakkalGramapanchayath,Kochitaluk	0.115	Geo bags in between CP stone 1109 & 1111	0.0824	State	Completed
60	KuzhuppillyGramapanchayath,Kochitaluk	0.059	Geo bags north of CESCP stone 1152	0.05	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
61	KuzhuppillyGramapanchayath,Kochitaluk	0.06	Geobags CESCP 1144 in two different gaps near Harijan Colony	0.045	State	Completed
62	PallipuramGramapanchayath,Kochitaluk	0.065	Geobags - south of CESCP 1160	0.05	State	Completed
63	NayarambalamGramapanchayath,Kochitaluk	0.155	Geobag in between CP stone 1117 and 1123 near Shanmukha Temple	0.125	State	Completed
64	EdavanakkadGramapanchayath,Kochitaluk	0.208	Geo bags between CP stone 1124 and 1128 at Aniyil	0.165	State	Completed
65	NayarambalamGramapanchayath,Kochitaluk	0.222	Geobags between CP stone 1111 and 1117 at Veliyathamparambu	0.3	State	Completed
66	NayarambalamGramapanchayath,Kochitaluk	0.07	Geobags between CP stone 1115 and 1120 at Veliyathamparambu	0.06	State	Completed
67	Thalassery taluk / Kannur	0.085	Urgent maintenance to the damaged sea wall	0.15	State	Completed
68.	Thalassery taluk / Kannur	0.113	Reformation of damaged sea wall	0.40	State	Completed
69.	Thalassery taluk / Kannur	0.09	Natural calamity-urgent protection	0.25	State	Completed
70.	Thalassery taluk / Kannur	0.035	Reformation of damaged sea wall	0.13	State	Completed
71.	Thalassery taluk / Kannur	0.06	Reformation of damaged sea wall	0.23	State	Completed
72.	Thalassery taluk / Kannur	0.02	Natural calamity-urgent protection	0.056	State	Completed
73.	Thalassery taluk / Kannur	0.04	Reformation of damaged sea wall	0.16	State	Completed
74.	Thalassery taluk / Kannur	0.054	Reformation of damaged sea wall	0.22	State	Completed
75.	Thalassery taluk / Kannur	0.045	maintenance to the damaged sea wall	0.17	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
76.	Thalassery taluk / Kannur	0.073	maintenance to the damaged sea wall	0.18	State	Completed
77.	Kannur municipality		New construction	0.3	State	Completed
78.	Kannur municipality		New construction	0.16	State	Completed
79.	Kannur municipality		Urgent Maintenance work	0.12	State	Completed
80.	Edakkad panchayat		New construction		State	Completed
81.	Kannur Contonment		Urgent Maintenance work	0.44	State	Completed
82.	Kannur municipality		Urgent Maintenance work	0.21	State	Completed
83.	Kannur municipality		Urgent Maintenance work	0.14	State	Completed
84.	Kannur Contonment		Urgent Maintenance work	0.10	State	Completed
85.	Kannur municipality		Urgent Maintenance work	0.15	State	Completed
86.	Kannur municipality	0.06	Urgent Maintenance work	0.33	State	Completed
87.	Kannur municipality	0.06	Urgent Reformation work	0.3	State	
88.	Kannur municipality	0.032	Reformation work	0.16	State	Completed
89.	Kannur municipality	0.039	Reformation work	0.20	State	Completed
90.	Kannur municipality	0.04	Reformation work	0.20	State	Completed
91.	Kannur municipality	0.04	Reformation work	0.20	State	Completed
92.	Kannur municipality	0.047	Reformation work	0.24	State	Completed
93.	Kannur municipality	0.059	EMERGENCY Maintenance work	0.3	State	Completed
94.	Kannur municipality	0.07	Monsoon preparedness- Urgent protection work	0.18	State	Completed
95.	Kannur municipality	0.035	Emergency Urgent Maintenance work	0.2	State	Completed
96.	Thalassery in Kannur		ASE Work-Urgent Maintenance to the damaged sea wall	0.088	State	Completed
97.	Dharmadam in Kannur		ASE Work-Urgent Maintenance to the damaged sea wall	0.0996	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
98.	Thalassery in Kannur		ASE Work-Urgent Maintenance to the damaged sea wall	0.098	State	Completed
99.	Dharmadam in Kannur		ASE Work-Urgent Maintenance to the damaged sea wall	0.0848	State	Completed
100.	Dharmadam in Kannur	0.067	ASE Work-Urgent Maintenance to the damaged sea wall	0.13	State	Completed
101.	Thalassery in Kannur	0.082	Natural Calamity - ASE Work	0.22	State	Completed
102.	Muzhappilangad in Kannur	0.092	ASE Work- Maintenance to the damaged return sea	0.325	State	Completed
103.	Muzhappilangad in Kannur	0.085	ASE Work- Reformation of damaged sea wall (Gap filling)	0.0501	State	Completed
104.	Pallikkunnu, Kannur, Kannur	0.113	Reformation of damaged sea wall	0.25	State	Completed
105.	Pallikkunnu, Kannur, Kannur	0.081	Reformation of damaged sea wall	0.15	State	Completed
106.	Pallikkunnu, Kannur, Kannur	0.045	Reformation of damaged sea wall	8.25	State	Completed
107.	Pallikkunnu, Kannur,	0.072	Reformation of damaged sea wall	13.75	State	Completed
108.	Pallikkunnu, Kannur,	0.074	Reformation of damaged sea wall	0.15	State	Completed
109.	Pallikkunnu, Kannur,	0.14	Reformation of damaged sea wall	0.73	State	Completed
110.	Azhikkal,Kannur,	0.037	Rubble mounded structure	0.15	State	Completed
111.	Azhikkal,Kannur,	0.082	Rubble mounded structure	0.20	State	Completed
112.	Azhikkal,Kannur,	0.098	Rubble mounded structure	0.25	State	Completed
113.	Azhikkal,Kannur,	0.12	Rubble mounded structure	0.32	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
114.	Azhikkal,Kannur,Kannur	0.073	Rubble mounded structure	0.20	State	Completed
115.	Madayi/Payyannur/Kannur	0.100	Reformation of damaged sea wall	0.47	State	Completed
116.	Madayi/Payyannur/Kannur	0.064	Reformation of damaged sea wall	0.27	State	Completed
117.	Madayi/Payyannur/Kannur	0.038	Reformation of damaged sea wall	0.15	State	Completed
118.	Mattool/Payyannur Kannur	0.100	Reformation of damaged sea wall	0.45	State	Completed
119.	Mattool/Payyannur Kannur	0.085	Reformation of damaged sea wall	0.13	State	Completed
120.	Madayi/Payyannur	0.650	new sea wall	1.20	State	Completed
121.	Koyippady	0.36	Emergency protection work using sand filled geobags	0.25	State	Completed
122.	Koyippady	0.1	Emergency protection work using sand filled geobags	0.055	State	Completed
123.	Koyippady	0.1	Emergency protection work using sand filled geobags h	0.1	State	Completed
124.	Perward	0.08	Emergency protection work using sand filled geobags	0.24	State	Completed
125.	Kasaragod	0.04	sea wall maintanance	0.14	State	Completed
126.	Kasaragod	0.53	sea wall construction	0.85	State	Completed
127.	Kasaragod	0.12	sea wall construction	0.59	State	Completed
128.	Kasaragod	0.031	sea wall maintanance	0.14	State	Completed
129.	Kasaragod	0.03	sea wall maintanance	0.14	State	Completed
130.	Kasaragod	0.03	sea wall maintanance	0.14	State	Completed
131.	Kasaragod	0.19	Emergency protection work using sand filled geobags	0.25	State	Completed
132.	Kasaragod	0.137	Emergency protection work using sand filled geobags	0.18	State	Completed
133.	Kasaragod	0.19	Emergency protection work using sand filled geobags	0.25	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
134.	Kasaragod	0.079	Emergency protection work using sand filled geobags	0.214	State	Completed
135.	Kasaragod	0.079	Emergency protection work using sand filled geobags	0.214	State	Completed
136.	Kasaragod	0.084	Emergency protection work using sand filled geobags	0.226	State	Completed
137.	Kasaragod	0.084	Emergency protection work using sand filled geobags	0.226	State	Completed
138.	Kasaragod	0.029	Emergency protection work using sand filled geobags	0.08	State	Completed
139.	Kasaragod	0.068	Emergency protection work using sand filled geobags	0.12	State	Completed
140.	Kasaragod	0.047	Emergency protection work using sand filled geobags	0.29	State	Completed
141.	Kasaragod	0.01	Emergency protection work using sand filled geobags	0.03	State	Completed
142.	Kasaragod	0.045	sea wall maintanance	0.23	State	Completed
143.	Kasaragod	0.05	sea wall maintanance	0.28	State	Completed
144.	Manjeswaram	0.30	Construction of Sea	0.77	State	Completed
145.	Manjeswaram	0.10	sea wall maintanance	0.028	State	Completed
146.	Manjeswaram	0.038	sea wall maintanance	0.147	State	Completed
147.	Manjeswaram	0.034	sea wall maintanance	1.525	State	Completed
148.	Manjeswaram	0.10	Emergency protection work using sand filled geobags	0.02	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
149.	13th FC-ASE works - Construction of sea wall for a length of 425M between ch: 39/060 to 39/485 KM at Janma - Kadappuram in Hosdurg Taluk Reach I Construction of a sea wall for a length of 300M from ch: 39/060KM to 39/360KM	0.425	Sea wall	1.219	State	Completed
150.	ASE maintenance - repairs to the damaged sea wall at Kottikulam for a length of 75m from ch: 42/300 to 42/375Km in Hosdurg Taluk	0.075	Sea wall	0.147	State	Completed
151.	Emergency protection work for a length of 65m near CP stone no 2681 (Protecting H No XX/61)in Uduma Grama panchayath	0.065	Sea wall	0.66	State	Completed
152.	Urgent protection work to the seacost using sand filled geaobags for a length of 275m in between 6m north of CP stone no: 2686 to 15m south of CP stone no: 2685 at KovvalKoppalKadappuram in Hosdurg taluk	0.15	Geobag	0.31	State	Completed
153.	Urgent protection work to the seacost using sand filled geaobags for a length of 275m in between 50m south of CP stone no: 2685 to 85m north of CP stone no: 2683at KoppalKappilKadappuram in Hosdurg taluk	0.15	Geobag	0.31	State	Completed

Sl. No.	Name of Village/ Taluka/	Length of Coastline protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
154.	Emergency protection work to the seacost using sand filled geaobags for a length of 56m near CP stone no: 2681 (protecting the house number XX/61) at KappilKadappuram in Hosdurg taluk	0.056	Geobag	0.13	State	Completed
155.	Emergency protection work to the sea coast using sand filled Geobags for a length of 55 M near CP Stone no.2671 (Pallivetta Mandapam) at ThrikkannadKadappuram in Uduma Gramapanchayath in Hosdurg Taluk.	0.055	Geobag	0.13	State	

Annexure-V (b)

The details of the proposed or on-going coastal protection works of Govt. of Kerala

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
1	Varkala	7	Offshore detached breakwater	Estimate under Preparation based on NCCR Design.	Central /state	
2	Varkala	2	seawall	16	Central /State	
3	Chirayinkeezhu	0.575	Sea wall	1.07	state	
4	TvpmTaluk, Thiruvananthapuram	1.1	Groynes	17.5	Budget – Plan	
5	TvpmTaluk, Thiruvananthapuram .	0.191	Sea wall	2	Budget – Plan	
6	TvpmTaluk, Thiruvananthapuram	1.12	Offshore Break water	71.5	World bank fund	
7	Kulathoor GP/ NeyyatinkaraTaluk /	2	Sea wall with tetraods	51	KIIFB	
8	Thiruvallam Village, Thiruvananthapuram Taluk,	0.293	Sea wall	1.465	State	
9	Thiruvallam Village, Thiruvananthapuram	3	Tetrapod armour unit	70	KIIFB	
12	Chavara/Karunagappally	0.182	Reformation of Seawall	0.7		Proposed
13	Chavara/Karunagappally	0.225	Reformation of Seawall	1.7		Proposed
14	Chavara/Karunagappally/	0.268	Reformation of Seawall	0.96		Proposed
15	Shakthikulangara	0.14	Reformation of Seawall	0.5		Proposed
16	Neendakara/Karunagappall	0.68	Reformation of Seawall	0.2		Proposed
17	Neendakara/Karunagappally	0.515	Reformation of Seawall	0.209		Proposed
18	Alappad Village	11	ASE	400	state	Proposed
20	Thrikkunnappuzha	0.867	Sea wall using	1.02		

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
	Panchayath		granite stone			
21	Thrikkunnappuzha Panchayath	0.8	Sea wall using granite stone	6.57		
22	Thrikkunnappuzha Panchayath	0.002	Sea wall using granite stone	1		
23	Thrikkunnappuzha Panchayath	0.3	Sea wall using geobag	2.54		
24	Thrikkunnappuzha Panchayath	0.4	Sea wall using tetrapods	10		
25	Thrikkunnappuzha Panchayath	0.8	Sea wall using tetrapods	20		
26	Thrikkunnappuzha Panchayath	1.018	Sea wall using tetrapods	25.45		
27	Thrikkunnappuzha Panchayath	0.495	Sea wall using tetrapods	12.38		
28	Thrikkunnappuzha Panchayath	0.556	Sea wall using tetrapods	13.9		
29	Thrikkunnappuzha Panchayath	0.843	Sea wall using tetrapods	21.07		
30	Thrikkunnappuzha Panchayath	0.2	Sea wall using geobag	0.26		
31	Thrikkunnappuzha Panchayath	0.216	Sea wall using geobag	0.28		
32	Thrikkunnappuzha Panchayath	0.17	Sea wall using geobag	0.22		
33	Thrikkunnappuzha Panchayath	0.139	Sea wall using geobag	0.18		
34	Thrikkunnappuzha Panchayath	0.025	Sea wall using granite stone	0.75		
35	Thrikkunnappuzha Panchayath	0.026	Sea wall using granite stone	0.98		
36	Thrikkunnappuzha Panchayath	0.025	Sea wall using granite stone	0.8		
37	Thrikkunnappuzha Panchayath	0.026	Sea wall using granite stone	0.85		
38	Thrikkunnappuzha Panchayath	0.247	Sea wall using geobag	0.348		
39	Thrikkunnappuzha Panchayath	0.153	Sea wall using geobag	0.2		
40	Thrikkunnappuzha Panchayath	0.097	Sea wall using granite stone	0.344		
41	Thrikkunnappuzha Panchayath	0.23	Sea wall using geobag	0.297		
42	Thrikkunnappuzha Panchayath	0.256	Sea wall using geobag	0.331		
43	Thrikkunnappuzha Panchayath	0.1	Sea wall using geobag	0.13		
44	Thrikkunnappuzha	0.205	Sea wall using	0.265		

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
	Panchayath		geobag			
45	Thrikkunnappuzha Panchayath	0.15	Sea wall using geobag	0.194		
46	Thrikkunnappuzha Panchayath	0.23	Sea wall using geobag	0.298		
51	Pallipuram Gramapanchayath,Kochi taluk	0.13	Geobags near CESCP 1170	0.152	State	Proposed
52	Kuzhuppilly Gramapanchayath,Kochi taluk	0.205	CESCP 1143 in gap of existing Geobag work	0.158	State	Proposed
53	Kuzhuppilly Gramapanchayath,Kochi taluk,	0.408	Tetrapod between CESCP stone 1139-1141	10.2	State	Proposed
54	Kuzhuppilly Gramapanchayath,Kochi taluk	0.4	Tetrapod between CESCP stone 1141-1143	10	State	Proposed
55	Kuzhuppilly Gramapanchayath,Kochi taluk	1.802	Tetrapod between CESCP stone 1143-1152	45.05	State	Proposed
56	Pallipuram Gramapanchayath,Kochi taluk	1.201	Tetrapod between CESCP stone 1152-1158	30.025	State	Proposed
57	Pallipuram Gramapanchayath,Kochi taluk	0.791	Tetrapod between CESCP stone 1158-1162	19.775	State	Proposed
58	Pallipuram Gramapanchayath,Kochi taluk,	0.606	Tetrapod between CESCP stone 1162-1165	15.15	State	Proposed
59	Pallipuram Gramapanchayath,Kochi taluk,	1	Tetrapod between CESCP stone 1165-1170	25	State	Proposed
60	Pallipuram Gramapanchayath,Kochi taluk	0.3	Tetrapod between CESCP stone 1170-1173	15	State	Proposed
61	Pallipuram Gramapanchayath,Kochi taluk,	2.2	Tetrapod between CESCP stone 1173-1184	55	State	Proposed
62	Pallipuram Gramapanchayath,Kochi taluk	3	6 Nos of bulb groynes	5.4	State	Proposed
63	Pallipuram Gramapanchayath,Kochi taluk	6.5	6 Nos of Bulb Groynes	5.4	State	Proposed
64	Nayarambalam Gramapanchayath,Kochi taluk	2.425	Tetrapod between CP stone CESCP 1111 -1124	56.918	State	Proposed
65	Edavanakkad	2.36	Tetrapod for the	55.937	State	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
	Gramapanchayath,Kochi taluk		damaged sunken sea wall in between CP stone 1124 and 1137			
66	Njarakkal Gramapanchayath,Kochi taluk	0.797	Tetrapod between CP stone 1101-1105	18.77	State	Proposed
67	Njarakkal Gramapanchayath,Kochi taluk	0.79	Tetrapod between CP stone 1105-1111	23.64	State	Proposed
68	Edavanakkad Gramapanchayath,Kochi taluk	0.8	6 nos bulb groyne	5.091	State	Proposed
69	Edavanakkad Gramapanchayath,Kochi taluk	0.75	2 nos of Bulb groynes(one groyne field 6 nos)	9.464	State	Proposed
70	Nayarambalam Gramapanchayath,Kochi taluk	0.82	2 nos of Bulb groynes(one groyne field 6 nos)	10.52	State	Proposed
71	Njarakkal Gramapanchayath,Kochi taluk	0.76	2 nos of Bulb groyne field (one groyne field 6 nos)	10.79	State	Proposed
72	Nayarambalam Gramapanchayath,Kochi	0.73	6 nos Bulb Groynes at	5.4	State	Proposed
73	Edavanakkad Gramapanchayath,Kochi taluk	0.151	Geo bags at different gaps between CP	0.2027	State	Proposed
74	Edavanakkad Gramapanchayath,Kochi taluk	0.05	Geobags in between CP stone 1125 to	0.0672	State	Proposed
75	Chellanam Panchayath, Kochi Taluk , Ernakulam	0.335	Geo Bag	0.459	State	Proposed
76	Chellanam Panchayath, Kochi Taluk , Ernakulam	3.36 & 1.2	Tetrapod- sea wall and groynes	320	State	Proposed .
77	Chellanam Panchayath Harbour South Side Kochi Taluk , Ernakulam	0.825	Tetrapod- sea wall and groynes	40	State	Proposed
78	Chellanam Panchayath and Cochin Corporation From Katti Parambu to INS -Kochi Taluk	4.6	Tetrapod- sea wall and groynes	230	State	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
79	Fort Kochi Beach Beautification -Cochin Corporation Kochi Taluk , Ernakulam	0.94	Tetrapod- sea wall and groynes	50	State	Proposed
80	Thrissur (Thalikkulam)	0.160	Geobag	0.303	State	Proposed
81	Thrissur (Thalikkulam)	1.611	Seawall	19.430	State	Proposed
82	Thrissur (Vatanappilly)	0.170	Geobag	0.258	State	Proposed
83	Thrissur (Vatanappilly)	0.485	Rubble mount	0.705	State	Proposed
84	Thrissur (Vatanappilly)	1.444	Seawall	17.415	State	Proposed
85	Thrissur (Engandiyur)	0.250	Geobag	0.300	State	Proposed
86	Kadappuram,Chavakkad, Thrissur	0.283	corewall	1.69	State	Proposed
87	Punnayurkulam/Chavakkad/Thrissur	0.5	Seawall	4.47	State	AS APPROVED
88	Kadappuram,Chavakkad, Thrissur	2.5	Tetrapod	60.5	State	Proposed
89	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	1.05	Tetrapod	19.901	State	Proposed
90	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	1.5	GEOBAG	1.8	State	Proposed
91	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	1.00	SEAWALL	12	State	Proposed
92	Mangalam,Vettom,NiramaruthurPanchayaths,TanurMuncipality in TirurTaluk in Malappuram	0.05	Reformation of damaged seawall	0.38	State	
93	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	0.08	Reformation of damaged seawall	0.452	State	
94	Mangalam,Vettom,NiramaruthurPanchayaths,TanurMuncipality in TirurTaluk in	0.26	Reformation of damaged seawall	1.45	State	

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
	Malappuram Mangalam Village, Tirur Taluk, Malappuram					
95	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	0.4	Reformation of damaged seawall	2.39	State	
96	Mangalam,Vettom,NiramaruthurPanchayaths,TanurMuncipality in TirurTaluk in Malappuram Mangalam Village, Tirur Taluk, Malappuram Mangalam Village, Tirur Taluk, Malappuram Purathur Village, Tirur Taluk, Malappuram	0.4	Reformation of damaged seawall	2.18	State	
97	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	0.15	Reformation of damaged seawall	1.16	State	
98	Mangalam,Vettom,NiramaruthurPanchayaths,TanurMuncipality in TirurTaluk in Malappuram Mangalam Village, Tirur Taluk, Malappuram	0.07	Reformation of damaged seawall	0.56	State	
99	Azhikode,Eriyad,Edavilangu,PadinjareVemballur, Koolimuttam/ Kodungallur/ Thrissur	0.33	Reformation of damaged seawall	2.06	State	
100	Mangalam,Vettom,NiramaruthurPanchayaths,TanurMuncipality in TirurTaluk in Malappuram Mangalam Village, Tirur Taluk, Malappuram Mangalam Village, Tirur Taluk, Malappuram Purathur Village, Tirur Taluk, Malappuram Mangalam Village, Tirur Taluk, Malappuram Purathur Village, Tirur Taluk, Malappuram	0.16	Reformation of damaged seawall	1.267	State	
101		0.25	Reformation of damaged seawall	1.96	State	
102		0.08	Reformation of damaged seawall	0.421	State	
103		0.12	Reformation of damaged seawall	0.684	State	
104		0.1	Reformation of damaged seawall	0.52	State	
105		0.100	Reformation of damaged seawall	0.496	State	

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
106	Purathur Village, Tirur Taluk, Malappuram Malappuram	0.065	Reformation of damaged seawall	0.35	State	
107		0.135	Reformation of damaged seawall	0.7	State	
108		0.08	Reformation of damaged seawall	0.43	State	
109		0.095	Reformation of damaged seawall	0.513	State	
110		0.04	Reformation of damaged seawall	0.216	State	
111		0.1	Reformation of damaged seawall	0.52	State	
112		0.1	Reformation of damaged seawall	0.504	State	
113		0.158	Reformation of damaged seawall	0.83	State	
114		0.38	Reformation of damaged seawall	2.939		
115		0.640	New design-ASE Wall	7.90		
116		0.2	New design-ASE Wall	1.69		
117		0.2	New design-ASE Wall	1.69		
118		0.176	New design-ASE Wall	1.49		
119		0.1	Old design-ASE Wall	0.63		
120		0.147	Old design-ASE Wall	0.789		
121		0.1	Old design-ASE Wall	0.537		
122		0.1	Old design-ASE Wall	0.631		
123	Purathur Village, Tirur Taluk, Malappuram Malappuram Malappuram Ponnani, Malappuram Ponnani, Malappuram	0.1	Old design-ASE Wall	0.613		
124		0.1	Old design-ASE Wall	0.617		
125		0.1	Old design-ASE Wall	0.626		

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
126		0.185	Old design-ASE Wall	1.213		
127	Purathur Village, Tirur Taluk, Malappuram Malappuram Malappuram Ponnani, Malappuram Ponnani, Malappuram Malappuram Ponnani, Malappuram Ponnani, Malappuram Perumpadappu/ Ponnani/ Malappuram Perumpadappu/ Ponnani/ Malappuram	0.145	Old design-ASE Wall	0.87		
128		0.825	Maintenance work (Ongoing)	7.19	state	
129		0.365	Maintenance work	3.01		
130		0.902	ASE work Using tetrapod	20	State	
131		2.53	ASE maintenance Work	42.367	State	
132		1.47	ASE work using sea wal	17.48	State	
133		0.06	ASE work using core wall	0.36	State	
134		0.6	Sea wall	4.5905	State	
135		6.47	Sea wall Tetrapod	260	State	
136	Malappuram Ponnani, Malappuram Ponnani, Malappuram Perumpadappu/ Ponnani/ Malappuram Perumpadappu/ Ponnani/ Malappuram Perumpadappu/ Ponnani/ Malappuram Perumpadappu/ Ponnani/ Malappuram Kozhikode corporation Kozhikode corporation	0.25	Sea Wall	1.96	State	
137		0.234	Sea Wall	1.804	State	
138		2.56	Sea wall Tetrapod	102.4	State	
139		1.91	Sea wall Tetrapod	76.4	State	
144	kozhikode corporation Vatakara Municipality	0.187	ASE Works - Reformation of Shanthi Nagar Seawall starts near CP 1843 towards north in Kozhikode corporation	2	State fund	Proposed
145		0.485	ASE Work- Reformation of Customs seawall 60 m north of	4.04	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			CP 2063 towards south in Vatakara Municipality.			
147	Koyilandy Municipality	0.2	ASE - Reformation of Valiyapally seawall for a length of 200m from 36m north of CP 1941 towards north in Koyilandy Municipality	1.5	State fund	Proposed
148	Kozhikode corporation		ASE Works - Reformation of Thoppayil Seawall near CP 1835 in Kozhikode corporation	1.3	State fund	Proposed
149	Payyoli Muncipality.	0.3	ASE Work - Reformation of seawall at Ayanikkad beach for a length 300m starting from C.P 2024 towards north in Payyoli Muncipality.	2.55	State fund	Proposed
150	Azhiyur Panchayat	0.08	ASE Works- Reformation of Kappuzhakkal sea wall from CP 2108 towards south in Azhiyur Panchayat/Vatakara LA.	0.7	State fund	Proposed
151	Kozhikode Corporation		ASE works - Reformation of Chakkumkadavu Sea wall at Chamundivalappu starting from 50 m North of CP 1807 towards South in Kozhikode Corporation	3	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
152	Chemenchery Panchayath		ASE - Constructing sea wall to close the existing fishing gap of length 40m at Kannankadavu Beach near CP 1891 in Chemenchery Panchayath.	0.51	State fund	Proposed
153	Vatakara Municipality	0.08	ASE- Reformation of Kuriyadi seawall from 38 m south of CP 2069 towards south in Vatakara Municipality/Vatakara LA	0.64	State fund	Proposed
154	Kadalundi Grama Panchayath		ASE Works - Reformation of Kadalundi Seawall starting from 50m North of CP 1750 towards south in Kadalundi Grama Panchayath	2	State fund	Proposed
155	Payyoli Municipality	0.15	ASE-Works- Reformation of Ayanikkad seawall for a length of 150m between CP 2027 and CP 2028 in Payyoli Municipality , in Kozhikode .	1.3	State fund	Proposed
156	Azhiyur panchayat	0.135	ASE Works- Reformation of Kappuzhakkal seawall from 60 m south of CP 2110 towards north in Azhiyur panchayat/ Vatakara LA	1.13	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
157	Kozhikode corporation		ASE - Reformation of Kozhikode South beach sea wall starts from 10m north of CP 1820 towars south	1.26	State fund	Proposed
158	Chorode Panchayat	0.565	ASE- Reformation of Chorode&Rayarangoth seawall from 83 m north of CP 2077 towards north in Chorode Panchayat/Vatakara LA	5.12	State fund	Proposed
159	Chemenchery Panchayath		ASE Works - Reformation of Kannamkadavu seawall from CP 1886 towards north in Chemenchery Panchayath	4.95	State fund	Proposed
160	Kozhikode corporation		ASE Works- Reformation of Kappakkal sea wall at Koyavalappu starting from 55m South of CP 1800 towards North in Kozhikode corporation	1	State fund	Proposed
161	Payyoli Municipality	0.27	ASE-Works- Reformation of Ayanikkad seawall for a length of 270m from 60m North of CP 2020 towards North in Payyoli Municipality	2.3	State fund	Proposed
162	Kozhikode Corporation		ASE works - Reformation of Godeeswaram	1.5	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			Sea wall starting from 13 m south of CP 1777 towards north in Kozhikode Corporation			
163	Chemenchery Panchayath	0.16	ASE - Reformation of Kappad sea wall for a length of 160m starting from 120m south of CP 1918 towards north in Chemenchery Panchayath	0.94	State fund	Proposed
164	Azhiyur Panchayat	0.166	ASE Works- Reformation of Kappuzhakkal Seawall from 48 m north of CP 2105 towards south in Azhiyur Panchayat/Vatakara LA	1.39	State fund	Proposed
165	chemanchery Panchayath	0.225	ASE - Reformation of Kappad sea wall for a length 225m starts from 24 m north of CP 1915 towards north in chemanchery Panchayath	1.36	State fund	Proposed
166	Chorode Panchayath	0.265	ASE - Reformation of Kuriyadi seawall from CP 2070 towards north in Chorode Panchayath/ Vatakara LA	2.24	State fund	Proposed
167	Chengottukavu Panchayath	0.16	ASE - Reformation of Parakkathazha sea wall for a length 160m near CP 1920 in Chengottukavu	0.92	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			Panchayath			
168	Vatakara Municipality.	0.4	ASE Work-Reformtion of Anad seawall at Koyilandyvalappu from CP 2057 towards south in Vatakara Municipality.	3.33	State fund	Proposed
169	Chengottukavu Panchayath	0.16	ASE - Reformation of Parakkathazha sea wall for a length 160m near CP 1921 in Chengottukavu Panchayath	0.95	State fund	Proposed
170	Koyilandy Municipality	0.4	ASE - Reformation of Seawall at Koothamvalli beach in between CP1945 and CP 1948 for a length of 400 m Koyilndy	2.44	State fund	Proposed
171	Kozhikode Corporation		ASE Works - Reformation of Godeeswaram Sea wall near CP 1778 in Kozhikode Corporation	0.8	State fund	Proposed
172	Kadalundi Grama Panchayath		ASE Works - Reformation of Kappalangadi Seawall starting from 40m north of CP 1754 towards south in Kadalundi Grama Panchayath	0.93	State fund	Proposed
173	Payyoli Municipality	0.1	ASE-Works-Reformation of Ayanikkad seawall for a length of 100m between CP 2026 and CP	0.85	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			2027 in Payyoli Municipality			
174	Kozhikode corporation		ASE Works - Reformation of Kappakkal sea wall at Manneduthparamba starting from 24m North of CP 1802 towards South	0.85	State fund	Proposed
175	Chengottukav Panchayath	0.1	ASE - Reformation of Poyilkavu sea wall for a length 100 m near CP 1919 in Chengottukav Panchayath	0.62	State fund	Proposed
176	Azhiyur Panchayat	0.04	ASE Works- Construction of seawall for closing two fishing gaps in between CP 2111 and CP 2116 in Azhiyur Panchayat/ Vatakara LA	0.51	State fund	Proposed
177	Kadalundi Grama Panchayath		ASE Works - Reformation of Kadalundi Seawall Starting from 55m south of CP 1751	0.65	State fund	Proposed
178	payyoli municipality	0.066	ASE - work - construction of seawall for closing fishing gap at kolavipalam in irringal seawall for a length of 66m near CP 2029 in payyoli	0.85	State fund	Proposed
179	Azhiyur panchayat	0.067	ASE Works- Reformation of Naduthodu seawall from 32 m north of CP	0.56	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			2112 towards south in Azhiyur panchayat/ Vatakara LA			
180	Kozhikode corporation		ASE Works-Reformation of Kappakkal sea wall at Koyavalappu starting from 55m north of CP 1798 towards south in Kozhikode	0.6	State fund	Proposed
181	Chemenchery Panchayath	0.11	ASE Works - Reformation of Kannamkadavu seawall for a length of 110m in between of CP 1892 and CP 1893 in Chemenchery Panchayath	0.68	State fund	Proposed
182	Kozhikode Corporation.		ASE Works-Reformation of Marad Sea wall in between CP 1791 and CP 1793 in Kozhikode Corporation.	1	State fund	Proposed
183	Koyilandy Municipality	0.017	ASE - Urgent protection works in fishing gap at Mannamangalam beach in between CP 1955 and CP 1956 for a length of 17 m in Koyilandy Municipality.	0.15	State fund	Proposed
184	Kozhikode corporation		ASE Works-Reformation of Kappakkal sea wall at Koyavalappu starting from	0.5	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			25m north of CP 1797 towards south in Kozhikode corporation			
185	Koyilandy Municipality.	0.03	ASE - Urgent protection works in fishing gap at Mannamangalam beach in between CP 1954 and CP 1955 for a length of 30 m in Koyilandy Municipality.	0.26	State fund	Proposed
186	Azhiyur panchayat		ASE Works- Reformation of Kappuzhakkal seawall from 60 m south of CP 2110 towards south in Azhiyur panchayat/ Vatakara LA	0.56	State fund	Proposed
187	Koyilandy Municipality	0.03	ASE - Urgent protection works in fishing gap at Mannamangalam beach in between CP 1953 and CP 1954 for a length of 30 m in Koyilandy Municipality.	0.21	State fund	Proposed
188	Chengottukavu Panchayath	0.03	ASE - Urgent protection works to the fishing gap at Valiyamangad beach near CP 1928 for a length of 30 m in Chengottukavu Panchayath.	0.26	State fund	Proposed
189	Koyilandy Municipality.	0.125	ASE - Reformation of Seawall at Parappalli beach	0.5	State fund	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			for a length of 125m starts from CP 1951 towards North in Koyilandy			
190	Chemenchery Panchayath	0.1	ASE Works - Reformation of Kappad seawall for a length of 100m from 55m south of CP 1917 towards south in Chemenchery	0.62	State fund	Proposed
191	Moodadi Panchayath.	0.1	ASE Works - Reformation of seawall at Moodadi beach for a length of 100m starts from 50 m north of CP 1963 towards North in ward No. 13 of Moodadi	0.4416	State fund	Proposed
192	Chengottukavu Panchayath	0.06	ASE WORKS - Construction of sea wall to close the existing fishing gap at Kavaladu Beach for a length of 60m in between CP1922 and CP1923 in Chengottukavu Panchayath	0.491	State fund	Proposed
193	Chengottukavu Panchayath	0.04	ASE WORKS - Construction of sea wall to close the existing fishing gap at Ezhukudikkal Beach for a length of 40m in between CP1924 and CP1925 in Chengottukavu Panchayath	0.329	State fund	Proposed
194	Chengottukavu	0.045	ASE WORKS -	0.37	State	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
	Panchayath		Construction of sea wall to close the existing fishing gap at Ezhukudikkal Beach for a length of 45m in between CP1924 and Ezhukudikkal bridge in Chengottukavu		fund	
195	Chengottukavu Panchayath	0.03	ASE WORKS - Construction of sea wall to close the existing fishing gap at Munnukudikkal Beach for a length of 30m in between CP1926 and CP1927 in Chengottukavu Panchayath.	0.248	State fund	Proposed
196	Chengottukavu Panchayath	0.06	ASE WORKS - Construction of sea wall to close the existing fishing gap at Valappil Beach for a length of 60m in between CP1927 and CP1928 in Chengottukavu Panchayath.	0.491	State fund	Proposed
197	Chengottukavu Panchayath	0.052	ASE WORKS - Construction of seawall to close the existing fishing gap at Parakkathazha Beach for a length of 52m in between CP1920 and CP1921 in Chengottukavu Panchayath.	0.426	State fund	Proposed
198	Onchiyam Panchayath	1.58	ASE-	**37.35**	World	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			Reforamtion of Madapally sea wall including construction of fishing gap using tetrapod in between CP 2084 and CP 2092 in Onchiyam Panchayath/Vadakara LA		bank	
199	Onchiyam Panchayath	0.99	ASE-Reforamtion of Madakkara sea wall including construction of fishing gap using tetrapod in between CP 2092 and CP 2097 in Onchiyam Panchayath/Vadakara LA	23.4	World bank	Proposed
200	Payyoli municipality	2.25	ASE - Reformation of ayanikkad and iringal sea wall including construction of fishing gap using tetrapod in between CP 2018 and CP2029 in payyoli municipality of koyilandy LAC	54	World bank	Proposed
201	Chemanchery panchayath	1.4	ASE - Reformation of Kappakkadavu sea wall using tetrapod in between CP 1895 and CP 1902 in Chemanchery panchayath of koyilandy LAC	33.6	World bank	Proposed

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
202	Kozhikode corporation	0.55	ASE - Construction of sea wall at Godeeswaram using tetrapod in between CP 1780 and CP 1783 in Kozhikode corporation	13	World bank	Proposed
203	Kadalundy panchayath	1.7	ASE - Reformation of Kadalundy and kappalangadi sea wall using tetrapod in between CP 1745 and CP 1755 in Kadalundy panchayath	39.5	World bank	Proposed
204	Kozhikode corporation	0.3	ASE - Reformation of Santhinagar sea wall using tetrapod on either side of CP 1843 in Kozhikode corporation	7	World bank	Proposed
205	Kozhikode corporation	0.1	ASE - Reformation of Koya road sea wall using tetrapod strats from CP 1850 towards south in Kozhikode corporation	2.25	World bank	Proposed
206	Payyoli Municipality	0.82	GROYNES- Construction of groynes at Kotta Kadapuram (Kuttiady river mouth) in Kozhikode	42.5	World bank	Proposed
207	Kannur municipality	0.68	Urgent Maintenance work	0.50	State fund	
208	Dharmadam in Kannur	0.060	ASE Work-	0.39	State	

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
			Urgent maintenance to the damaged sea wall		Fund (2711-02-103-99-00-34-03-	
209	Dharmadam in Kannur	0.2	ASE Work-Reformation of damaged sea wall	1.235	State Fund (4711-02-103-99-01-00-00-P-V)	
210	Mattool, Kannur, Kannur	0.662	Reformation of damaged sea wall	3.50	State	
211	Azhikkal/Kannur/ Kannur	0.12	Reformation of damaged sea wall	0.40	State	
212	Mattool, Madayi,Kannur, Kannur	2.158	Reformation of damaged sea wall	12.0992	State	
213	Ezharakadappuram in Kannur	0.255	ASE Work-Construction of sea wall	2.134		
214	Ezharakadappuram in Kannur	0.230	ASE Work-Construction of sea wall	1.93		
215	Ezharakadappuram in Kannur	0.37	ASE Work-Reformation of damaged seawall	1.78		
216	Ezharakadappuram in Kannur	0.22	ASE Work - Reformaton of damaged sea wall	1.264		
217	Ezharakadappuram in Kannur	0.15	ASE Work - Construction of sea wall	1.243		
218	Kannur corporation	0.075	New construction	0.65		
219	Kannur corporation	0.1	Urgent Maintenance work	0.75		
220	Kannur corporation	0.045	Emergency Maintenance work	0.33		
221	Kannur corporation	0.575	Reformation work	3.2		

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
222	Kannur corporation	0.16	Reformation work	0.88		
223	Kannur corporation	0.38	Reformation work	2.09		
224	Kannur corporation	0.1	Reformation work	0.55		
225	Kannur corporation	0.06	Reformation work	0.33		
226	Kannur corporation	0.3	Reformation work	1.65		
227	Thalasserytaluk / Kannur	0.070	Reformation of damaged sea wall	0.48	State Fund	
228	Thalasserytaluk / Kannur	0.06	maintenance to the damaged sea wall	.0.45	State Fund	
229	Thalasserytaluk / Kannur	0.05	maintenance to the damaged sea wall	0.31	State Fund	
230	Thalasserytaluk / Kannur	0.6	Reformation of damaged sea wall	4.52	State Fund	
231	Pallikkunnu, Kannur, Kannur	0.256	Reformation of damaged sea wall	1.30		
232	Azhikode South, Kannur, Kannur	0.072	New construction	0.90		
233	Choottad, Kannur, Kannur	0.35	New sea wall	7.1	world bank fund	
234	Peringady	0.25	Emergency protection work using sand filled geobags	0.8	State	
235	NangiI Koppala	0.27	Construction of sea wall	2	State	
236	kasargod	0.165	CONSTRUCTION OF SEA WALL USING TETRAPOD	3.61	State	
237	kasargod	0.15	CONSTRUCTION AND REFORMATION OF SEA WALL	1.55	State	
238	kasargod	0.91	Reformation of existing damaged sea wall	0.966	State	

Sl. No.	Name of Village/Taluka/	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
239	Koyippadi	1.20	Construction of sea wall using tetrapod	-	-	Proposed World bank project
240	Perward	1.20	sea wall tetrapod	-	-	
241	NangiI Koppala	1.20	sea wall using tetrapod	-	-	
242	Peringady	0.85	Construction of sea wall using tetrapod	-	-	
243	Manjeswaram	0.22	Construction of sea wall	2		
244	Construction of Sea wall using Tetrapod for a length of 220 m near CP stone 2687 at Kanni - Kovval kadapuram in Uduma Grama Panchayath of Hosdurg Taluk in Kasaragod .	0.220	Tetrapod construction	5	state	
245	Construction of Sea wall using Tetrapod for a length of 1500 m in between CP stone No 2679 and CP stone 2687 at Kappil-Koppal - Kovval kadapuram in Uduma Grama Panchayath of Hosdurg Taluk in Kasaragod .	1.5	Tetrapod construction	33.9	state	

Annexure-VI (a)

The details of coastal protection measures adopted by Govt. of Tamil Nadu along with expenditure incurred in the last 10 years

Sl. No	Name of Village / Taluk /	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Ennore / Madhavaram / Thiruvallur	1.50	Groynes	31.82	NABARD
2	EranavoorKuppam / Madhavaram/ Thiruvallur	1.45	Groynes	38.38	NABARD
3	Chinna Kuppam/ Madhavaram/ Thiruvallur	0.18	Rehabilitation of existing damaged RMS wall	0.62	13th FC
4	Periyakuppam/ Madhavaram/ Thiruvallur	0.18	Rehabilitation of existing damaged RMS wall	0.67	13th FC
5	Thalankuppam/ Madhavaram/ Thiruvallur	0.18	Rehabilitation of existing damaged RMS wall	2.00	13th FC
6	Nettukuppam/ Madhavaram/ Thiruvallur	0.90	Rehailitation and rising the existing RMS wall	5.00	NABARD
7	Nettukuppam/ Madhavaram/ Thiruvallur	1.46	Rehailitation and rising the existing RMS wall	9.00	NABARD
8	Nettukuppam/ Madhavaram/ Thiruvallur	0.93	Rehailitation and rising the existing RMS wall	5.00	NABARD
9	Nettukuppam/ Madhavaram/ Thiruvallur	1.20	Rehailitation and rising the existing RMS wall	7.58	NABARD
10	Chinnamudaliyarchavadi / Vanur / Villupuram	0.60	Construction of Sea wall	2.88	13th FC
11	Devanampattinam / Cuddalore / Cuddalore	0.80	Rubble Mound Sea Wall (RMS Wall)	3.00	State Fund
12	Devanampattinam / Cuddalore / Cuddalore	0.42	Rubble Mound Sea Wall (RMS Wall)	1.79	13th FC
13	Thazhanguda / Cuddalore / Cuddalore	0.65	Rubble Mound Sea Wall (RMS Wall)	2.54	13th FC
14	Suba Uppalavadi / Cuddalore / Cuddalore	0.21	Rubble Mound Sea Wall (RMS Wall)	0.84	13th FC
15	Poothurai / Vilavancode / Kanyakumari	0.530	Reformation of RMS wall	2.090	13th FC
16	Mulloorthurai / Vilavancode/ Kanyakumari	0.965	Reformation of RMS wall	0.281	13th FC
17	Kesavanputhanthurai / Agastheeswaram / Kanyakumari	0.520	Construction of RMS wall	1.310	13th FC
18	Gap between Eraviputhanthurai and Vallavilaithurai / Vilavancode / Kanyakumari	1.250	Construction of RMS wall	2.810	13th FC
19	Kottilpadu/ kalkulam / Kanyakumari	0.460	Construction of RMS Wall	3.240	13th FC

Sl. No	Name of Village / Taluk /	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
20	Melmidalam/Vilavancode/ Kanyakumari .	0.120	Reconstruction of RMS wall	0.695	13th FC
21	Mandaikaduputhoor/ kalkulam / Kanyakumari	0.065 0.060 0.063 0.060 0.090 0.081	Construction of Groyne	7.820	NABARD - RIDFXX
22	Eraviputhenthurai / Vilavancode/ Kanyakumari	0.750	Rehabilitation of RMS Wall	3.000	NABARD
23	Chinnathurai / Vilavancode/ Kanyakumari	0.050	Construciton of RMS Wall	0.160	State Fund
24	Gandhi Mandapam and Kamaraj Mandapam / Agastheeswaram / Kanyakumari	0.210	Reformation of RMS Wall	1.020	Swadesh Darshan
25	Protection of houses infront of Community Hall at Vallavilaithurai / Vilavancode/ Kanyakumari	0.120	Reformation of RMS Wall	0.490	NADP - RKVY
26	Protection of houses infront of Church at Vallavilaithura/ Vilavancode / Kanyakumari	0.120	Reformation of RMS Wall	0.455	NADP - RKVY
27	Easten flank of Keezhmidalam hamlet / Vilavancode / Kanyakumari	0.106	Reformation of RMS Wall	0.727	State Fund
28	Marthandamthurai / Vilavancode / Kanyakumari	0.128	Construction of RMS wall for	0.692	State Fund
29	Poothurai / Vilavancode / Kanyakumari	0.050 0.050 0.050 0.050 0.050 T – GROYNE 0.050 + T 0.030 0.050	Construction of Groyne	14.686	NABARD
30	Helan Colony hamlet / Vilavancode / Kanyakumari	0.133	Construction of RMS wall	1.058	NABARD
31	Saveriyarpuram / Thoothukudi / Thoothukudi	0.23	Construction of RMS Wall	0.66	13th FC
32	Thoothukudi / Thoothukudi / Thoothukudi	0.35	Reformation of RMS Wall	0.67	13th FC
33	Saveriyarpuram / Thoothukudi / Thoothukudi	0.08	Extension of RMS Wall	0.33	13th FC
34	Punnakayal / Tiruchendur / Thoothukudi	0.3	Training Wall	8.47	13th FC
35	Periyathalai / Tiruchendur / Thoothukudi	1.1	Groyne	25.20	State Fund

Sl. No	Name of Village / Taluk /	Length of Coastline to be protected (Km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
36	Veerapandiapattinam / Tiruchendur / Thoothukudi	0.65	Groyne	10.64	State Fund
37	Kallamozhi / Tiruchendur / Thoothukudi	0.30	Groyne	7.70	State Fund
38	Alanthalai / Tiruchendur / Thoothukudi	1.20	Groyne	52.46	State Fund
39	Mullimunai/Thiruvadanai/Ramanathapuram	0.60	RMS Wall	4.22	NABARD
40	Sathakonvalasai/ Rameshwaram/ Ramanathapuram	1.415	RMS Wall	11.15	NABARD
41	Keelavaippar / Vilathikulam / Thoothukudi	0.500	Groyne	11.75	State Fund
42	Poompuhar / Sirkali / Nagapattinam	0.515	RMS Wall	0.087	13th FC
43	Tharangambadi / Tharangambadi / Nagapattinam	0.30	RMS Wall	0.319	13th FC
44	Poompuhar / Sirkali / Nagapattinam	0.10	RMS Wall	0.178	13th FC
45	Palayar / Sirkali / Nagapattinam	1.00	RMS Wall	0.597	13th FC
46	Thirumullaivasal / Sirkazhi / Nagapattinam	1.00	RMS Wall	0.546	13th FC
47	Vanagirikuppam / Sirkali / Nagapattinam	0.50	RMS Wall	1.697	13th FC
48	Vanagirikuppam / Sirkali / Nagapattinam	0.95	RMS Wall	1.698	13th FC
49	Akkarapettai / Nagapattinam / Nagapattinam	1.00	RMS Wall	5.180	13th FC
50	Kallar / Nagapattinam / Nagapattinam	0.70	RMS Wall	3.650	13th FC
51	Seruthur / Nagapattinam / Nagapattinam	0.77	RMS Wall	3.50	13th FC

Annexure-VI (b)

The details of the proposed or on-going coastal protection works of Govt. of Tamil Nadu

SL. No	Name of Village / Taluk /	Length of Coastline to be protected by Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Ennore / Thiruvottiyur / Thiruvallur	0.50	Kosasthalaiyar River Mouth Training wall	156.20	Kamarajar Port Limited (KPL) Deposit fund
2	Chepauk / Egmore / Chennai	0.30	Cooum River Mouth Training wall	70.00	State Fund (CRRT)
3	KovalamHamlet /Agastheeswaram / Kanyakumari	0.240 (Rehabilitation) 0.135 (Extension)	Extension of Groyne	11.020	NABARD
4	Periyanayagi street / Agastheeswaram / Kanyakumari	0.040 (Rehabilitation) 0.171 (Construction)	Construction of Groyne	6.948	NABARD
5	Melmidalam /Vilavancode / Kanyakumari	0.105 0.087 0.099	Construction of Series of Groyne	9.354	NABARD
6	Azhikkal village in Agastheeswaram Taluk of Kanyakumari	0.064 0.060 0.057 0.050	Construction of Series of Groyne	9.375	NABARD
7	Enayam village in Vilavancode Taluk of Kanyakumari .	L Groyne Vertical length – 0.086 Horizontal length - 0.026	Construction of series of Groyne	8.123	NABARD
8	Pozhikkarai village in Agastheeswaram taluk of Kanyakumari .	0.192	Construction of Groyne	10.118	NABARD
9	Keelavaippar / Vilathikulam / Thoothukudi	0.5	Extension of Groyne	15.200	State Fund
10	Muttukadu / Thiruporur / Chengalpattu	0.50	River Mouth Training wall	170.00	Estimate Preparation is in progress
11	INS Adyar / Egmore/Chennai	2.20	Shoreline Protection using Hybrid model of living Shorelines	20.00	(TN-SHORE) (World Bank)
12	Mamallapuram /	1.70	Shoreline Protection	95.95	

SL. No	Name of Village / Taluk /	Length of Coastline to be protected by Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
	Thirukazhukundram / Chengalpattu		with Hybrid model		
13	Periyakuppam / Cuddalore / Cuddalore	1.00	Groynes	40.00	
14	Erayumanthurai /Vilavancode/ Kanyakumari	0.255	RMS wall(Reformation)	3.650	-
15	Erayumanthurai /Vilavancode / Kanyakumari	0.230	RMS wall(Reformation)	3.250	-
16	Thoothoor village / Vilavancode/ Kanyakumari	0.250	RMS wall	2.000	-
17	Thoothoor village / Vilavancode/ Kanyakumari	0.165	RMS wall(Reformation)	1.200	-
18	Vallavilai / Vilavancode/ Kanyakumari	2.400	RMS wall(Reformation)	16.800	-
19	West side of Eraviputhenthurai /Vilavancode / Kanyakumari	0.780	RMS wall(Reformation)	4.500	-
20	Eraviputhenthurai /Vilavancode / Kanyakumari	0.150	T- Groyne	19.850	-
21	Chinnathurai /Vilavancode / Kanyakumari	0.300	RMS wall(Reformation)	2.850	-
22	Neerodicolony /Vilavancode / Kanyakumari	0.130	RMS wall(Reformation)	1.000	-
23	East of Kovalam /Agastheeswaram / Kanyakumari	0.550	New groyne	14.900	-
24	Vavathurai/ Agastheeswaram / Kanyakumari	0.175	Reconstruction of RMS wall	1.750	-
25	Azhikal /Agastheeswaram / Kanyakumari	0.560	RMS wall(Reformation)	3.880	-
26	Periyakadu/ Agastheeswaram / Kanyakumari	0.225	Renovation and Extension of groyne	18.450	-
27	Chothavillai and Manakudy /Agastheeswaram	1.730	RMS wall	13.000	-
28	Thekkurichi/ Agastheeswaram /	0.200	RMS wall	1.480	-

SL. No	Name of Village / Taluk /	Length of Coastline to be protected by Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
	Kanyakumari				
29	West side of Pozhikarai /Agastheeswaram / Kanyakumari	0.200	RMS wall	1.539	-
30	Rajakkamangalam /Agastheeswaram / Kanyakumari	1.100	RMS wall(Reformation)	4.600	-
31	Puthenthurai /Agastheeswaram / Kanyakumari	0.150	RMS Wall	0.290	-
32	Kesavanputhenthurai /Agastheeswaram / Kanyakumari	0.300	RMS Wall	1.870	-
33	Kottilpadu /Kalkulam / Kanyakumari	0.220	Reformation of RMS wall	2.130	-
34	Kadiyapattinam / Kalkulam / Kanyakumari	0.120	RMS wall	1.200	-
35	Kodimunai /Kalkulam / Kanyakumari	0.260	Construction of RMS wall	2.630	-
36	Inico Nager / Thoothukudi / Thoothukudi	1.00	Groyne	50.00	-
37	Therspuram / Thoothukudi / Thoothukudi	1.50	Groyne	25.00	-
38	Singidurai and Kombudurai / Tiruchendur / Thoothukudi	1.50	Groyne	70.00	-
39	Punnakayal / Tiruchendur / Thoothukudi	0.50	Groyne (Extension)	7.50	-
40	Nambuthalai / ThiruvadanaiRamanathapuram	0.32	Protection arrangements using Geobags and Training Wall	9.00	
41	Karankadu /Thiruvadanai / Ramanathapuram	0.74	Protection arrangements using Geobags and Training Wall	24.00	
42	Madavamedu village / SirkhazhiTaluk / Mayiladuthurai	1.000	RMS wall	45.00	-

SL. No	Name of Village / Taluk /	Length of Coastline to be protected by Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
43	Kizhakottayamedu / Sirkhazhi Taluk / Mayiladuthurai	1.000	RMS wall	50.00	-
44	Koozhaiyar / Sirkhazhi / Mayiladuthurai	1.000	RMS wall	50.00	-
45	Thirumullaivasal / Sirkazhi / Mayiladuthurai	2.000	RMS wall	80.00	-
46	Chinnamedu / Tharangambadi / Mayiladuthurai	2.000	RMS wall	60.00	-
47	Tharangambadi / Tharangambadi / Mayiladuthurai	2.000	RMS wall	15.00	-
48	Manikkapangu /Tharangambadi / Mayiladuthurai	1.100	RMS wall	50.00	-
49	Chinamedu /Tharangambadi / Mayiladuthurai	1.000	RMS wall	90.00	-
50	Perunthotam / Tharangambadi / Mayiladuthurai	1.600	RMS wall	50.00	-
51	Keelaiyur / Sirkali / Mayiladuthurai	1.800	RMS wall	100.00	-
52	Chandrapadi / Tharangambadi / Mayiladuthurai	2.500	RMS wall	75.00	-
53	Tharangambadi / Tharangambadi Mayiladuthurai	0.560	RMS wall	10.00	-
54	Vanavanmahadevi/ Vedaraniyam / Nagapattinam	0.45	RMS Wall	43.00	Central Fund
55	Naluvethapathi / Vedaraniyam /Nagapattinam .	0.60	RMS Wall	57.00	Central Fund
56	Vettaikaraniruppu / Keevalur / Nagapattinam	0.55	RMS Wall	52.00	Central Fund
57	Vettakaraniruppu / Keevalur / Nagappattinam	0.12	River Training works	90.00	Central Fund
58	Naluvethapathi / Vedaraniyam / Nagapattinam	0.12	River Training works	100.00	Central Fund
59	Naluvethapathi / Vedaraniyam /Nagapattinam	0.12	River Training works	90.00	Central Fund

SL. No	Name of Village / Taluk /	Length of Coastline to be protected by Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
60	Vellappallam / Vedaraniyam / Nagapattinam	0.12	River Training works	90.00	Central Fund

Annexure-VII (a)

The details of coastal protection measures adopted by Govt. of Odisha along with expenditure incurred in the last 10 years

SI No.	Name of Village/Taluka/	Length of coastline protected by Protection Work (KM)	Type of Protection work	Project Cost (Rs. In Crore)	Source of Fund(Central/State/Loan)
1	At Pentha in Rajnagar block of Kendrapada	0.561	Geo textile tube Embankment work as Groynes (Coastal Protection)	34.69	State
2	Udaipur-Talsari in Bhograi Block of Balasore	2.60	Sea Wall cum Service road (Coastal Protection)	20.73	Anti Sea Erosion
3	Chandrabali-Kirtania in Bhogral block in Balasore	0.80	Sea Wall (Coastal Protection)	12.92	RIDF
4	Chaulati-Kasatal in Basta block in Balasore	0.78	Sea Wall (Coastal Protection)	11.06	NABARD
5	Chandipur-Parikhi In Balasoresadar block of Balasore	1.71	Sea Wall (Coastal Protection)	56.67	NABARD
6	Kalamatiapahi&Talapada in Balasore	0.42	Sea Wall (Coastal Protection)	8.04	NABARD

Annexure-VII (b)

The details of the proposed or on-going coastal protection works of Govt. of Odisha

SI No.	Name of Village/Taluka/	Length of coastline protected by Protection Work (KM)	Type of Protection work	Project Cost (Rs. In Crore)	Source of Fund(Central/State/Loan)
1	River mouth of Hansua in Rajnagar Block of Kendrapada	0.735 (not along the coastline)	Drainage improvement of River mouth	60.16	State
2	RamayapatanaChikiti Tehsil in Ganjam	1.32	Sea Wall (Coastal Protection)	23.00	State
3	Bahada Nalla in Haripur of Ganjam	1.23	Drainage improvement of River mouth & River Training Wall &Groynes construction	84.71	State
4	Bahana Nalla in Markandi in Ganjam	1.17	Drainage improvement of River mouth & River Training Wall &Graynes construction	93.06	State

Annexure-VIII (a)

The details of coastal protection measures adopted by Govt. of West Bengal along with expenditure incurred in the last 10 years

SI No.	Name of Village/Taluka/	Length of coastline protected by Protection Work (KM)	Type of Protection work	Project Cost (Rs. In Crore)	Source of Fund(Central /St ate/Loan)
1	Vill-Boga, Block: Khejuri-Il, Sub- Division on Contai, :	0.800	Brick Block slope pitching	2.84	Loan
2	Vill-Panchuriya, Block: Khejuri-II, Sub- Division: Contai, , PurbaMedinipur	2.100	CC. block pitching with RCC toe wall	6.38	Loan
3	VillDhablat, Block Sagar, Sub-Division: Kakdwip, : South 24 Parganas	3.450	CC. Block pitching	47.40	Centrally assisted
4	VillBeguyakhali, Block Sagar, Sub- Division: Kakdwip, : South 24 Parganas	3.000	C.C. Block patching	45.27	Centrally assisted
5	Will Laxmipurabad, Block Namkhana, Sub-Division Kakdwip, : South 24 Parganas	1.360	C.C. Block pitching	12.88	State
6	VillLaximipurabad, Block: Namkhana Sub-Division: Kakdwip, : South 24 Parganas	0.300	CC Block pitching	2.92	State
7	VillBaliara, Block Namkhana, Sub Division: Kakdwip. : South 24 Parganas	2.160	CC Block pitching	39.40	Centrally assisted
8	VillGobardhanpir, Block Patharpatıma, Sub-Division Kakdwip. : South 24 Parganas	1.310	CC Block pitching	15.53	State
9	VillGobardhanpur, Block Patharpratima, Sub-Division: Kakdwip. South 24 Parganas	0.400	CC. Block pitching	9.19	Loan
10	Vill, Sitarampur, Block Patharpratima, Sub Division Kakdwip. , South 24 Parganas	1.700	CC Block pitching	19.52	Centrally assisted
11	VillBuroburutat, Block, Patharpratima, Sub-Division Kaldwin, : South 24 Parganas	0.370	Brick Block pitching	11.19	Centrally assisted

Annexure-VIII (b)

The details of the proposed or on-going coastal protection works of Govt. of West Bengal

SI No.	Name of Village/Taluka/	Length of coastline to be protected (Km)	Type of Protection work	Project Cost (Rs. In Crore)	Source of Fund(Central/State/Loan)
1	Mouza Bhogpur, Block: Deshopran, : Purba Medinipur	0.405	Comexete RC Cop wall Black stone	0.49	State
2	Mouza: Bankıpot, Block Deshopran, : Purba Medinipur	0.080	Sheet pale toe wall with boulder	1.00	State
3	Mouza, JamraShyampur, KP. Talgachari II, Block Ramnagar-I and Purba	0.915	Coastal structure (Retaining wall, CC	13.10	Loan
4	Vill-Raypur (Buramper) Block, Ramnagar 1. Sub-Division ContaiDestPurba	0.180	Sen Wall (Rivetment Boulder pitching)	1.46	State

Annexure-IX (a)

The details of Salinity Ingression prevention/mitigation measures adopted by Govt. of Gujarat along with expenditure incurred in the last 10 years

S. No.	Name of Village/ Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
1	Mota Mandha/ khambhaliya/ Devbhumi	0.01	Checkdam	0.57	State	Completed.
2	Village- Bela, Taluka	-	Causeway Cum Check dam	0.107	State	Completed.
3	Ranjitpar, Jodiya . Jamnagar	4.5	Construction of New Causeway on Jodiya-ManamoraReclamation (Part-I Earthen Bund)	0.49	State	Completed.
4	Chorvad, Ta. Maliya Hatina . Junagadh	25	Providing Ogee Spillway by Removing Vertical Lift Gate No. 1 to 20 (Ch. 878.62 to 1090.00, R.L.- 1.15 to 2.50 Mt.) Dismantling of Hoist Unit, C.D.U/E.D.U, Embedded Parts and Construction of Additional Spill-Way (Ch.773.62 to 878.62 Mt. L=105.00 Mt.) by Dismentling Earthen Dam of Meghal T.R in Maliya Hatina Taluka of Junagadh	9.76	State	Completed.
5	Chorvad, Ta. Maliya Hatina . Junagadh	10	Cleaning of Noli-Meghal Canal Bed Level and Removing Humps and Boulders Between chainage 0.00 m to 5520 m. In Taluka Maliya Hatina Of Junagadh	0.33	State	Completed.
6	Alang / Talaja / Bhavnagar		Alang Bandhara	1.89	state	Completed.

S. No.	Name of Village/ Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
7	Alang / Talaja / Bhavnagar		JasparaBandhara	1.89	state	Completed.

Annexure-IX(b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of Gujarat

S no	Name of Village/Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
1	Pindara/ Kalyanpur/ Dwarka	1.6	Bandhara	3.38	State	
2	Mevasa/ Kalyanpur/ Dwarka	0.01	Checkdam	1	State	
3	ManekpurBandhara	200	Salinity Ingress Prevention Works	39.4	State	
4	Village- Zinzuda, Taluka/ .- Morbi	3.7	Tidal Regulator	19.88	State	
5	Ranjitpar , ta. Jodiya . Jamnagar	2	Strenghthening& Renovation work of Causeway No.6	1.78	State	
6	Solankinagar ta. Jodiya . Jamnagar	4.5	Raising and Repairing of Existing Causeway no - 15, 16 and 17	2.28	State	
7	Ranjitpar , ta. Jodiya . Jamnagar	3	Strengthing work of Jodiya- Manamora Reclamation bund	0.88	State	
8	manamora ta. Jodiya . Jamnagar	1.5	reconstruction of damage earthen bund of jodiyamanamora	0.82	State	
9	Uatbet Sampar ta. Jodiya . Jamnagar	2	Strenghthening& Repairing work of Jodiya-manamora reclamation bund	0.3	State	
10	Jamsar ta. Jodiya . Jamnagar	1.3	Strengthning& renovation of causeway-7	1.5	State	
11	Jamsar ta. Jodiya . Jamnagar	5	Strenghthening& Repairing work of Jodiya-manamora	5	State	

S no	Name of Village/Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
12	Chorvad, Ta. Maliya Hatina . Junagadh	25	Repairing of Apron and Strengthening Of Spillway of Meghal T.R. from Ch. 68.41 m to Ch 496.75 m and Ch.878.62 m to Ch 1090.00 m near village Chorwad in Maliya Hatina Taluka of Junagadh	14	State	
13	Chorvad, Ta. Maliya Hatina . Junagadh	10	Maintenance & Deepening Of Noli-Meghal Spreading Canal in Taluka	1	State	
14	Village-Mul-Madhavpur, taluka- Mangrol, -Junagadh	3	Construction of phase-3 canal between river madhuvanti& netravati – madhuvanti spreading canal at ch. 9200 m near village mul Madhupur in Porbandar .	5	state	
15	Village- shill, taluka – Mangrol, -Junagadh	3	Construction of shilBandhara near village shil in Mangrol taluka of Junagadh .	10	state	
16	Methala/ Talaja / Bhavnagar	-	Methalabandhara	45.63	state	
17	Sartanpar/ Talaja / Bhavnagar	-	Sartanpar check dam	27.87	state	
18	Bhavnagar	-	Maleshri CD Cum Bandhara	15.51	State	
19	Mityala/ Jafrabad/ Amreli	-	Bandhara	36	State	
20	Dharasana/ Valsad/ Valsad	0.5	Tidal Regulator	5.112	State	
21	Palasva	4.6	Bandhara	7.82	State	
22	Guneri	3.06	Bandhara	5.27	State	
23	Vaghrech/Gandevi/ Navsari	-	Tidal Regulator	249.99	NABARD	

S no	Name of Village/Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)	Remarks
24	Purna/ Jalalpore/Navsari	-	Tidal Regulator	87.49	State	
25	Mindhola/ Navsari	-	Tidal Regulator	-	-	Consultancy Tender under progress.

Annexure-X (b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of Maharashtra

Sr. No	Name of village/ Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/ State/ Loan)
1	Nagaon, Tal-Alibag , - Raigad	0.20	Protection Wall	3.00	State
2	Nagaon, Tal-Alibag , - Raigad	0.20	Protection Wall	3.00	State
3	Nagaon,Tal-Alibag , - Raigad	0.20	Protection Wall	3.00	State
4	Aapte, Tal-Panvel , - Raigad	0.40	Protection Wall	3.00	State
5	Rave, Tal-Pen , - Raigad	0.25	Protection Wall	1.87	State
6	Urnoli, Tal-Pen , - Raigad	0.30	Protection Wall	2.25	State
7	Mora kota ,rave, Tal-Pen , - Raigad	0.30	Protection Wall	2.25	State
8	Vashigaon, Tal-Pen , - Raigad	0.50	Protection Wall	3.75	State
9	Shirkichawl, Tal-Pen , - Raigad	0.50	Protection Wall	3.75	State
10	Dadargaon, Tal-Pen , - Raigad	0.20	Protection Wall	2.50	State

Annexure-XI (a)

The details of Salinity Ingression prevention/mitigation measures adopted by Govt. of Goa along with expenditure incurred in the last 10 years

SL. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Keri - Kajarcond	1.20	PCC wall with bund	5.00	State
2	Pernem - Khajangundu	0.70	PCC wall with bund	10.00	State
3	Korgao - Konadi band	0.895	PCC wall with bund	2.42	State
4	Khazan Bund - Carambolim	0.05	Boulder Masonry	0.071	State
5	Bund - Curca	1.2136	Concrete Wall	4.37	State
6	Bund -Sinquerim, Candolim	1.500	Laterite Boulder	3.18	State
7	Protection Wall of Nallah Malwar bund - Caisua, Anjuna	0.600	PCC wall	2.06	State

Annexure-XI (b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of Goa

SL. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Re-Construction of Sluice Gateand Improvement to theBund "Goltim"	1.406	Sheet Piles	6.25	Deposite work by Agriculture Department
2	Strengthening and renovation of existing bund - candolim (In Progress)	1.200	PCC wall	4.03	State
3	Improvement to Bund - Moira, Aldona (Estimate under Scrutiny)	1.600	Rubble wall	7.35	State

Annexure-XII (a)

The details of Salinity Ingression prevention/mitigation measures adopted by Govt. of Kerala along with expenditure incurred in the last 10 years

Sl. No.	Name of Village/ Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)
1	Eloor Municipality Ernakulam	0.186	Pathalam Regulator cum Bridge with Lock	60.5	State
2	Parakkadavu block/KalamasseryMunicipality	0.308	Purappillikaavu Regulator cum Bridge with Lock	100	State
3	Parakkadavu	0.113	Anti salinity bund at Kanakkankadavu	2	State
4	Malappuram	Temporary bund, new cut maintenance		0.125	State
5	Malappuram	protection work		0.2	State

Annexure-XII (b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of Kerala

Sl. No.	Name of Village/Taluka/	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs. in Crore)	Source of Fund (Central/State/ Loan)
1	Mavilakadavu / Trivandrum	-	Regulator cum lock	20	KWA-JJM
2	Punnayur Grama panchayath / Thrissur		Sluice & protection wall	0.3	State
3	Malappuram	3.72	Protection work	4.464	state

Annexure-XIII (a)

The details of Salinity Ingression prevention/mitigation measures adopted by Govt. of Tamil Nadu along with expenditure incurred in the last 10 years

Sl. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Chettichery /Nagapattinam / Nagapattinam	-	New Tail end Regulator	16.27	NABARD
2	Jaganathapuram /Nagapattinam / Nagapattinam	-	New Tail end Regulator	18.61	NABARD

Annexure-XIII (b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of Tamil Nadu

SL. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Therkkupoigainallur/ Nagapattinam/ Nagapattinam	--	Tail end Regulator	3.4045	NABARD(Completed)
2	Vadakkupoigainallur/ Nagapattinam / Nagapattinam	--	Tail end Regulator 1 & 2	3.468	NABARD (Completed)
3	Paapakovil/ Nagapattinam / Nagapattinam	--	New Tail end Regulator	12.70	
4	Kiramathumedu / Nagapattinam/ Nagapattinam	--	New Tail end Regulator	7.90	
5	Perumgadambanur / Nagapattinam/ Nagapattinam	--	New Tail end Regulator	4.80	
6	Uthamacholapuram / Nagapattinam/ Nagapattinam	--	New Tail end Regulator	49.50	

Annexure-XIV (a)

The details of Salinity Ingression prevention/mitigation measures adopted by Govt. of Odisha along with expenditure incurred in the last 10 years

SL. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Bagapatia Saline embankment in Rajnagar tehsil of Kendrapara	0.652 (not along the coastline)	Strengthening of Saline Embankment	1.74	State

Annexure-XIV (b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of Odisha

SL. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	20 nosworks of Saline embankment in Balasore	89.9 (not along the coastline)	Strengthening of Saline Embankment	375.32	State
2	02 nosworks of Saline embankment in Bhadrak	15.075 (not along the coastline)	Strengthening of Saline Embankment	50.30	State
3	06 nosworks of Saline embankment in Kendrapada	47.046 (not along the coastline)	Strengthening of Saline Embankment	205.45	State
4	07 nosworks of Saline embankment in Puri	30.225 (not along the coastline)	Strengthening of Saline Embankment	97.50	State

Annexure-XV (a)

The details of Salinity Ingression prevention/mitigation measures adopted by Govt. of West Bengal along with expenditure incurred in the last 10 years

SL. No	Name of Village / Taluk /	Length of the Protection Works (km)	Type of Protection Work	Project Cost (Rs in Crore)	Source of Fund (Central / State / Loan)
1	Vill.-Boga, Block: Khejuri-II, SubDivision: Contai, : Purba Medinipur	0.800	Brick Block slope pitching with brick sausage toe wall	2.84	Loan
2	Vill.-Panchuriya, Block: Khejuri-II, SubDivision: Contai, : Purba Medinipur	2.100	C.C. block pitching with RCC toe wall	6.38	Loan
3	Vill. Dhablat, Block: Sagar, Sub-Division: Kakdwip, : South 24 Parganas	3.450	C.C. Block pitching	47.40	Centrally assisted
4	Vill. Beguyakhali, Block: Sagar, SubDivision: Kakdwip, : South 24 Parganas	3.000	C.C. Block pitching	45.27	Centrally assisted
5	Vill. Laxmipurabad, Block: Namkhana, Sub-Division: Kakdwip, : South 24 Parganas	1.360	C.C. Block pitching	12.88	State
6	Vill. Laxmipurabad, Block: Namkhana, Sub-Division: Kakdwip, : South 24 Parganas	0.300	C.C. Block pitching	5.92	State
7	Vill. Baliara, Block: Namkhana, SubDivision: Kakdwip, : South 24 Parganas	2.160	C.C. Block pitching	39.40	Centrally assisted
8	Vill. Gobardhanpur, Block: Patharpratima, Sub-Division: Kakdwip, : South 24 Parganas	1.310	C.C. Block pitching	15.53	State
9	Vill. Gobardhanpur, Block: Patharpratima, Sub-Division: Kakdwip, : South 24 Parganas	0.400	C.C. Block pitching	7.19	Loan
10	Vill. Sitarampur, Block: Patharpratima, Sub-Division: Kakdwip, : South 24 Parganas	1.700	C.C. Block pitching	19.52	Centrally assisted
11	Vill. Buroburirtat, Block: Patharpratima, Sub-Division: Kakdwip, : South 24 Parganas	0.370	Brick Block pitching	11.19	Centrally assisted

Annexure-XV (b)

The details of the proposed or on-going Salinity Ingression prevention/mitigation measures of Govt. of West Bengal

SL. No	**Name of Village / Taluk /**	**Length of the Protection Works (km)**	**Type of Protection Work**	**Project Cost (Rs in Crore)**	**Source of Fund (Central / State / Loan)**
1	Vill.-Kadirabad, Block: Khejuri-II, SubDivision: Contai, : Purba Medinipur.	0.600	C.C block pitching with RCC toe wall	3.00 (approx)	State
2	Vill.-Kendamari, Block: Nandigram-I, SubDivision: Haldia, : Purba Medinipur.	0.750	C.C block pitching with RCC toe wall	3.50 (approx)	State
3	Vill.-Chemaguri, Block: Sagar, SubDivision: Kakdwip, : South 24 Parganas	0.625	Brick block pitching	17.20	Loan
4	Vill.-Shibpur, Block: Sagar, Sub-Division: Kakdwip, : South 24 Parganas	2.000	Brick block pitching	56.30	State
5	Vill.-Laxmipurabad, Block: Namkhana, Sub-Division: Kakdwip, : South 24 Parganas	0.800	C.C. block pitching	22.08	State
6	Vill.-Gobardhanpur, Block: Patharpratima, Sub-Division: Kakdwip, : South 24 Parganas	0.460	C.C. block pitching	16.41 State	State

Minutes of 1st Quarterly Dialogue (FY-2024-25) with the States/UTs – With the State of Andhra Pradesh

As per Chairman, CWC's directions that the 1st Quarterly Dialogue in FY 2024-25 for coastal States be held on the subject "Coastal Area Management", KGBO, CWC, Hyderabad organized the 1st Quarterly Dialogue with the officers of the concerned Authority of Govt of Andhra Pradesh and concerned departments/organizations of the Central Govt at Krishna-Godavari Bhawan, CWC, Hyderabad on 05.04.2024 (Friday) in hybrid mode.

At the outset, Sri. Virendra Sharma, Chief Engineer, KGBO, CWC welcomed the participants, who attended in person and also joined online. He briefed the background and objectives of the meeting stating that the Deptt. of Water Resources, River Development & Ganga Rejuvenation (DoWR, RD & GR) under Ministry of Jal Shakti, Govt of India is responsible for matters connected with 'sea erosion' as per allocation of business rules. He stressed the importance of Coastal Area Management, as it has commercial, strategic and human dimension and is critical for economic development besides sustaining livelihood; Central Water Commission (CWC), has planned to address these issues through systematic approach & interactions through Quarterly Dialogues with the coastal / maritime States & UTs and related national institutes. Andhra Pradesh is the first State which is being discussed in the series of discussions on the Coastal Area Management. The list of participants is enclosed as Annexure I.

Shri D. P. Mathuria, Chief Engineer(P&D), CWC, New Delhi who is dealing with CMIS activities has explainedthe objectives of the CMIS programme in general and with regard to Andhra Pradesh in particular. He further informed that as per Govt of India (Allocation of Business) Rules, 1961, 'Sea Erosion' is one of the mandate of DoWR, RD &GR under Ministry of Jal Shakti. Coastal Protection Schemes are eligible for central assistance under Flood Management & Border Area Programme of DoWR, RD & GR; CWC is the appraising agency for the schemes proposed for external funding; Govt of India initiated Technical Assistance programme for the Climate Resilient Coastal Protection & Management Project; It is also informed that 'Guidelines for preparation of DPR for Coastal Management Projects under Climate Change Scenario' was published by CWC to bring uniformity in preparation of project proposals for funding.

He further informed that AP has the 3rd longest coastline after Gujarat and Tamil Nadu. As per Shoreline Change Atlas of Indian Coast for 2004-16, as far as AP is concerned, out of 1053.07km coast line which is to be confirmed by the State authorities, around 189 km (approx 796 ha) is under erosion, 208 km (808 ha) is under accretion and 413 km of length is stable coastline.

He pointed out that site specific data is either not available or there is limited availability with the agencies. Data collected by different agencies like NCCR, NIO, NIOT, etc., is not directly usable for planning/design of coastal protection works.

Therefore, prime objective of CMIS is to collect, transmit, process & analysis of near shore 9 parameters (wave, tide, current, riverine data, wind, coastal sediment, beach profile, Bathymetry & Shoreline Change) at vulnerable reaches of the east and west coast which can be used in the design, construction & maintenance of site specific coastal protection structures. Also to create an integrated data bank to tackle coastal engineering problems in a scientific manner, alongwith challenges of climate changes. collection of data on coastal processes is relevant for evolving long term coastal management plans and coastal protection measures; 8 coastal sites already established; and 12 are proposed by 2026 (out of these one site in the East Godavari District of AP). He further requested the State Govt. officials to furnish the data sought on the subject at an early date. A copy of the presentation made by Shri Mathuria is enclosed as Annexure-II.

Shri P.V.B.L.G. Sastry, Senior Environmental Engineer, Andhra Pradesh Pollution Control Boardand who is also assisting the Member Secretary, A.P. Coastal Zone Management Authority (APCZMA) made a presentation on the basic duties of Coastal Zone Management Authority. He explained that APCZMA is constituted by the Ministry of Environment, Forest & Climate Change, GoI, New Delhi. APCZMA Plan was prepared as per the Coastal Regulation Zone (CRZ) Notification 2011, and subsequently it was approved by M/o EF&CC, New Delhi and fresh Notification was issued in 2019.

In AP, the CZMA is dealing with the areas in and around Visakhapatnam only at present. The second one is to prohibit or regulate the activities which are harmful to both the coastal communities and environment. Third one is to plan for a sustainable management so that livelihoods of millions of people are protected and coastal environment is preserved for the future generation. Most of the cases, the CRZ mapsareprepared by the Central Govt organization viz., National Centre for Sustainable Coastal Management (NCSCM), M/o EF&CC, Chennai. It is preparing CZM maps for AP also. The draft is expected during this month. Final CZM Maps will be approved & notified after taking public opinion, updation, justification by NCSCM and final vetting by the technical committees in M/o EF&CC. Till such revision, the existing 2011 maps are in force.

Regarding Shoreline Management Plan (SMP), he informed that APCZMA requested M/o Earth Sciences to prepare the SMP for the state of A.P. through NCCR, in order to save the eroding coast of A.P.Draft SMP was received during March 2024, which will be put for discussion later April, 2024.A copy of the presentation made by Shri Shastri is enclosed as Annexure-III.

Shri A. Arun Kumar, Project Director, Coastal & Environmental Engineering Group, National Institute of Ocean Technology, M/o Earth Sciences, Chennai shared his views on Coastal Erosion Mitigation Measures Across India as a special attention to Andhra Pradesh coast. He informed the activities of NIOT as dealing with coastal engineering and energy, freshwater desalination, ocean structures, deep sea technologies, development of marine sensors and equipment, ocean research vessels, marine bio-technology, etc. C&EE Group of NIOT is expertise in design, planning, analysis of coastal port, upper structures, development of the industry modeling of hydrodomics, sediment transport, shoreline preparation, plants, etc.

He shared the coastal engineering project sites carried out across India and the demonstration of coastal protection measures carried out at various locations, in Kerala, Tamil Nadu, beach restoration work at R.K.Beach in Visakhapatnam, Andhra Pradesh and at two locations - one at Ramaypatnam near the border of Andhra Pradesh &Odissa, another at Konark.

As per the Shoreline Change Analysis Studies based on satellite images by NCCR during 1990-2022, 32% of AP coastline is eroding, 44% is under accretion and 24% is stable. And 48% of East & West Godavari districts coast of AP are experiencing the erosion whereas 75.5% of Guntur and 55.3% of Prakasam districts coast are accreting; which means northern coast of AP is experiencing stable erosion.A copy of the presentation made by Shri Kumar is enclosed as Annexure-IV.

Dr R.S. Mahendra, Scientist 'F', Indian National Centre for Ocean Information Services (INCOIS), M/o Earth Sciences, Hyderabad in his presentation pointed out that INCOIS is basically working on ocean advisory services. Coastal Vulnerability Atals has been prepared by the sister concern NCCR in 2012 using the methodology – Coastal Geomorphology, Coastal Regional Elevations, Coastal Slope, Shoreline Change Rate, Sea-Level-Change Rate, Mean Significant Wave Height and Tide Range. Coastal multi-hazard vulnerability happens due to coastal flooding due to oceanogenic hazards like tsunami, cyclone, floods, sea level rise and erosion. A copy of the presentation is enclosed as Annexure-V.

Dr Jaya Kumar Seelam, Chief Scientist, Ocean Engineering Division, CSIR, National Institute of Oceanography (NIO), M/o Science & Technology, Goa gave presentation on coastal erosion. A copy of the presentation made by him is enclosed as Annexure-VI.

Shri G. Ravi Kumar, Scientist 'D', Central Ground Water Board (CGWB), M/o Jal Shakti, Visakhapatnam gave his presentation on 'Salinity Ingress in Coastal Areas of Andhra Pradesh'. He explained that CGWB has established 205 observation wells (shallow dug wells) along the coast of AP; by using these wells, monitoring quantity of groundwater in terms of variation of water-level in pre-monsoon and post-monsoon, and also variation in water quality with time scale is being measured; and the decadal depth water level is drawn, which is 2-5 meters for the coastal AP. About 40 major and 20 minor rivers of AP are completely merging into the Bay of Bengal. Hence, the coastal line of AP is rich in surface water resources. Even lot of groundwater resources are available but because of the inherent salinity, the water is not usable. Major issues in Coastal districts of AP: Water logging, limited occurrence of fresh water resources, salinity and rampant aqua culture.

As far as groundwater exploration is concerned, Godavari &Krishna delta is underlined by thick saline clays and sediments; beyond 20 meters it is completely saline and thus, these wells are not used. Due to the geogenic nature of the sediment deposition, the groundwater has become saline.

Fresh water – Saline water Interface: The Ghyben-Herzberg Relation describes the relationship between the depth of a fresh water-salt water interface in coastal aquifers and the elevation of the water table; this relation is particularly applicable to unconfined coastal aquifers where fresh water floats on denser salt water, forming a stable interface. This Relation states that in a coastal aquifer, the depth of the fresh water to salt water interface below sea level is approximately 40 times the height of the water table above sea level.

Salinity hazard is prevalent in the coastal Andhra Pradesh alluvial tract. Salinity in ground water occurs due to retention of ions from salt water entrapped at the time of deposition, intrusion of salt water due to heavy withdrawal of ground water or change in sea level, tides/cyclones, aqua culture pollution, the coast was subjected to marine transgressions & regressions in the geological past, thus the salinity could be imparted during the time of deposition of sediments; due to salinity hazard, the ground water development is constrained. A copy of the presentation is enclosed as Annexure-VII.

In the wrap-up remarks Shri D.P. Mathuria opined that successful efficacy of any intervention shall rest with the length of the data that has been utilized as there is a risk of having a suboptimal solution. As the salinity ingress problemis quite widespread, but the areas micro focus on the issues have not been captured in various development to plan and there is a definite need for the same.

There should be a cooperative mechanism among Central Govt departments, the specialized central research institutes and the State Govt departments, etc. for benefit of all who address this problem; the data collected or information available with the partners should be made available on a centralized platform; the same has to be updated regularly; so that uniformity in the conclusions are achieved; CWC is also working on dissemination policy of the data. The information on costal protection works including beach nourishment initiatives that have been taken up by States, value of those works, source of funding, future plans of Zonal Management Authorities of States such as urgent initiatives that states are taking etc., have to be inventorized and placed on the GIS platform; this will be of great help to CWC.

On the changed length of shoreline, as all the other States have already responded and only concurrence of Govt of A.P. is awaited, the State representative is requested to convey the concurrence at the earliest, as the next meeting is scheduled shortly.

Shri M. Ramesh Kumar, Director, Monitoring &Appraisal (Telangana & Andhra Pradesh) Directorate, CWC, Hyderabad presented vote of thanks.

List of Participants

S. No.	Name	Designation
Central Water Commission		
1.	Shri. Virendra Sharma	Chief Engineer & Chairman of the Meeting, KGBO, Hyderabad
2.	Shri. D.P. Mathuria	Chief Engineer, P&D Organisation, New Delhi
3.	Shri. M. Ramesh Kumar	Director, Monitoring & Appraisal (Telangana & Andhra Pradesh) Directorate, KGBO, Hyderabad
4.	Shri. Srinivasu Bairy	Superintendent Engineer, Krishna & Coordination Circle, KGBO, Hyderabad
5.	Shri. Deepak Kumar	Director, Coastal Managament Directorate, New Delhi
6.	Shri. A. Praveen	Deputy Director, Monitoring & Appraisal (Andhra Pradesh) Directorate, KGBO, Hyderabad
7.	Shri. K. Shanker	Deputy Director, Monitoring & Appraisal (Andhra Pradesh) Directorate, KGBO, Hyderabad
8.	Shri. Dheeraj Singhal	Deputy Director, Monitoring & Appraisal (Telangana) Directorate, KGBO, Hyderabad
9.	Shri. N. Charan	Deputy Director, O/o Chief Engineer, Hyderabad
10.	Shri. Abhishek Gaurav	Executive Engineer, Upper Krishna Division, Pune
11.	Shri. D.S. Prasad	Executive Engineer, Lower Krishna Division, Hyderabad
12.	Shri. E. Venkateswarulu	Executive Engineer, Upper Godavari Division, Hyderabad
13.	Shri. M.L. Franklin	Executive Engineer, Lower Godavari Division, Hyderabad
14.	Shri. G. Dinakar	Junior Engineer, Monitoring & Appraisal (Telangana) Directorate, KGBO, CWC, Hyderabad
15.	Shri. S. Gnaneswara rao	Junior Engineer, Monitoring & Appraisal (Andhra Pradesh) Directorate, KGBO, CWC, Hyderabad
Andhra Pradesh Coastal Zone Management Authority, Govt. of A.P, Vijayawada		
16.	Shri. P.V.B.L.G. Sastry	Senior Environmental Engineer
Ground Water Department, Govt. of A.P, Vijayawada		
17.	Shri. John Satya Raju	Director
18.	Shri. N. Srinivas	Joint Director
National Institute of Oceanography, M/o Science & Technology, Goa		
19.	Dr Jaya Kumar Seelam	Chief Scientist, Ocean Engineering Division, CSIR
Indian National Centre for Ocean Information Services, M/o Earth Sciences, Hyderabad		
20.	Dr R.S. Mahendra	Scientist 'F'
National Institute of Ocean Technology, M/o Earth Sciences, Chennai		
21.	Shri. A. Arun Kumar	Project Director, Coastal & Environmental Engineering Group
Central Ground Water Board, M/o Jal Shakti, Visakhapatnam		
22.	Shri. G. Ravi Kumar	Scientist 'D'
23.	Ms. Rani V.R	Scientist

Minutes of the Meeting of the 1st Quarterly Dialogue meeting on "Coastal Area Management" with Govt of Goa held on 10.04.2024.

As per the directions of Chairman, CWC that the 1st Quarterly Dialogue in FY 2024-25 for coastal states shall be held on the subject "Coastal Area Management", MSO, CWC, Bengaluru organized the 1st Quarterly Dialogue with the officers of the Water Resource Department of Govt of Goa in association with CGWB and all other stakeholders (Academia, State Govt, Central Govt depts., institutes etc.) working in this field for the coastal area of Goa under the Chairmanship of Sh. Virendra Sharma, Chief Engineer, MSO, Bangalore at 11.00 hrs in the conference hall of O/o Chief Engineer, Water Resources Department (WRD), Goa on 10.04.2024 (Wednesday) in hybrid mode.

At the outset, Sh. Virendra Sharma, Chief Engineer, MSO, CWC welcomed the participants, who attended the meeting in person and on virtual mode. He briefed the background and objectives of the meeting stating that as per allocation of business rules one of the mandates of the Deptt of Water Resources, River Development & Ganga Rejuvenation (DoWR, RD & GR) under Ministry of Jal Shakti, Govt of India is "Sea Erosion". He stressed upon the importance of Coastal Area Management, as it has commercial, strategic, and human dimension and is critical for economic development. To manage coastal areas effectively, it is essential to involve various stakeholders such as government agencies, local communities, environmental organizations, tourism industry representatives, and experts in the field. Collaboration and coordination among these stakeholders are key to developing comprehensive coastal management plans that address issues related to beach erosion, pollution, infrastructure development, and sustainable tourism practices especially in Goa where the state is depending heavily on beach tourism. He also mentioned that CWC through its Coastal Management Information System (CMIS), has planned to address these issues through systematic approach & interactions through Quarterly Dialogues. The list of participants is enclosed as Annexure - I.

Thereafter, a PPT on Coastal Management/ Salinity Ingress was presented by Sh. Ashish Kumar Ranjan, DD, Coastal Management Dte., CWC, New Delhi in which, he elaborated on the coastal features of Goa state, objectives of the CMIS program in general and its implementation in the maritime state of Goa. He informed that the length of the coastline has been re-verified by Coastal Protection and Development Advisory Committee (CPDAC) in association with National Hydrographic Office (NHO), Dehradun (which is yet to be released) and for Goa, he informed that the coastline length has increased from 181.48 Km to 193.95 Km due to addition of offshore islands and closing of river mouths & creeks. He also added that Goa is having Erosion in 19.2%, Accretion of 13.7% and Stable coast for 67.1% of its coastal length. Out of the total 8 Coastal sites already established under CMIS in all over India, 2 sites are in Goa i.e., Baga – Anjuna (North Goa) and Benaulim – Varca (South Goa).

He further informed that Coastal Protection Schemes are eligible for central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR; CWC is the appraising agency for the schemes proposed for external funding; Govt of India initiated Technical Assistance programme for the Climate Resilient Coastal Protection & Management Project; He also informed that 'Guidelines for preparation of DPR for Coastal Management Projects under Climate Change Scenario' was published by CWC to bring uniformity in the preparation of project proposals for funding. Regarding salinity ingress, the action needs to be taken by the State Govt. and the way forward to tackle that was discussed. It was also informed that 'Guidelines for preparation of DPRs related to Salinity Ingress Management Projects in Coastal Areas', is under finalization. A copy of the presentation made by Sh. Ashish Kumar Ranjan is enclosed as Annexure – II.

Sh. Pramod Badami, Chief Engineer, WRD, Ex. Officio Addl. Secretary to the Govt. of Goa who is also holding the charge of Chief Engineer, Tourism Department, Goa made a presentation on the present sea erosion & salinity ingress issues in Goa and also on other coastal issues pertaining to the state. As per him, Coastal Area Management is a crucial aspect of sustainable development, particularly for the state of Goa with a significant dependence on tourism. He told that the coastal areas are not only important for their natural beauty and biodiversity but also for their economic significance, especially in terms of tourism, fisheries, and other coastal activities.

He informed that approx. 50 Lakhs of floating population had visited Goa this year putting a heavy burden on coastlines and beaches. In addition to that, around 60-70% of the population is concentrated in the coastal talukas making the coastal management aspect a critical factor to focus on. The Department has been taking up measures to counter the erosion on recommendations of Central Water & Power Research Station (CWPRS), Pune after modeling the whole system based on site specific parameters. Moreover, mitigation measures recommended from the organizations like National Institute of Oceanography (NIO) and National Institute of Ocean Technology (NIOT) have been implemented by the department, however, the erosion problem, still persists / continues. He informed that local people and authorities are not allowing for any hard structures on the beach as tourism cannot operate once it is built / constructed. He suggested that the moment any site is prone to be affected by erosion, soft measures need to be taken up so that the situation does not get worse / aggravated to the level demanding the hard measures to be put in place. He further added around 13,000 ha of Khazan land (reclaimed wet lands / low lying lands located in the estuaries / tidal affected rivers, which are protected and regulated by Marginal Marine Clay bunds, fringed with mangrove and have Sluice gate system (MANAS)) is being lost due to outer marginal bunds are getting damaged and entire sea water is flooding the field making unsuitable for agriculture, inundation, ground water salinity ingress. He requested that the construction of tidal bunds be included under GoI scheme FMBAP program. A copy of the presentation made by Sh. Pramod Badami is enclosed as Annexure – III.

Thereafter, Sh. Basanta Kumar Jena, Scientist – G, NIOT made a presentation on brief details about NIOT organization and its works along with Integrated River Basin and Shoreline Management for Goa under National Hydrology Project (NHP). He then presented 4 Coastal Erosion Projects that they successfully carried out in the states of Odisha, Andhra Pradesh, and UT Puducherry. He further informed that objective of the Integrated River Basin and Shoreline Management for Goa under National Hydrology Project is to prepare an integrated river basin and shoreline management plan for Goa coast. He presented the shoreline analysis done using satellite imagery and the field measurements for data collection using Topography, Bathymetry, River cross-sections, Bed and suspended sediment properties for 2 Seasons and Hydrodynamic survey. With the help of model studies, 3 eroding hotspots viz. Ashwem, Coco and Talpona have been found out in the state of Goa for detailed coastal area management works. A copy of the presentation made by Sh. Basanta Kumar Jena is enclosed as Annexure – IV.

Chief Engineer, WRD, Goa requested NIOT that as the base model has already been prepared by the NIOT team, an advanced information on the erosion and accretion occurred on the coastlines in the form of quarterly ya annual report may be provided so that department/state can take preventive action in consultation with NIO, NIOT, CWPRS to alleviate that. In this regard, NIOT agreed to work on the same. Other officials present in the meeting were also in agreement for an advance warning system to be in place so that the state government can take preventive soft measures there by avoiding hard measures which would not go well with the local people in Goa.

Dr. Jaya Kumar Seelam, Chief Scientist, CSIR - National Institute of Oceanography (NIO), Goa added that in the recent CPDAC research proposals, there is a plan to put in a Decision Support System (DSS) that will work both ways in providing information on the coastlines if something happens in the catchment and vice-versa. On that, Chief Engineer, MSO, CWC, Bengaluru offered to have institutional mechanisms that will automatically monitor the situation and report it. Chief Engineer, WRD, Goa stated that once the situation is reported to them, the same will be deliberated upon in consultation with all stakeholders and appropriate action will be taken. He further added that there is a need to find a soft solution for mitigating the sea erosion of beaches as Coastal Regulation Zone (CRZ) committee of Goa state has clearly objected to the use of cement at any beach.

Further, a presentation on Coastal area, erosion and management was presented by Dr. Jaya Kumar Seelam, Chief Scientist, CSIR - National Institute of Oceanography (NIO), Goa explaining the basics of coastal areas, its classification, structures, design and then briefed on coastal erosion topic. He also shared methods of coastal monitoring like physical, remote sensing through satellite & video, indigenous Video Beach Monitoring System (VBMS) and community beach monitoring. He further informed that NIO has been implementing CMIS for collecting 9 parameters at 3 locations covering Goa (2) and south Maharashtra (1) coasts on behalf of CWC and storing all the data in the central server. A copy of the presentation made by Dr. Jaya Kumar Seelam is enclosed as Annexure – V.

Moving forward, Sh. U B Patil from CWPRS, Pune shared a presentation on the contribution of this research organization in the field of coastal area management and coastal protection works. He informed that a total of 6 studies have been carried out by CWPRS, Pune in the state of Goa and reports of the same have also been published. A copy of the presentation made by Sh. U B Patil is enclosed as Annexure – VI.

Afterwards, Smt. Sangita P. Bhattacharjee, Scientist-D, CGWB, Belagavi made a presentation on Coastal Zone Management of Goa in terms of the ground water perspective. She informed that CGWB has finalized the reports on “Special Study on Demarcation of Groundwater Potential in the Coastal Tract with Special Emphasis on Sea Water Intrusion in Candolim, Calangute and Anjuna villages in Bardez Taluk, Goa State” and “Ground Water Year Book 2023-24” and the copy of reports were presented by Regional Director, CGWB, Bangalore to the chairman and other officers present in the meeting. She further stated that CGWB has installed Digital Water Level Recorder (DWLR) at 39 locations in Goa and the data is being received at the server located at Bengaluru. She further shared the National Aquifer Mapping and Management (NAQUIM) program studies being done in the state of Goa and its outcome along with the salinity ingression in the ground water situations. A copy of the presentation made by Smt. Sangita P. Bhattacharjee is enclosed as Annexure – VII.

Once all presentations from the participants were over, discussion on the subject was taken up. Chief Engineer, WRD, Goa requested the representatives/stake holders from different organization present in the meeting for the following aspects to be looked into:

- Early warning system or Decision Support System for the vulnerable or high value beaches of Goa
- A Standard Operating Procedure (SOP) for putting coastal area management proposals for central funding.
- Types of solutions (Hard or soft) for mitigating the coastal erosion problems – as hard structures are not being allowed in Goa, soft solutions may be explored and researched upon that can be re-validated in the field by the department.
- Inclusion of proposals on the protection of estuarine areas from salinity ingress and land erosion by construction of outer marginal bunds in the central funding

Director, M&A Dte., CSRO, Chennai suggested that representatives from Coast Zone Management Authority may be invited to Goa for field knowledge sharing.

Director, Coastal Management Dte., CWC, New Delhi stated that Govt of Goa can propose projects under Coastal Protection Schemes for Central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR.

Chief Scientist, CSIR - National Institute of Oceanography (NIO), Goa inquired and suggested on the following points:

- Quantification of amount of ground water being discharged from aquifer to the sea
- Reducing the frequency of data collection through DWLR from 6 hrs to 2-3 hrs for better analysis and results
- Possibility of making Ground Water Recharging points at all new properties in the state Goa
- Before putting tidal regulators, an Environmental Impact Assessment (EIA) study may also be carried out.

On the third bullet point, Chief Engineer, WRD, Goa informed that as per recent Govt of Goa's notification issued, all the Government buildings, industries and private building / apartments with more than 2000 sqm of floor area will have to be constructed with Rain Water Harvesting recharge system mandatorily. He further added that under Jal Shakti Abhiyan of Govt of India, department through its own state funds, has put in place Rainwater Harvesting recharge system in all Govt. & private schools for ground water recharging and creating awareness among the young students. The department has also given a subsidy of Rs. 5 Lakhs for putting Rainwater Harvesting recharge system to the people of Goa. However, the department has hardly received any application or response from the public during the last 6 months, therefore, to simplify the paperwork formalities as per the subsidy guidelines, the department has planned to empanel agencies which will complete all the procedures on the applicant's behalf and install the system at the site, if approved.

Overall, it was felt in the specific context of Goa state, where the tourism economy heavily relies on the health and attractiveness of its beaches, it is even more critical to prioritize coastal area management. Preserving the natural beauty of the coastline, ensuring water quality, managing waste effectively, and promoting sustainable tourism practices are all essential for the long-term well-being of the state.

In the end, a vote of thanks was presented by Sh. Ashok Kumar V, Director, Appraisal Dte., MSO, CWC, Bengaluru.

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List of officers participated in the 1st Quarterly Dialogue meeting on "Coastal Area Management" with Govt of Goa held on 10.04.2024

A. Officers attended in the physical mode

Sl. No.	Name, Designation and Organisation of the officer
Government of India	
1.	Sh. Virendra Sharma, Chief Engineer, MSO, CWC, Bengaluru
2.	Sh. Ashok Kumar V, Director, App Dte, MSO, CWC, Bengaluru
3.	Sh. Jyothi Kumar Nalla, Regional Director, CGWB, SWR, Bengaluru
4.	Sh. Rahul R. Shende, Scientist D, CGWB, SWR, Bengaluru
5.	Sh. Sangitha P. Bhattacharjee, Scientist D, CGWB, SUO, Belgavi
6.	Sh. Asish Kr Rajan, Deputy Director, Coastal Management Dte, CWC, Delhi
7.	Sh. Arun Kumar, Deputy Director, App Dte, MSO, CWC, Bengaluru
8.	Sh. Sushant S Navarat, AHG, CGWB, SUO, Belgavi
Government of Goa	
9.	Sh. Pramod Badami, Chief Engineer, WRD, Goa
10.	Sh. Shantaram B Chantkar, Superintending Engineer, WRD, Goa
11.	Sh. Nevil Alphonso, Director, Directorate of Agriculture, Govt. of Goa
12.	Sh. Ram Asare M Gupta, Captain of ports Department
13.	Sh. Sujay Shorodhav, Agri officer, Directorate of Agriculture, Krishi Bhavan, Goa
14.	Sh. Sundesh Tari, Assistant Engineer, WRD, SD IV, WD III, WRD, Porvorim
15.	Dr. V. Kunhambu, Senior Ground water Consultant, WRD, Goa
CSIR - National Institute of Oceanography (NIO)	
16.	Dr. Jaya Kumar Seelam, Chief Scientist, CSIR – NIO, Goa
17.	Dr. R. Mani Murali, CSIR - NIO, Goa
National Institute of Ocean Technology (NIOT)	
18.	Dr. Basanta Kumar Jena, Scientist - G, CEI, NIOT, Chennai
National Centre for Earth Science Studies (NCESS)	
19.	Sh. Ramesh Madipally, Scientist – D, NCESS, Trivandrum

B. Officers attended in Virtual mode through VC

Sl. No.	Name, Designation and Organisation of the officer
Central Water Commission	
1.	Sh. A K Pradhan, Chief Engineer, M&ERO, CWC, Bhubaneshwar
2.	Sh. S Biswas, Chief Engineer, T&BDBO, CWC, Kolkata
3.	Sh. R. Thangamani, Director, CWC, Chennai
4.	Sh. Deepak Kumar, Coastal Management Dte, CWC, New Delhi
5.	Sh. M S Sahare, SE Coordination, MCO, CWC, Nagpur
6.	Sh. K V Prasad, Director, BE Dte., CWC, Kochi
7.	Sh. Y S Varshney, SE, HOC, MTBO, CWC, Gandhinagar
8.	Sh. Siddhartha Mitra, Director, T&BDBO, CWC, Kolkata
Central Ground Water Board	
9.	Smt. Veena R Achutha, Scientist D, CGWB, SWR, Bengaluru
10.	Sh. Sakthivel, Scientist D, CGWB, SWR, Bengaluru
11.	Smt. Suchetana Biswas, Scientist C, CGWB, SWR, Bengaluru
Central Water and Power Research Station	
12.	Dr. R S Kankara, Director, CWPRS, Pune
13.	Sh. G A Raj Kumar, Scientist C, CWPRS, Pune
14.	Sh. Uday Baburao Patil, Scientist C, CWPRS, Pune
National Institute of Hydrology (NIH)	
15.	Dr. Abhilash R, Scientist C, NIH, Roorkee

Summary Record of discussion held during 1st Quarterly Dialogue (2024-25) with State of Maharashtra and other stakeholders on Coastal Management

1st Quarterly Dialogue (2024-25) with the officers of various agencies of Central & State Government of Maharashtra working in the field of Costal Area management was held in hybrid mode on 18.04.2024 in the office of Chief Engineer, Monitoring (Central) Organization, Central Water Commission, Nagpur. The list of participants is attached at **Annexure-I**.

At the outset, Chief Engineer, Monitoring (Central) Organisation, Central Water Commission, Nagpur welcomed all the participants. He further stated that this is the1st Quarterly Dialogue in FY 2024-25 in series of Quarterly Dialogue in collaboration with Central Ground Water Board (CGWB) on the various issues and topics related to water resources. These Dialogues will be organized by CWC and CGWB alternately. He informed that as directed by Chairman the topic of discussion for this meeting is “Coastal Area Management” He then requested Shri Deepak Kumar, Director, CMD, CWC, New Delhi to give presentation on Coastal management/ salinity ingress.

I. Director, CMD, CWCgave the overview of the total coast length of India and Maharashtra in particular, its status in respect of erosion, accretion and stability and land mass lost or gained due to the sea action. He further informed that revision of coastal length has been undertaken by CPDAC in association with NHO, Dehradun. The revised length, as calculated by NHO and verified by SoI, now stands at 11098.81 km. (yet to be released) as against the earlier length of 7516.60 km. Important issues discussed during the dialogue are as given below:

- As per allocation of Business rules 1961 of Govt. of India “Sea Erosion” is one of the mandates of DoWR, RD & GR under Ministry of Jal Shakti.
- Coastal Protection Schemes are eligible for Central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR and CWC is the Appraising Agency for such schemes as well as schemes proposed for External Funding. “Guidelines for preparation of DPR for Coastal Management Projects under climate change scenario” was published by CWC.
- With the Prime objective to collect near shore parameters at vulnerable reaches of the entire east and west coast to create an Integrated Data bank which will be used in the design, construction and maintenance of site specific coastal protection structures, DoWR,RD&GR, Govt of India initiated Coastal Management Information System

(CMIS) –aimed at collecting consolidated coastal data at the national level during the XII Plan under DWRIS Scheme

- CWC already established 8 Coastal sites and 12 additional sites are proposed to be established by 2026.
- Data is being collected at 2 CMIS sites in Maharashtra through reginal offices of CWC i.e., MTBO and KGBO. The CWPRS and NIO, Goa each collecting data at Satpati (Northern Maharashtra) and Tarkhali (South Maharshtra) respectively through a tripartite MoU with State Government.
- Total 9 parameters are being collected each would be used as an input in planning, designing and execution of various disaster management activities such as surge warning, Tsunami warning, coastal protection, flood forecasting; Development activities such tourism, port & Harbour development, fishing, Power generation,etc.

Salinity Ingress Management is the process of movement of Saline water into fresh water sources both surface and underground impacting the water quality, agricultural activities, drinking water, industrial supply, changes in local climatic conditions and creating health problems etc. Ingress of saline water into the moth of river during high tide and cyclonic activities impacts surface fresh water sources whereas excess withdrawal of ground water impacting ground water reserves along the coastal line. Khar lands of Maharashtra including Ratnagiri & Thane districts are the result of Saline water ingress. The Guidelines for preparation of DPRs related to Salinity Ingress Management Projects in Coastal Area is being prepared in CWC with inputs from agencies working in the area and the same is under finalisation.

II. NIO, Goa is the executing agency for collection of CMIS data at Tarkhali in Southern Maharashtra through a tripartite MoU with KGBO, CWC and Government of Maharashtra. Prof. Jaya Kumar Seelam from NIO, Goa participated in the dialogue through VC and gave a presentation on various topics of Coastal classification, Coastal protection structures, Design of Coastal structures, materials used in the protection structures, Coastal Hazards, coastal erosion and causes of erosion, etc. Various case studies of coastal erosion dealt by NIO, Goa in the past in the states of Tamilnadu, Orissa, Andhra Pradesh, Goa were presented and discussed about the causes and impact of erosion and the solutions implemented were discussed. He discussed the various instruments used in the data collection of beach profile and quantification of erosion and accretion. Various Coastal processes causing erosion, accretion and shore line changes such as winds, waves, currents, Tides, sediments, river discharge and water table were discussed.

Further discussions were held on the scope of data collection under CMIS starting from identification of suitable sites, procurement of equipment, various parameters to be collected with location, frequency etc; collection of raw data, validation, processing and transmission of data etc. The data collected and processed from January 202- to December 2022 has been presented in graphical format to give an understanding of beach profile changes, bathymetry, sediment data, shoreline changes, etc. The use of coastal parameters in identification, design and alignment of various structures such as marine out fall structures, Marine intake structures were highlighted. The use of Numerical modelling studies in the analysis of the coastal processes with the objective of design of preventive measures and / or design of protection structures were briefly described during the meeting. Further challenges in Shoreline Management such as vast coast line, varied geography, complex administration or jurisdiction limitation, limitations or requirements of various data collection methodologies, conflict of interest between environment and people were discussed briefly. The need for a national shoreline management program involving multiple institutes NIO, NITs, NIOT, NCCR, IITs, Universities, Maritime Boards, Central and State government departments has been suggested for a comprehensive study culminating in sustainable coastal management to have continuity of data in geographical extent and common time lines across Indian coast instead of independent activities in time and space by various agencies.

III. MTBO, CWC is implementing CMIS data collection at Satpati in Northern Maharashtra through a tripartite MoU with MMB, Government of Maharashtra and CWPRS, Pune. SE, MTBO participated in the meeting through VC and gave a presentation on the activities under CMIS within the jurisdiction of MTBO. CWPRS is collecting data at 2 sites; 1 in Maharashtra and 1 in Gujarat. The mode of implementation of CMIS data collection, role and responsibilities of various agencies involved, various parameters being collected, the project cost and time lines, issues challenges and other safety concerns encountered during implementation such as cyclone, COVID-19, unavailability of skilled man power, challenges for procurement through GEM, installation of equipment in deep sea were discussed. Further site selection, equipment used, parameters collected with its frequency and length of data collection were also discussed.

IV. CWPRS is the executing agency for collection of data under CMIS at 2 sites; 1 in Maharashtra and 1 in Gujarat through a tripartite agreement with MTBO, CWC and the state government of Maharashtra and Gujarat respectively. Team of officers of CWPRS, Pune participated in the dialogue through VC. CWPRS team lead by Shri Prabhat Chandra gave a presentation on Role of CWPRS in Coastal development, involvement in Coastal protection, case studies involving site specific solutions-Long term and Sort term measures, CMIS, National Hydrology Project-Purpose driven study and a new technology Satellite derived bathymetry (SDB) for ocean profiling. A brief of discussions oneach of the topic is given below:

- Coastal engineering studies are required in design and implementation of Port layouts, Dredging& disposal, breakwaters, ship navigation, tidal inlets, coastal protection, Safe grade elevation, intake & outfall and for addressing the shoreline changes and coastal ecology issues.
- CWPRS has an extensive infrastructure in terms of physical modelling facilities Random & Regular Sea wave flumes, Multipurpose wave basin, wave basins for port & harbour models and Tidal basins for port & harbor models for coastal studies.
- Various software being used by CWPRS for mathematical modelling for various coastal engineering studies and design of infrastructure were mentioned such as MIKE 21-BW/SW, MIKE 21-HD/MT/ST, TELEMAC, CORMIX, NAVIGA, MIKE 21-MA, ARC GIS.
- Various field equipment for data collection being used by CWPRS are Impeller type current meters, Acoustic Doppler Current Profiler, Wave rider buoys, Pressure type wave gauges, Automatic in-situ Tide gauges, Coastal bathymetry Survey, DGPS & Total Station, Salinity-temperature-depth unit, Grab and Water Samplers, etc.
- Coastal protection works are broadly classified as soft solutions involving Vegetation, beach nourishment, dune care, sand bypassing, sand back-passing, flood proofing, zoning and retreat, etc. and Hard solutions involving Seawall, revetment, groynes, offshore reefs and detached seawalls, etc.
- Methodology adopted in coastal protection:

  Remote sensing, Geographic Information Systems(GIS), field data collection and modeling techniques arebeing used for coastal vulnerability assessments,shoreline mapping, and monitoring coastal processes.These tools aid in better understanding coastaldynamics, identifying vulnerable areas, and designingappropriate protection measures.

  The government of India has introduced policies andregulatory frameworks to guide coastal protection andmanagement. The Coastal Regulation Zone (CRZ) Notification, issued by the MoEFCC provides guidelines for development activities along the coast to ensureecological integrity and sustainable coastalmanagement.

- Various case studies analyzing the issues, studies done and coastal protection solutions implemented in the Maharashtra state involving groynes, Tetrapod seawall, sea wall construction, groynes of varied length, half buried geotextile tubes, Gabions with octagonal concrete block, artificial sand dunes made with sand covered geotextile tubes filled with sand, steep slope protection using gabion wall filled with rubble, etc

- Based on the past experience of CWPRS in addressing various coastal protection issues of State governments the challenges in coastal protection were elaborated and the following recommendations were given:

  The selection of site for coastal protection work should be based on morescientific methods. Whereas, the state govt. proposals are based on theavailability of budget funding in the respective financial year proposingcoastal protection works in a piece-meal manner (not in a comprehensiveway).

  Training should be imparted to the concerned officials/engineers of state govt.which helps them understand coastal processes, field data collection,construction methodology, etc.

  Regular monitoring and maintenance of the coastal protection works, as andwhen any damage occurs may be undertaken. A provision of specific fundsmay be planned for the repair works.
- The activities undertaken by CWPRS in implementation of CMIS for CWC including the data collected, equipment used, data processing and presentation, trainings conducted is also discussed during the dialogue.
- CWPRS has informed that they have conducted a purpose driven study under National Hydrology Project with the objective of coastal processes assessment for the three selected sites (Aaravi, Anjarale and Guhagar) along the coast of Maharashtra and propose coastal management. The study involved field surveys, mathematical modelling and remote sensing studies for analysing the coastal processes associated with coastal erosion, shoreline change assessment.
- CWPRS informed that they are working on a project where the bathymetry for ocean profiling is being done through satellite derived data for time and cost optimization.
- During the meeting CWPRS informed that since 2000 they have suggested remedial measures for more than 180 sites to Maharashtra Maritime Board and Coastal Engineer, PWD, Govt of Maharashtra.

V. Maharashtra Maritime Board is the project facilitator for implementationof CWC‟s CMIS activities in Maharashtra state. Sri Sudhir Hankare of MMB participated in the dialogue through VC and gave a presentation on Maharashtra Sustainable Climate Resilient Coastal protection and management investment programme. The project with a cost of Rs.52 Cr is being implemented with funding from Asian Development bank. It involves both hard and soft solutions. Installation of offshore Geotextile reef and beach nourishment at Mirya Bay and Dune construction at Bhatye, Maharashtra. During the Tranche-I of the project in addition to the coastal protection measures implemented, web based CMIS and mobile app developed. Shore line management plans (SMPs) developed for the entire state, district and 103 individual beaches. Shoreline management organisations constituted for community participation.

VI. Sh Vardhrajan, regional Director, CGWB and Dr. Pandith Madhnure, Scientist „D" of CGWB, Nagpur participated in the dialogue inperson along with his team and gave presentation on outcome of NAQUIM studies in coastal districts of Maharashtra state viz., Sindhudurg (High salinity in SW parts in deeper aquifers), Ratnagiri, Raigad, Thane, Palghar.

The officers of coastal divisions under PWD, Government of Maharashtra also participated in the meeting through VC. The data as sought by CMD in the proforma was provided by Coastal Engineer, PWD and the same was sent to CMD, CWC.

After presentations, the discussions were held and it is opined that data collected by various State agencies / research institutes in the filed of coastal area management for various erosion prone areas and erosion prevention structures / measures already implemented can be integrated with INDIA-WRIS. The site-specific data collected for various purposes can be populated / integrated with CMIS.

The meeting ended with thanks to the chair.

List of Participants

OFFLINE

Central Water Commission (CWC)

1. Shri Neeraj Kumar Manglik, Chief Engineer, MCO, CWC – In chair
2. Shri Deepak Kumar, Director (CMD), CWC, New Delhi
3. Shri M. S. Sahare, SE (C), MCO, CWC
4. Shri Harish Girish Umbarje, Director (Monitoring), MCO, CWC
5. Shri N. V. Satish Seemakurti, Director (Appraisal), MCO, CWC
6. Shri D. Ganesh Kumar, DD, App Dte, MCO, CWC
7. Shri Karan Raghuwanshi, DD, Mon Dte, MCO, CWC
8. Shri Aditya S.S. Moola, EE, WD, MCO, CWC
9. Shri O.P. Patidar, AD, MCO, CWC
10. Shri Amit Godbole, AD-II, MCO, CWC
11. Shri Nilesh Pawar, JE, MCO, CWC

Central Ground Water Board (CGWB)

12. Shri. N. Varadaraj, Reginal Director, CGWB
13. Shri Pandit Madhnure, Scientist „D", CGWB

ONLINE

14. Shri Aditya Sharma
15. Shri Jaya Kumar, NIO, Goa
16. Shri Yoki Vijay, SE-C, CWC, Gandhinagar
17. Shri Ashish Singhal, DD, CWC, Pune
18. Shri Ramesh Dhone, AD, CWC, Pune
19. Shri Bal Chandra Borker, SDE, CWC
20. CWPRS, Pune
21. EE (Harbour), Sindhudurg
22. EE, UKD, CWC, Pune
23. Harbour Engineer, PWD, Konkan Bhavan
24. Harbour Engineer, PWD, Ratnagiri
25. Smt Jyothi Patil, MMB, Mumbai
26. Shri Manish Metkar
27. N.R. Ramteke, SDE, CWC

28. SDE, PGSD
29. Sudhir Deore, EE, MMB, Mumbai
30. Sudhir Hanker, EE, MMB, Mumbai
31. Shri. Utkarsh Singh
32. Shri Bhausaheb Hajare, EE, PWD
33. CM Dte, CWC, New Delhi

Summary Record of the Discussion of the 1st Quarterly Dialogue meeting on "Coastal Area Management" with the Govt. of Karnataka held on 23.04.2024.

As per the directions of the Chairman, Central Water Commission (CWC) to hold a dialogue on "Coastal Area Management" for the coastal states, Monitoring South Organization (MSO), CWC, Bengaluru in coordination with the Infrastructure Development Ports & Inland Water Transport Department, Government of Karnataka conducted 1st Quarterly Dialogue for the financial year 2024-25 on the topic of "Coastal Area Management" in the State of Karnataka on 23.04.2024. The dialogue was held in Room No. 317, 3rd floor, Vikas Soudha, Bengaluru. Most of the stakeholders working in the field of Coastal Area Management participated in the dialogue. The list of participants is enclosed as Annexure-I.

1. At the outset, Sh. Virendra Sharma, Chief Engineer, MSO, CWC, Bengaluru welcomed all the participants present for the Quarterly Dialogue. He briefed about the Quarterly Dialogue meetings being undertaken from last financial year to synergize the works being carried out by CWC/CGWB and those undertaken by States and this year CWC has chosen a subject of Coastal Area Management in the coastal States.

   He then gave a background of the subject stressing the importance of Coastal Area Management, as it has commercial, strategic, and human dimensions and is critical for economic development. As per Govt. of India (allocation of Business) Rules 1961 "Sea Erosion" is one of the Mandate of DoWR, RD & GR, under the Ministry of Jal Shakti. The objective of taking this subject for discussion is to understand the issues and problems being faced by the State and how these issues are being addressed at the State level. According to him, the dialogue inputs from the State will be collected and it may be studied how Central agencies and Central Government can aid and assist State Government in this field.

2. Dr. N. Manjula, Secretary, Infrastructure Development Ports & Inland Water Transport Department to the Government of Karnataka in her opening remark appreciated the initiative taken by the Central Water Commission to hold quarterly dialogues with States on various topics. She was surprised to know that CWC is also involved in the management of Coastal areas. She then briefed that Karnataka is one of the coastal States with around 300 Km of coastline spread over three Districts i.e. Uttara Kannada, Udupi & Dakshin Kannada. They are facing a lot of challenges like erosion, and accretion due to natural interventions like tidal activities, waves tectonic activities, etc., and other interventions such as economic development, and human activities.

She opined that the solutions provided by the State Government, so far, are inadequate causing problems in the coastline. She informed that a project under Asian Development Bank (ADB) was implemented in the Karnataka coastline with hard solutions like groynes, sea walls, etc, but these solutions are now creating a problem of erosion, and accretion. According to the Secretary, Dakshin Kannada district has different coastal issues than Udupi district and in the same district, the problems are different and standalone. Also, the solutions being applied are not sufficient. Therefore, she suggested a systematic approach to the solution of coastline issues.

Then, the Secretary admired that Quarterly Dialogue is a comprehensive forum where the Central Govt, State Govt, and expert institutes in this field have come together to understand the issues concerned and find out the solutions and technologies that can be applied for sustainable management of coastal areas.

3. Sh. Deepak Kumar, Director, Coastal Management Directorate, CWC, New Delhi made a presentation on Coastal Management/ Salinity Ingress. He listed out the general problems of the Indian coast and stressed that Karnataka is one of the worst affected State after Kerala. He briefed the coastline scenario of India and informed that the length of the coastline has been re-verified by Coastal Protection and Development Advisory Committee (CPDAC) in association with National Hydrographic Office (NHO), Dehradun (which is yet to be released) and for Karnataka, the coastline length has revised from 280 Km to 343.3 Km due to addition of offshore islands, and closing of river mouths & creeks.

   Then, he introduced the Coastal Management Information System (CMIS) Scheme initiated by DoWR, RD & GR, Govt. of India intending to collect consolidated coastal data at the national level. The prime objective of CMIS is to collect near-shore parameters at vulnerable reaches of the entire east and west coast which will be used in the design, construction, and maintenance of site-specific coastal protection structures. He told that under this scheme 8 CMIS sites have been established and 12 sites are proposed to be established by 2026 out of which 1 site is proposed in Karnataka.

   Shri. A V Mahalingaiah, Scientist –E from Central Water and Power Research Station (CWPRS) suggested to propose 2 CMIS sites in Karnataka. One in Dakshin Kannada and another in Uttar Kannada due to the dynamic nature of coastal parameters.

   Sh. Deepak Kumar, further informed that Coastal Protection Schemes in India are eligible for central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR.

   Regarding salinity ingress issues in Karnataka, he stressed that Uttar Kannada district of Karnataka is heavily affected by the salinity ingress and needs immediate attention. He also explained the possible way forward to tackle this issue. A copy of the presentation made by Sh. Deepak Kumar, Director, CWC, New Delhi is enclosed as Annexure – II.

Shri. Jayaram Raipura, Chief Executive Officer (CEO), Karnataka Maritime Board requested the funding scenario in the last 5 years from Govt of India and the funds provided to States towards coastal protection works. In reply, Director, CWC, New Delhi informed that the coastal protection works are being funded under FMBAP scheme of DoWR, RD & GR. As and when the project proposals come from the State Govts the funds are provided in the ratio of 60 (Central): 40 (State).

4. On behalf of Government of Karnataka, Shri. Jayaram Raipura, CEO, Karnataka Maritime Board (KMB) presented the overview of Coastal Area Management in Karnataka State. He briefed the mandate of Karnataka Maritime Board and activities undertaken, its formation, and functions of the board. He then explained the mitigation measures proposed by the State Govt. in various districts for the protection of shoreline, in which he told that 17 no. of projects are identified for shoreline protection works. Some 13 no. of projects are identified for the protection of sea erosion and 20 projects are aimed for the construction of breakwater, groynes & sea walls in all three districts.

   He added that Karnataka Maritime Board in collaboration with National Centre for Sustainable Coastal Management (NCSCM), Chennai has conducted a study on Shore Change Map and Shoreline Management Plan for the coast of Karnataka and expected to be completed shortly. He also explained that some of the previous mitigation works were successfully carried out by the State Govt as in the case of Maravanthe Beach where groynes have been constructed for mitigation of sea erosion, and reefs and berms are provided at Someshwara.

5. Sh. Deepak Kumar, Director, CWC, New Delhi requested State Officials to share the success stories with the subcommittee of CPDAC which can be studied and followed in other States also.

6. Shri. Jayaram Raipura, CEO, KMB then informed that Karnataka has been graced with the total 300.26 Km of coastline out of which 93.73 Km of coastline is affected. Out of 93.73 Km of the affected coastline, some measures have been taken by the State Govt in the last 10 years i.e. in 54.81 Km of coastline for mitigation and 32.71 Km has been left unprotected.

   He put forward the broad action plan for the unprotected coastline where the State has proposed works like shoreline protection, breakwater extensions, construction of fisheries and tourism harbors, multipurpose harbors, etc. To fund these schemes KMB is discussing with the ADB and State finance department. But he added that due to budgetary constraints, finance department is not interested in taking a loan from ADB. Instead they have evinced interest in collaboration with Central Govt. He told that after discussion with the finance department State will come up with proposals for funding under Central Schemes. A copy of the presentation made by Shri. Jayaram Raipura, CEO, Karnataka Maritime Board is enclosed as Annexure – III.

7. On behalf of National Institute of Ocean Technology (NIOT), Ms. Shyamala Varthini, Scientist-E made a presentation on the activities of NIOT and the expertise available with NIOT. She then gave a NIOTs approach towards coastal engineering projects and explained various projects demonstrated by NIOT in the last 10 years and told that NIOT has done most of the work on the east coast of India.

   She then presented the case study of severe erosion that occurred in Kadalur Periyakuppam, Tamilnadu where submerged breakwater made of geosynthetic tubes has been provided and it has been found to be a good solution for mitigation of coastal erosion. Apart from that, various site-specific solutions for the mitigation of coastal erosion measures were explained.

   Further, she added that NIOT in coordination with Govt of Goa is preparing the integrated shoreline management plan for Goa, where not only the coastalprocesses but also the riverine processes are being studied. The riverine study includes the hydrology and catchment properties of the major rivers and their influence on the coast. At the end, she gave a detailed list of the studies on coastal area management that are being carried out by NIOT, Chennai in various States. A copy of the presentation made by Ms. Shyamala Varthini, Scientist-E, NIOT, Chennai is enclosed as Annexure – IV.

8. Dr. Sanil Kumar V, Chief Scientist, National Institute of Oceanography (NIO), Goa made a presentation. He briefed about the various studies done by NIO, Goa in Karnataka State. He added that a lot of data has been collected and studies have been conducted in respect of Karnataka coast and it is available with various agencies and the State Govt can collect the data for any analysis.

   He told that the NIO, Goa in coordination with National Center for Coastal Research (NCCR), Chennai has conducted studies for the management of river mouths in selected locations like Devbag (Karwar), Pavinkurve (Honnavar), Kundapur Kodi (Kundapur), and Uliargoli Padukere (Malpe) of Karnataka between 2008 to 2012 due to the erosion issues. According to him, collection of data is costly and various coastal data has been collected continuously for 3 years for the study. The data is available with NCCR, Chennai, and can be collected for future references or studies.

   He suggested State Govt that during the construction of proposed port near Honnavar, the capital dredging material should be put into the northern part as it will be used as beach nourishment to counter erosion after the construction of the port. A copy of the presentation made by Dr. Sanil Kumar V, Chief Scientist, NIO, Goa is enclosed as Annexure – V.

9. Shri. A V Mahalingaiah, Scientist -E, Central Water and Power Research Station, (CWPRS), Pune who has contributed to the majority of work in Karnataka coast made a presentation. He gave a brief introduction of CWPRS, which is one of the premier R&D organization in the field of hydraulic and allied areas, establishedin 1916.

   Then he put forward the NCCR data of shoreline changes along the Indian coast (1990-2018) where 313.02 Km is the coast length of Karnataka out of that 23.7% i.e.

   74.34 Km of coastline is prone to erosion whereas 26.2% i.e. 81.9 Km length is prone for accretion and 50.1% i.e. 156.78 Km coastline is stable.

   He explained the various studies carried out by CWPRS for Karnataka coastal development where all the designs of the sustainable coastal protection work under ADB were reviewed by the CWPRS. Apart from that, various solutions provided by CWPRS and successfully carried out under ADB funds were explained. A copy of the presentation made by Shri. A V Mahalingaiah, Scientist -E, CWPRS, is enclosed as Annexure – VI.

10. Shri. N. Jyothi Kumar, Regional Director, CGWB, Bengaluru gave a brief introduction of functions and works carried out by CGWB in the State of Karnataka. He added that CGWB collects the groundwater data and the department has also completed

    National aquifer mapping where district-level and village-level groundwater management plans have been prepared and submitted to State Govt. He also added that groundwater also plays an important role in the management of coastal areas where excess extraction of groundwater can cause reversal of flow and salinity ingress issues.

11. Dr. Suchetana Biswas, Scientist-C, CGWB, Bengaluru made a presentation. She gave a brief introduction of rainfall and drainage patterns, geomorphology, and soil characteristics of the 3 districts of coastal Karnataka. She then briefed about the various analyses and initiatives taken by CGWB for coastal zone management such as taluk-wise NAQUIM studies, master plan for artificial recharge, regular periodic water level and water quality monitoring, and groundwater resource assessment.

    The activities proposed by CGWB in coastal areas were informed such as 126 no. of piezometers proposed for construction along coastline villages for real-time monitoring of water quality in the shallow and deeper aquifers. Apart from that to study the effects of groundwater extraction as well as the effects of industrial pollution a study has been planned in Baikampady Industrial Area, Mangalore City in 2024-25 by CGWB. A copy of the presentation made by Dr. Suchetana, Scientist -C, CGWB is enclosed as Annexure – VII.

12. After the completion of the presentations, discussions on the agenda took place. Capt. C. Swamy, Director, Ports, Govt of Karnataka said that under ADB funds various structures have been built as a coastal protection measure and asked whether the Central Govt can fund for the maintenance of these structures. In reply, Sh. Deepak Kumar, Director, CWC, New Delhi informed that Central Govt can fund for the development and construction of new coastal protection works under FMBAP scheme, and in any scheme, the maintenance of the structures lies with the State Govt.

13. Sh. Virendra Sharma, Chief Engineer, CWC, Bengaluru appreciated all the presentations, made by expert agencies and told that the discussions and knowledge sharing was very useful. The purpose of conducting this dialogue has been fructified. He also added that due to this Quarterly Dialogue, all the stakeholders working in the field of coastal management have come closer and understood everyone's strengths and weaknesses which will be helpful in planning and management of coastal areas in a sustainable way.

14. While concluding the discussions Dr. N. Manjula, Secretary, Infrastructure Development Ports & Inland Water Transport Department highly appreciated the efforts made for holding this Quarterly Dialogue. She accepted that with this

    Quarterly Dialogue, State Govt has come to know about plenty of information available with various organizations which was not fully known before. The research and studies conducted by various organizations will therefore help in many ways for the management and development of coastal areas of Karnataka in a sustainable way. She again added that this dialogue has given lot of learning in terms of what is going on in this field, and new technologies adopted which can be studied and implemented in Karnataka.

    She informed that funding is the major challenge for carrying out any mitigation or development work in this field. The coastal sector is not getting adequate funds and this needs to be addressed.

    She then urged CWC to set up at least 1 CMIS site in Karnataka in the initial phase as at present there was not a single CMIS site available in Karnataka out of 8 sites opened by CWC. In the end, she admired CWC and Ministry of Jal Shakti for taking

    the initiative in conducting this Quarterly Dialogue and thanked all the experts from various institutes who participated in the dialogue.

15. The quarterly dialogue on coastal area management in Karnataka ended with a vote of thanks by Dr. J Harsha, Director (Monitoring), MSO, CWC, Bengaluru.

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List of officers participated in the 1st Quarterly Dialogue on "Coastal Area Management" with Government of Karnataka held on 23.04.2024

Sl. No.	Name, Designation and Organization of the officer
	Central Water Commission, Government of India
1.	Sh. Virendra Sharma, Chief Engineer, MSO, CWC, Bengaluru
2.	Sh. Deepak Kumar, Director, Coastal Management Directorate, CWC, New Delhi
3.	Dr. J Harsha, Director (Monitoring), MSO, CWC, Bengaluru
4.	Sh. Ashok Kumar V, Director, App Dte, MSO, CWC, Bengaluru
5.	Sh. Pratap Shelke, Deputy Director, MSO, CWC, Bengaluru
6.	Sh. Shashidhar T, AD-II, MSO, CWC Bengaluru
7.	Sh. Sujeet Kumar Maurya, JE, MSO, CWC, Bengaluru
	Central Ground Water Board, Government of India
8.	Sh. Jyothi Kumar Nalla, Regional Director, CGWB, SWR, Bengaluru
9.	Sh. Rahul R. Shende, Scientist D, CGWB, SWR, Bengaluru
10.	Smt. Sangitha P. Bhattacharjee, Scientist D, CGWB, SUO, Belgavi
11.	Dr. Suchetana Biswas, Scientist -C, CGWB SWR, Bengaluru
12.	Dr. Baby Swetha S , Scientist -B , CGWB SWR, Bengaluru
	Government of Karnataka
13.	Dr. N. Manjula, IAS, Secretary, Infrastructure Development Ports & Inland Water Transport Department
14.	Sh. Krishnamurthy B Kulkarni, Secretary, Water Resources Department
15.	Sh. Jayaram Raipura, Chief Executive Officer, Karnataka Maritime Board
16.	Capt. C Swamy, Director Ports, Karnataka Maritime Board
17.	Sh. Prameeth B.S., Chief Engineer, Karnataka Maritime Board
18.	Sh. K G Mahesh, Director (CE) KERS, Mandya
19.	Sh. Girisha K, Chief Research Officer, Coastal Engineering Division, KERS
20.	Sh. Dinesh Kumar , Director, Fisheries Department
21.	M.V. Prasad, EE Ports, Ports Division Baithcol
22.	Sh. Vinayak R Haradatti, Superintending Engineer, MI & GWI circle, Mysore
23.	K Syed, Executive Engineer, MI & GWI circle Mangalore
24.	Smt. Vanithamani, Under Secretary (Technical-4) WRD, Vikas Soudha, Bengaluru
25.	Smt. P Yashoda, Water Resources Department, Vikas Soudha, Bengaluru
26.	Sharada k, Executive Engineer, ACIWRM, WRD
27.	Lakshmi , Assistant Executive Engineer, ACIWRM, WRD

28.	Swetha N, Assistant Engineer, ACIWRM, WRD
29.	Sh. Dnyashwar Joshi, Junior Engineer, IDD, Port & Inland Water Transport Department
30.	Sh. Shreyansh K, IDD, Port & Inland Water Transport Department
CSIR - National Institute of Oceanography (NIO), Goa	
31.	Dr. Sanil Kumar V, Chief Scientist, Head, Ocean Engineering & Head, Business Development, NIO, GOA
National Institute of Ocean Technology (NIOT)	
32.	Ms. Shyamala Varthini, Scientist-E, NIOT, Chennai
Central Water and Power Research Station (CWPRS)	
33.	Sh. A V Mahalingaiah, Scientist -E, Head of Coastal Hydraulic Structure, CWPRS

ANNEXURE-XX

Minutes of 1 st Quarterly Dialogue (FY-2024-25) with the States/UTs – With the State of Gujarat

Chairman, CWC directed that the 1st Quarterly Dialogue in FY 2024-25 for coastal states shall be held on the subject "Coastal Area Management". Accordingly, 1st Quarterly Dialogue with the State/ UTs on the subject of "Coastal Area Management" was organised through Hybrid Mode under the chairmanship of Shri K. A. Patel, Secretary, Water Resources Department (WRD), Govt. of Gujarat (GoG) & Shri D. S. Chaskar, Chief Engineer (CE), Mahi & Tapi Basin Organization (MTBO), Central Water Commission (CWC), Gandhinagar on **25.04.2024** from **1100 hrs** onwards in the Committee Room, 2nd Floor, Block No. 9, Sachivalaya, Gandhinagar.

All the stakeholders (State Govt organisations, Central Govt organisations, Academic Institutions, Research Institutes,. etc) working in the field of coastal area were invited to participate in this Quarterly Dialogue to share their studies, research, work done on coastal sites etc. The main objective was to share latest development in the field of coastal management and to know the State Govt. perspective on the same. Accordingly, various stakeholders working in the field in the said State were invited to share their perspective.

Officers from following organisations participated in the meeting:

- Central Water Commission (CWC)
- Central Ground Water Board (CGWB)
- Central Water Power & Research Station (CWPRS), Pune
- Maharashtra Maritime Board (MMB), Mumbai **(Hybrid)**
- Gujarat Maritime Board (GMB), Gandhinagar **(Hybrid)**
- Indian Institute of Technology (IIT), Mumbai **(Hybrid)**
- Indian National Centre for Ocean Information Services (INCOIS), Hyderabad **(Hybrid)**
- National Institute of Oceanography (NIO) Goa **(Hybrid)**
- National Institute of Ocean Technology (NIOT) Chennai **(Hybrid)**
- Public Works Department, Daman **(Hybrid)**
- Water Resources Department (WRD), Govt. of Gujarat
- Gujarat Water Resources Development Corporation (GWRDC), Gujarat

A list of participants is enclosed at **Annexure-I.**

At the outset, Shri D. S. Chaskar, CE, CWC welcomed the Secretary, WRD, GoG and all the participants attending the dialogue physically as well as online (Hybrid). Discussion were initiated with an elocution over brief background of the quarterly dialogues by Chief Engineer (CE), Mahi & Tapi Basin Organization (MTBO), Central Water Commission (CWC), Gandhinagar. He informed that :

- Two organizations under Ministry of Jal Shakti namely CWC and CGWB are having pan India presence and supposed to work in close tandem with concerned State/ U.T. Govt. for implementation of various schemes, projects, policy matters etc. There is a dire need of close co-ordination between Central and State Govt. for effective implementation of any scheme. In this backdrop, Shri Kushvinder Vohra, Chairman, CWC has put forth the idea of having a quarterly dialogue between regional offices of CWC in collaboration with CGWB with the concerned State Govt. As a part of this initiative, 4 quarterly dialogues have been held during FY 2023-24. This 1st quarterly dialogue for the FY 2024-25 is organized by MTBO, CWC focused for one particular technical area that is **Coastal Management**.
- CWC & CGWB (offices under Ministry of Jal Shakti) are implementing many flagship schemes of Govt. of India related to water resources development and management as well coastal area management in Gujarat and Maharashtra.
- India is having a vast coast line area & we are facing an issue of coastal erosion and also salinity ingress at numerous places, and these issues are closely connected with the Socio-Economical development of the coastal region. The main importance of this dialogue designing, constructing & maintaining the coastal erosion measures. There are many departments working on various aspects of coastal issues like as Coast Guard, Coastal zone regulatory authorities, Maritime Boards & various institutes like INCOIS, NIOT, NIO, NCCR, IIT's, CSIR etc. but there is one aspect that is missing is Coastal data, (i.e. Wave Data, Riverine data, tide data, current data etc.). This data is very fundamental before we take up any anti erosion measures or for design of coastal erosion structures. In this regards Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation in 12th plan formulated a scheme **CMIS (Coastal Management Information System)** basically to collect the data vulnerable of sites & also to create a comprehensive central data base, so that all stakeholders who require that data, they can access it.

- CWC Started taking data observations at 8 sites in Eastern & Western Coast with the help of expert organisations i.e. CWPRS Pune, NIO Goa, IIT Chennai These organisations are helping Central Water Commission in establishing a site and also taking the data collection and hosting data in one single place. There are many Organisations, Academic Research, State Government Department as well as Central Government Organisation working in this field of coastal management, but there are hardly any linkages among them. So, this particular occasion is an opportunity for all of us to come together to discuss the works that we are doing, discuss the studies research and all the schemes we are implementing and learn from each other's experiences & expertise.
- At the National level we have an apex committee for Coastal Projection & Development Advisory Committee (CP-DAC). This committee is doing pioneering work in taking forward the issues related to Coastal Erosion & Salinity ingress. With the initiative of this committee an externally aided project has also been started for Government of Goa, Karnataka & Maharashtra. The re-assessment of coastal length is undertaken by NHO & revised shoreline change atlas has been brough out by SAC, NRSC.

Thereafter, Detailed presentations were made by each of the organisations covering their expertise and the projects they have done.

Presentation by CWC:

A PPT on Coastal Management/ Salinity Ingress was presented by Sh. Deepak Kumar, Director, Coastal Management Directorate, CWC, New Delhi in which, he elaborated on the coastal features of Gujarat state, objectives of the CMIS program in general and its implementation in the maritime state of Gujarat. He informed that the length of the coastline has been re-verified by Coastal Protection and Development Advisory Committee (CPDAC) in association with National Hydrographic Office (NHO), Dehradun (which is yet to be released) and for Gujarat, he informed that the coastline length has increased from 1214.70 Km to 2340.62 Km due to addition of offshore islands and closing of river mouths & creeks. He also added that Gujarat is having Erosion in 27.6%, Accretion of 19.4% and Stable coast for 53% of its coastal length. Out of the total 8 Coastal sites already established under CMIS in all over India, 1 site is in Gujarat i.e., Nanidanti- Motidanti, Valsad.

Coastal Protection Schemes are eligible for central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR; CWC is the appraising agency for the schemes proposed for external funding; Govt of India initiated Technical Assistance programme for the Climate Resilient Coastal Protection & Management Project. Guidelines for preparation of DPR for Coastal Management Projects under Climate Change Scenario' was published by CWC to bring uniformity in the preparation of project proposals for funding. Regarding salinity ingress, the action needs to be taken by the State Govt. and the way forward to tackle that was discussed. 'Guidelines for preparation of DPRs related to Salinity Ingress Management Projects in Coastal Areas', is under finalization. A copy of the presentation made by Sh. Deepak Kumar is enclosed as **Annexure – II**.

Presentation by CGWB:

Presentation of CGWB is enclosed as **Annexure-III**.

Presentation on study of Gandevi Tidal Regulator under NAQUIM 2.0

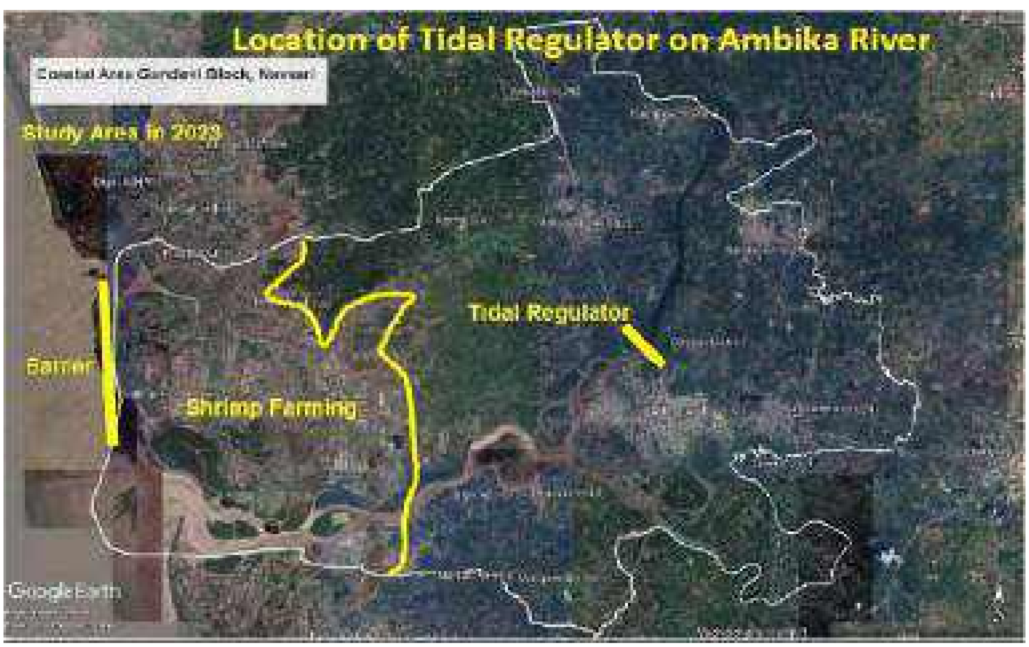
CGWB, Ahmedabad informed that CGWB has taken up NAQUIM 2.0 study in Coastal parts of Gandevi Block, Navsari District on recommendation of GWRDC Ltd. around Devdha Tidal Regulator, to know the efficacy of the tidal regulator in mitigating Salinity in the area. CGWB has carried out field surveys and established key wells to understand the hydrogeological scenario in the study area. The regulator was built in 2002 and the study has been taken up for period 2002-2024 (present). The outcomes of the study show that in 2002, before construction of the Tidal regulator the average Electrical conductivity of Ground water in the study area was around 2274 μS/cm, which has improved to 1390 μS/cm due to Tidal Regulator. The Tidal regulator is helping in improvement of Ground water quality and mitigating salinity of Ground Water. The Tidal regulator is also augmenting the recharging process of phreatic aquifer and developing a blanket of Fresh water floating over saline water upto 10 m depth, which can be used for domestic purpose after primary treatment with minimal pumping to restrict up-coning of saline water. Water Resources Department, Gujarat informed that the state government is also in the process of constructing a Tidal Regulator at Kaveri River and 75% works are completed and on the other rivers the Tidal regulator works are under progress.

CGWB requires the state govt. to provide the Maximum Discharge (Q) for all of the wells at the time of pumping, this discharge data is more beneficial for Tidal Regulator design.

Shri Prabhat Chandra, CWPRS suggested to CGWB that such kinds of models are available which gives some reports & predictions for Tidal Regulator designing.

CE, CWC requested WRD, Gujarat to take up some projects and engage some agencies for model studies before constructing the Tidal Regulators.

Coastal Area Gandevi :Study area before Tidal Regulator (2001)



Presentation by IIT Mumbai:

Thereafter, a PPT on **Understanding Coastal Processes & Dynamics: Research Experiences** was presented by Shri Balaji Ramakrishnan, Professor, Department of Civil Engineering, IIT Bombay in which he elaborated about the role of IIT Bombay in the field of Coastal & Ocean Engineering in presentation. He also explained about the holistic approach of coastal data collection & validation.

Prof. Balaji informed about the experience & expertise of IITB in their work for Gujarat coast line area especially Large & Local Scale Hydrodynamics for Khambat & Kutch Region. Earlier IIT Bombay prepared a Coastal Urban Flooding model for the area of Valsad- Auranga, Surat-Tapi on special request of WRD, Gujarat.

IIT Bombay have a salinity model of Tidal Regulator of Navsari-Purna River of Gujarat Coastline, and expertise in Low-cost drone- marshland topography, Seawall- Tomography dynamics. Apart from modelling and data analysis, IIT Bombay also have experience & expertise of data collection at coastal sites like wave, current, tide, beach profile etc Presentation of IIT, Mumbai is enclosed as **Annexure-IV**.

Presentation by CWPRS Pune:

Thereafter, a PPT on **Coastal Area Management-Gujarat** was presented by Shri Prabhat Chandra, Additional Director, CWPRS Pune. CWPRS has been rendering services on the Coastal protection works to all the Coastal states. Shri Chandra said that CWPRS suggested remedial measures for Coastal erosion problems for more than 60 sites in Gujarat with the collaboration of Narmada, Water Resources, Water Supply and Kalpsar Department, Government of Gujarat.

Shri Chandra presented about the methodology adopted in Coastal protection of CWPRS, future challenges in Coastal Protection, CMIS & other activities related to Coastal Management is briefly explained in presentation.

Shri Chandra CWPRS, Pune also shared a presentation on the contribution of this research organization in the field of coastal area management and coastal protection works done in Gujarat at coastal protection work at Tithal, Dwarka, Somnath, Dumas-Sultanabad, Surat coast etc. Presentation of CWPRS is enclosed as **Annexure-V**.

Coastal Protection works at Tithal

Coastal Protection works at Dwarka

Presentation by NIO Goa:

Thereafter, a presentation on **Coastal Area Management** was delivered by Dr. Jaya Kumar Seelam, Chief Scientist, CSIR - National Institute of Oceanography (NIO), Goa explaining the basics of coastal areas, its classification, structures, design and then briefed on coastal erosion topic. He also shared methods of coastal monitoring like physical, remote sensing through satellite & video, indigenous Video Beach Monitoring System (VBMS) and community beach monitoring.

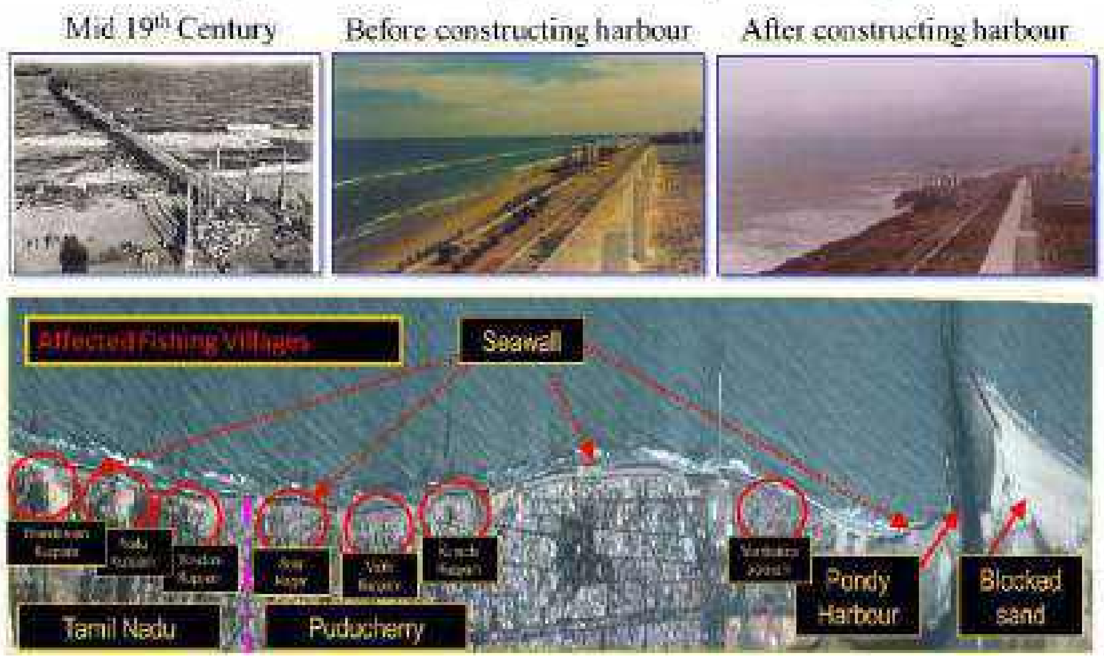
He further informed that NIO has been implementing CMIS for collecting 9 parameters at 3 locations covering Goa (2) and south Maharashtra (1) coasts on behalf of CWC and storing all the data in the central server. A copy of the presentation made by Dr. Jaya Kumar Seelam is enclosed as **Annexure – VI**.

Presentation by NIOT Chennai

Thereafter, Dr. Basanta Kumar Jena, Scientist – G, NIOT made a presentation on brief details about NIOT organization and its works along with **Integrated River Basin and Shoreline Management for Goa** under National Hydrology Project (NHP). He presented about 4 Coastal Erosion Projects that they successfully carried out in the states of Odisha, Andhra Pradesh, and UT Puducherry. He further informed that objective of the Integrated River Basin and Shoreline Management for Gujarat under National Hydrology Project is to prepare an integrated river basin and shoreline management plan for Gujarat coast. He presented the shoreline analysis done using satellite imagery and the field measurements for data collection using Tomography, Bathymetry, River cross-sections, Bed and suspended sediment properties for 2 Seasons and Hydrodynamic survey.

Dr. Basanta Kumar Jena informed about the inhouse development of mobile App N.I.O.T (North Indian Ocean Tide) that provides predicted tides along Gulf of Khambhat. The database of N.I.O.T App has been updated till June-2024. NIOT has also developed wave atlas Version 2.0 including Lakshadweep and Andaman & Nicobar Island from 1995 to 2022. And Decision Support Tool-Shoreline Response Evaluation System (ShoRES) has also been developed by NIOT. A copy of the presentation made by Sh. Basanta Kumar Jena is enclosed as **Annexure – VII**.

Erosion along Pondicherry Coast



Hybrid Solution (Reef + Beach Nourishment)

Presentation by INCOIS, Hyderabad

Dr. P. C. Mohanty, Scientist- D, INCOIS, Hyderabad shared a presentation about the **Operational Ocean Services of INCOIS**. The objective of INCOIS is to provide the Ocean Information and Advisory Services to Society, Industry, Government Agencies and Scientific Community through Sustained Ocean Observations and Constant improvements through Systematic and Focussed Research. Dr. Mohanty explained the works of INCOIS, Hyderabad which are dealt by them in two types of operational ocean services one is the Ecosystem services which includes Potential Fishing Zone, Coral Bleaching Alert, Harmful Algal Bloom, Coastal Water Quality and the second type of ocean services that INCOIS provides is Multi Hazard Early Warnings such as Tsunami Early Warning, Storm Surge Early Warning, Ocean State Forecast, Marine Heat Wave, Marine Search and Rescue, Oil Spill Trajectory.

A copy of the presentation made by Dr. P. C. Mohanty is enclosed as **Annexure – VIII**

Presentation by WRD, Govt. of Gujarat:

Sh M R Patel, Chief Engineer, WRD delivered a presentation on the **Issues of Salinity Ingress and Coastal Erosion in Gujarat State**. It was informed that Gujarat has longest coastline of 2340.62 kms which is approximately one third of total coastline of India and Two gulfs, Gulf of Kachchh and Gulf of Khambhat covers 60 % of coastline. Sh M R Patel informed that there is Arid to Semi-Arid climate along coastal area of Saurastra and Kachchh. Salinity ingress is serious issue in 10.65 lacs Ha. coastline area of Saurashtra and Kutch region where more than 13.3 lacs people live.

The state of Gujarat is having various issues of ground water which includes Salinity ingress. Worldwide, Salinity affects approximately 20% of irrigation land. Controlling salinity and reclaiming saline land is an urgent priority matter for increasing productivity of existing land, make better use of irrigation and demonstrate that new irrigation areas can be managed in a sustainable manner. The reasons of salinity ingress in Gujarat are Less and irregular rainfall. Porous geographical formation, less natural water filling, Weak land management, Excessive lifting of ground water. Further Sh M R Patel informed about the initiatives and projects undertaken by State Govt on the issues of salinity ingress and coastal erosion.

Measures adopted by Gujarat Govt. in control of Sea Erosion and Salinity Ingress:

- For examination of problems of sea water Intrusion along Coastal Area of Saurashtra and kachchh the High-Level Committee appointed under the chairmanship of the Chief Secretary in 1976 (HLC-I) and 1978 (HLC-II). Study area for HLC-I: Una- Madhavpur reach, and Study area for HLC-II : Bhavnagar-Una, Madhavapur- Okha, Okha-Malia , Malia-Lakhpat. The various measures suggested by the Committee are as follows:

  a) 53 Tidal Regulator

  b) 127 Bandhara, 1575 Check Dam

  c) 47 Recharge reservoirs, 122 Recharge Tanks, 1480 Recharge Wells

  d) 526 km. long Spreading & Connecting Channels

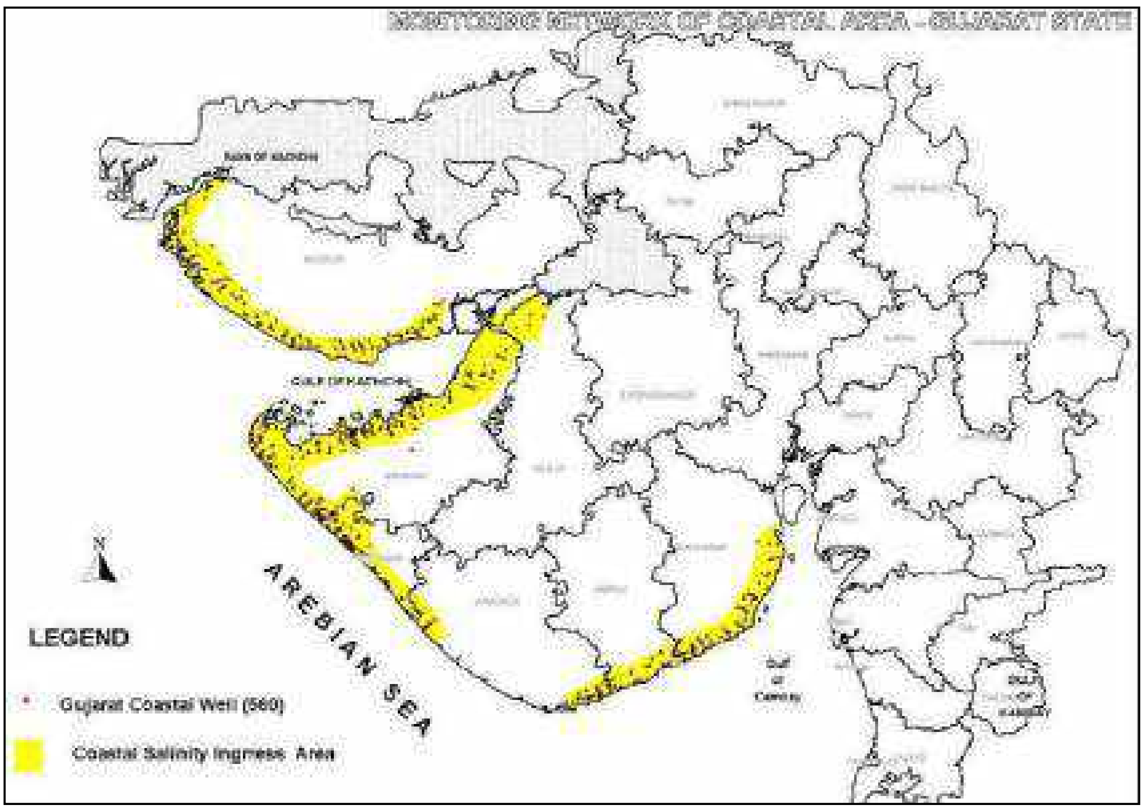
  e) Afforestation and change in cropping pattern

  f) Financial assistance under 12th and 13th Finance commission from NABARD

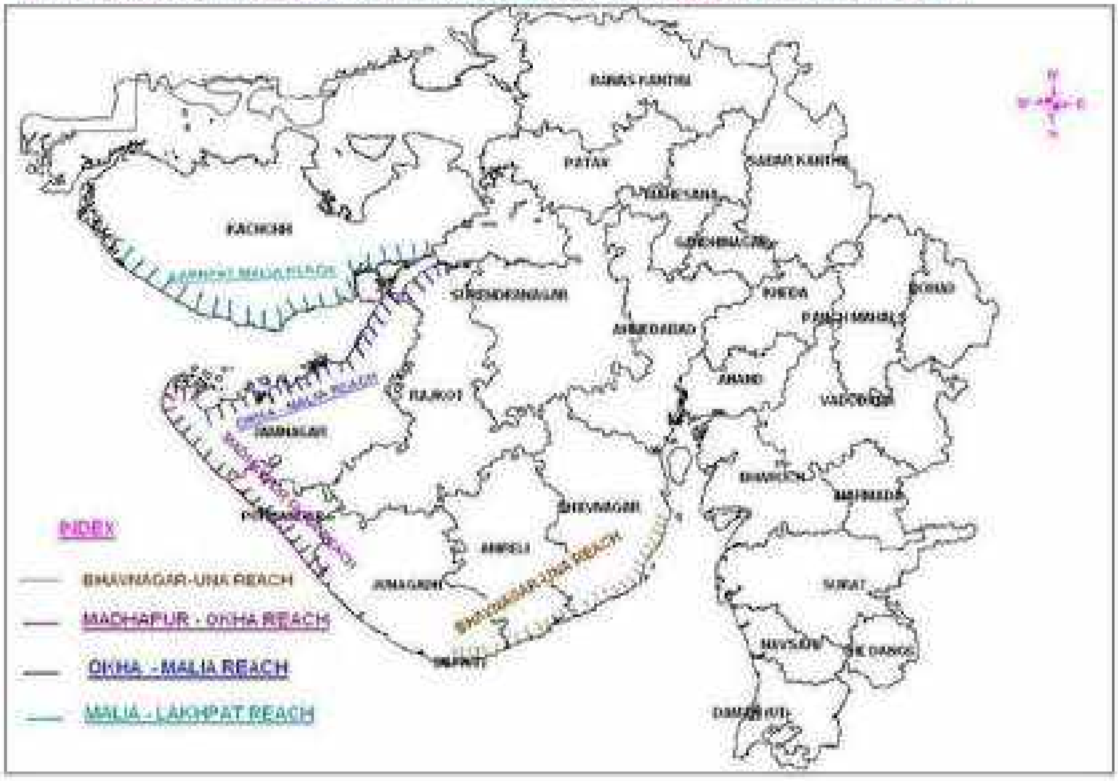
  g) Total Expenditure was of the order of Rs. 700 Crore

Status of Salinity Ingress works as suggested by Committee:

No.	Type of Structure	Suggested		Benefitted Area (in Ha.)
		Proposed	Completed	
1	Tidal Regulator	53	39	33,976
2	Bandhara	127	94	41,353
3	Recharge Reservoir	47	28	9,904
4	Check Dams	1575	1471	23,789
5	Recharge Tank	122	66	12,212
6	Recharge Well	1480	1244	-
7	Spreading Canal (Km)	526 Km	291 Km	29,997
	Total			1,51,231



Reaches covered for investigation of Salinity Ingress along Coastal Area: Saurashtra and Kachchh



Benefits accrued by SIP Works:

- 326 MCM water storage capacity generated, by which 1.51 lac Ha. of land has got irrigation benefit.
- Ground water quality is improved and water table has risen.
- Shifting of 2000 TDS line toward sea.
- 2.26 lac Ha. land area is prevented from further deterioration & 44,260 Ha land has reclaimed.
- Positive impact on yield of Agricultural product & rise in value of land.
- Increase in the socio–economic standards of the people.

Bhadbhut Barrage:

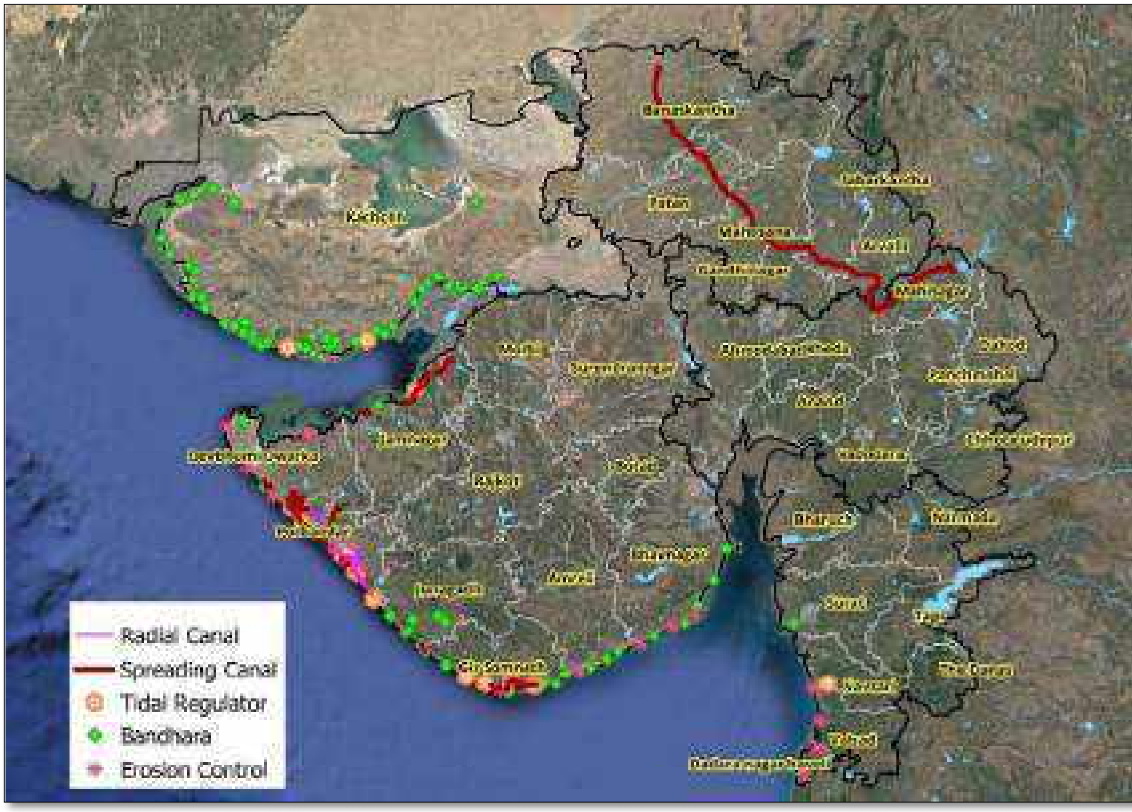
Benefits of Bhadbhut Barrage:

- Prevents salinity ingress in 55 kms river stretch.
- Flood protection and prevention from river side land erosion.
- Create 600 MCM water storage.
- Water storage for industrial and drinking purposes.
- Reduce 18 km road distance between Dahej to Surat.

Coastal Erosion

- Belt of Gujarat comprises of sand and silty sand which can be easily eroded by waves and heavy current of sea and tides which ultimately results in huge amount of land erosion.
- There are various techniques used to control costal erosion such as Tetrapode, Zn+PVC coated box wire mesh gabion, Armour layer of **Heavy Stone Concrete wall** with toe protection of heavy stones , Geo fabric in foundation and core & Heavy Stone in Armour layer.

- Total 50 works in 33 kms stretch has been completed for prevention of soil erosion in 8 districts of Gujarat state.



Map showing Salinity and Coastal Erosion Control Interventions

Outcomes:

- For Approximately 32,972 m length, the schemes for prevention of sea erosion has been completed at a cost of Rs. 365.65 crores in 8 district of Gujarat state.
- In Gujarat 134 Bandharas/Tidal regulators has been constructed at a cost of 520.63 crores. Due to which 78,329 hectare land area got the benefit of irrigation.
- In the state of Gujarat, 2809 recharge reservoirs/recharge wells/recharge tanks/check dams has constructed at a cost of 269.26 crores. By this 45,905-hectare land area got the benefit of irrigation.
- In the state of Gujarat 291 kms long Spreading Canal has been constructed at a cost of 104.76 crores.

A copy of the presentation made by M R Patel, Chief Engineer is enclosed as **Annexure – IX**

Vaghrech Tidal Regulator, Navsari

Meghal Tidal Regulator, Gir Somnath

After every presentation there were many questions from the participants, which were comprehensively answered by the presenters. The presentations and interaction was highly enriching for all the participants. CE, MTBO appreciated the initiatives taken by WRD, GoG for the salinity Ingress & Coastal Erosion works and emphasized that the main objective this quarterly dialogue is to meet the all agencies, stakeholder, academics and research institutes, to share the ideas, experiences, problems etc. It is asked from State Govt. officers that after seen all the presentations what they expect from Central Agencies, Academics Institutes, Research Organisation & all other stakeholders who are working in coastal studies to help in designing the coastal protection works, researches, modelling, capacity building etc in Gujarat State.

CE, MTBO is also said that as of now no central schemes & funds are available for Salinity ingress. He pointed out that in the presentation of WRD, Gujarat, it was mentioned that they have constructed many Coastal Structures but at the present, the some of the structures are not working. Moreover, some of structures suggested by High-level Committee are yet to be constructed. CE, MTBO enquired whether GoG need any external funds to build these Balance structures.

Perspective from the State Authorities:

Shri K. B. Rabadia, Additional Secretary, WRD, Gujarat said that about the balance structures there is no issues of fund as of now, but there are some local issues such as for acquisition of land at that time because of some peoples are opposing that type of structure. Shri Rabadia also said that they are trying to resolve the issues with the help of local MLA's & MP's. Shri K. B. Rabadia also said that about the salinity Ingress structure construction, GoG do not have sufficient data for the designing of that type of structures. He also requested CWC to for handholding of state authorities on coastal & SI matters as there is lack of technical knowhow in the area. The state is ready to invest but due to lack of manpower with requite knowledge & lack of design data the state is unable to take the issue forward.

Shri Rabadia also informed that the state government is ready to establish CMIS sites along its coast, if CWC informs about the suitable locations and also gives support for establishing such sites. He furthers requested that the full technical support will be required from CWC and also from other academic as well

as Research Institutes as the state government need to develop own expertise in the area. He said that such site installation and operation can also be done with the state funds.

Shri Rabadia requested to all the stake holders specially CWC to make a master plan for the data collection of coastline area of Gujarat. Trainings may also be organised for capacity building of their officers.

Shri D. S. Chaskar, CE, MTBO, CWC, Gandhinagar said that the matter of master plan can be taken up in CPDAC meeting and training on coastal data measurements shall also be planned soon.

CE, MTBO further informed that National water Academy Pune is organising the training on coastal management information system (CMIS). Last year, two such training programs were organised for CWC officers. If further informed that NWA has been organising training programs on the subject of "Coastal erosion and postal management" since many years. One such training program is proposed in the training calendar of 2024-25. He requested the state government and also the other stakeholders participating in the meeting, to nominate their offices for this training, whenever it is conducted by NWA.

In the end, Shri K. A. Patel, Secretary, WRD, GoG appreciated the initiative of CWC and assured to continue whole hearted support in all matters.

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Date: 25.04.2024 (Thursday)

Venue: Committee Room, 2nd Floor, Block No. 9, Sachivalay, Gandhinagar

Topic: "Quarterly Dialogue with the State/ UTs on the subject of Coastal Area Management"

List of participants (Physical Presence)

Mahi & Tapi Basin Organization, Central Water Commission

Sl. No.	Name (Mr./Mrs./Miss)	Designation	Mobile No.
1	D. S. Chaskar	Chief Engineer	9422309043
2	Yoki Vijay	Director, Monitoring	9990093428
3	Y. S. Varshney	Superintending Engineer, HOC	9825075127
4	Ashish Tripathi	Deputy Director (Mon.)	9911096907
5	Pushpendu Majumdar	Executive Engineer, TD, Surat	9717262760
6	Manish Sharma	Assistant Director -II	8460878495
7	Vikas Kumar	Assistant Director -II	9934510153
8	Jitendra Nayak	Junior Engineer	9407106199
9	Abhay Kandpal	Junior Engineer	7579288228

Central Water Power & Research Station, Pune

Sl. No.	Name (Mr./Mrs./Miss)	Designation	Mobile No.
1	Dr. Prabhat Chandra	Additional Director	9373317260

Western-Central Region, Central Ground Water Board

Sl. No.	Name (Mr./Mrs./Miss)	Designation	Mobile No.
1	Kartik P. Dongre	Head of Office	9764950899
2	Naresh Kumar Jatav	Scientist-D	9435168535
3	Ankit Vishwakarma	Scientist-C	8507412009
4	Himesh Pandya	Scientist- C	8899204036

Water Resources Department, Govt. of Gujarat

Sl. No.	Name (Mr./Mrs./Miss)	Designation	Mobile No.
1	K. A. Patel	Secretary	--
2	K. B. Rabadia	Additional Secretary	--
3	R. M. Patel	MD, GWRDC	9909003766
4	A. D. Kanani	Chief Engineer & AS	9909939803
5	M. R. Patel	Chief Engineer (South Guj.) & AS	9913701310
6	D. A. Thakkar	Chief Engineer (Mech.) & AS	9925049489
7	S. G. Pandya	OSD (IP), WRD	9428078117
8	H. J. Pathak	Deputy Executive Engineer	9714806760
9	Kartik Patel	Deputy Executive Engineer	8128920289
10	Jeet Chavda	Assistant Engineer	9165374718

List of participants (Online Presence)

Sl. No.	Name (Mr./Mrs./Miss)	Designation & Name of Department
1	Deepak Kumar	Director, CWC, New Delhi
2	Ajay	INCOIS
3	Dr. Basanta Kumar Jena	Scientist – G, NIOT, Chennai
4	Dr. K. M. Nayak	CGWB, Ahmedabad
5	Dr. P. C. Mohanty	Scientist- D, INCOIS, Hyderabad
6	Manoj S	MISO
7	Dr. Jaya Kumar Seelam,	Chief Scientist, CSIR - National Institute of Oceanography (NIO), Goa
8	Vinay Banagani	National Institute of Oceanography (NIO), Goa
9	Balaji Ramakrishnan,	Professor, Department of Civ il Engineering, IIT Bombay
10	Ramesh Jena	CGWB
11	S. R. Shrivastava	AEE, MTSD, CWC, Dhule
12	Sourabh Sharma	JE, DGSD, CWC, Silvasa
13	Sidhartha Mitra	Director Mon and App Kolkata

14	Dhanraj Sengunthar	--
15	Alia Bano	--
16	Arun	--
17	Pinakin Vyas	--
18	Pratik Rathod	--
19	SK MMB	--
20	UKD Pune	--
21	Upasana	--
22	PWD Daman	--
23	Satish	--

1. Introduction

The coastal regions of India encompass a vast expanse of approximately 7517 kilometres (under revision), forming a crucial interface between land and sea. These coastal areas are of immense importance, with 15% of the country's population residing in the districts along the coast. As per the data from the Shoreline Change Atlas prepared by SAC, Ahmadabad, a significant portion of India's coastline experiences dynamic changes, with around 15% undergoing erosion and 14% experiencing accretion.

The maritime states and union territories (UTs) of India, including Tamil Nadu, Puducherry, and the Andaman & Nicobar Islands, exhibit diverse coastal features and ecosystems. Tamil Nadu, situated on the southern part of the Indian peninsula, is characterized by varied coastal ecosystems such as mangroves, corals, and sand dunes. The region boasts a rich biodiversity, with numerous rivers draining into the coastline and supporting vibrant ecosystems.

Puducherry, located on the southeastern coast, features sandy beaches and rocky shores, attracting tourists with its scenic beauty. Fishing and tourism are significant economic activities in Puducherry, contributing to the local economy and livelihoods of coastal communities.

The Andaman & Nicobar Islands, an archipelago in the Bay of Bengal and Andaman Sea, possess a long coastline with varied topography, including sandy beaches, rocky stretches, and coral reefs. These coastal areas are home to diverse marine life and support livelihoods through fishing and tourism.

Despite their ecological and economic significance, these coastal regions face challenges such as erosion and accretion. As per the National Assessment of Shoreline Changes, Tamil Nadu and Puducherry experience erosion in significant portions of their coastline. Urgent action is required to address these challenges comprehensively.

Key coastal strategies include: Identification of vulnerable areas prone to erosion, Collection of requisite data for informed decision-making, Development of Coastal Management Plans, Evaluation of past coastal protection projects, Mobilization of funding for future initiatives, Establishment of nodal agencies for coordination and strengthening inter-departmental coordination. By implementing these strategies, Tamil Nadu, Puducherry, and the Andaman & Nicobar Islands can safeguard their natural assets, promote sustainable development, and ensure the resilience of coastal communities. These initiatives align with the broader goals of coastal conservation and sustainable coastal development outlined by the Government of India.

2. Overview

The Shoreline Change Atlas of the Indian Coast (2021), published by ISRO, presents invaluable insights into the dynamic coastal landscape of Tamil Nadu, the Union Territory of Puducherry, and the Andaman & Nicobar Islands. Covering approximately 849 kilometres, the Tamil Nadu coast displays a dynamic interplay of coastal processes shaping its diverse geomorphological features. Serving as a crucial interface between land and sea, this coastline hosts rich biodiversity and sustains numerous communities. Erosion affects approximately 129 kilometres of the coast, while around 189 kilometres are experiencing accretion, with 532 kilometres remaining stable.

In the southern sector, erosion impacts 42 kilometres of coastline, while 56 kilometres are undergoing accretion, and 121 kilometres remain stable. Notably, erosion along the Arabian Sea-facing coast underscores significant coastal vulnerability, exemplified by Plate 1 depicting erosion at Chinnaturai. Conversely, accretion is observed at Karikovil, Aalagappapuram, and Thangammalpuram.

Moving to the second sector, encompassing the Gulf of Mannar and Palk Strait, erosion spans 22 kilometres, with 41 kilometres experiencing accretion. The irregular coastline orientation, influenced by small promontories, contributes to localized erosion and accretion patterns. Plate 2 showcases changes near Ervadi due to shifts in coastal orientation, while stability characterizes the Palk Strait shoreline, interspersed with patches of erosion and accretion.

The third sector, comprising the Kaveri deltaic plain, exhibits substantial shoreline changes, with 44 kilometres undergoing erosion, 54 kilometres accreting, and 63 kilometres stable. Plate 3 depicts severe erosion at Pichavaram, highlighting the dynamic nature of this region. Notable erosion sites include Kodiakkadu and Akkarapettai, while accretion is observed at Samiyapettai.

Lastly, the northern sector, covering districts like Puducherry, Villupuram, and Chennai, experiences erosion along 21 kilometres, with 37 kilometres accreting, and 141 kilometres remaining stable. Severe erosion near Karungali underscores the imperative for robust coastal management strategies.

In conclusion, the Shoreline Change Atlas provides invaluable insights into the evolving coastal dynamics of Tamil Nadu and the Union Territory of Puducherry. These findings emphasize the urgency of implementing sustainable coastal management practices to mitigate erosion, foster accretion, and safeguard coastal ecosystems and communities against future environmental challenges.

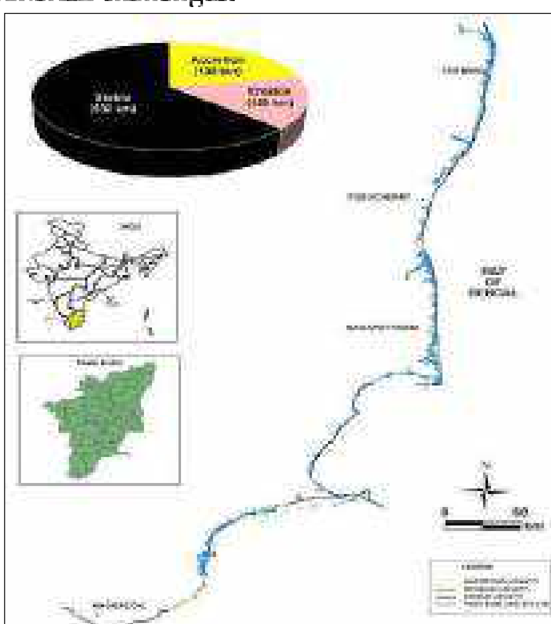

Figure 1. Shoreline Changes in Tamil Nadu & U. T. of Puducherry (SAC ISRO, 2021)

The Shoreline Change Atlas of the Indian Coast (2021), published by ISRO, sheds light on the dynamic shoreline alterations along the coast of the Andaman and Nicobar Islands, particularly post the December 2004 earthquake and tsunami. Encompassing a total coastline of 2156.8 kilometres, the analysis divides the region into three sectors: North and Middle Andaman, South Andaman, and Nicobar districts, revealing distinct patterns of erosion and accretion across these areas.

In the North and Middle Andaman districts, a notable accretion of 73 kilometres is observed, primarily attributed to land uplift triggered by the 2004 earthquake. This uplift facilitated the emergence of submerged reefs, fostering terrestrial vegetation growth and pushing the shoreline seaward. Notable accretions are documented along Kishorinagar, Interview Island, and Barren Island.

Conversely, the South Andaman District experiences a mixed scenario of erosion and accretion, with 79 kilometres eroding and 72 kilometres accreting. Coastal erosion is particularly prominent along Rutland Island and Ross Island, while certain stretches, like Taramugli Island, witness accretion.

The Nicobar Islands, being severely impacted by the 2004 tsunami, exhibit significant erosion along 123 kilometres of coastline, with 112 kilometres undergoing accretion. Areas such as Malacca, Campbell Bay, and Trinkat Island display notable shoreline deterioration, with slow recovery evident. The detailed mapping provides a nuanced understanding of erosion and accretion dynamics at specific locations within the islands.

Overall, the analysis underscores the intricate and dynamic nature of coastal processes in the Andaman and Nicobar Islands, heavily influenced by geological events like earthquakes and tsunamis. It emphasizes the necessity for continuous monitoring and effective management strategies to mitigate the repercussions of shoreline changes on coastal communities and ecosystems.

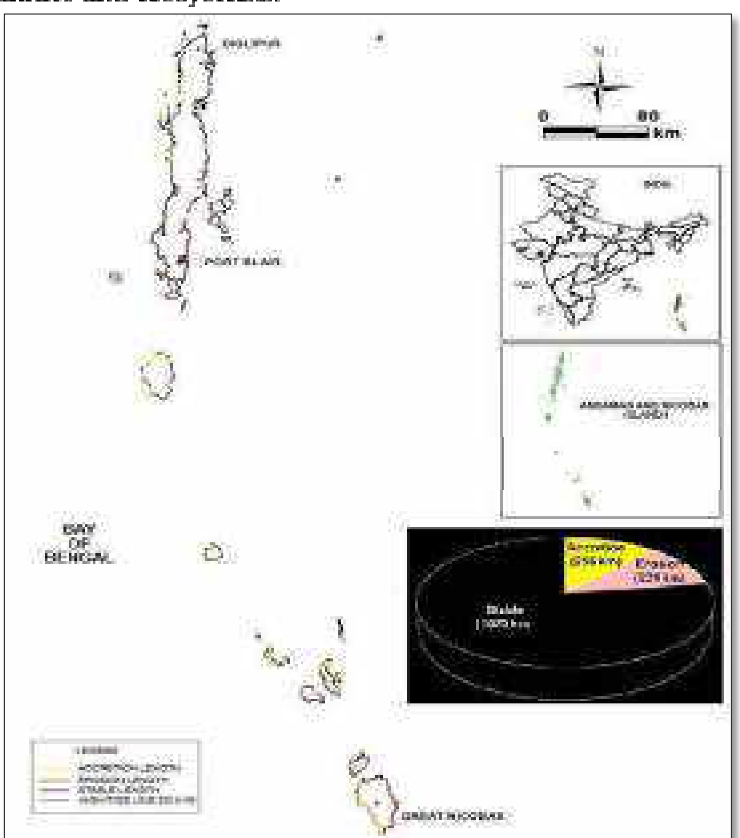

Figure 2. Shoreline Changes in Andaman & Nicobar Islands (SAC ISRO, 2021)

Another formidable challenge in the coastal regions of Tamil Nadu, Puducherry, and the Andaman & Nicobar Islands is the salinity ingress, posing multifaceted risks to sustainable development. The extensive extraction of groundwater for various purposes amidst rapid urbanization and industrialization exacerbates salinity intrusion in Tamil Nadu. Notably, areas like Minjur and Cuddalore bear witness to seawater encroachment, while districts such as Ramanathapuram and Tuticorin grapple with in-situ salinity issues. In Puducherry, groundwater salinity emerges as a pressing concern, driven by extensive agricultural, industrial, and domestic usage, leading to overexploitation. The intrusion of seawater along the coast, penetrating up to 4 km inland in certain areas, highlights the severity of the issue.

The Andaman & Nicobar Islands confront salinity ingress primarily due to sea water intrusion, compounded by factors like groundwater overexploitation, tidal influence, and seasonal recharge variability. Capillary rise of saline water and subsurface groundwater discharge further exacerbate the situation, underscoring the complex interplay of natural and anthropogenic factors. Urgent attention is warranted to address these challenges effectively.

State and Union Territory governments have instituted various measures to combat salinity ingress. In Puducherry, initiatives like beach nourishment, restoration, and the construction of check dams serve as critical interventions. However, concerted efforts are needed, including the identification of vulnerable areas, mapping of coastal regions for salinity, and conducting comprehensive studies to evaluate the efficacy of past interventions. Collaboration between local and central governments, along with support from relevant institutions, is imperative to mitigate salinity ingress and safeguard the ecological integrity and socio-economic well-being of these coastal regions.

2.1 Agencies and Key Role in Coastal Issues

The Department of Water Resources, River Development & Ganga Rejuvenation, under the Ministry of Jal Shakti, is instrumental in addressing coastal challenges in Tamil Nadu and U.T. of Puducherry. Central Water Commission (CWC), mandated with managing sea erosion, actively spearheads initiatives to mitigate coastal erosion and salinity intrusion. The implementation of the Coastal Management Information System (CMIS) by CWC serves as a pivotal platform for collecting, processing, and analysing near shore data vital for coastal protection measures. This comprehensive system enables scientific planning and design of site-specific coastal protection structures, enhancing the region's resilience against coastal hazards. Also, the Government of Tamil Nadu has demonstrated a proactive approach towards coastal protection and salinity ingress management in the state. Through the efforts of institutions like the Institute of Hydraulics and Hydrology (IHH) within the Water Resources Department (WRD), the government has actively engaged in understanding and addressing coastal challenges. Moreover, the government has recognized the seasonal variations in monsoons, which influence wave heights and tidal ranges along the coast. To combat erosion and accretion, Tamil Nadu has implemented a mix of soft and hard measures, including beach nourishment, vegetation, and the construction of coastal protection structures like groynes and reinforced concrete walls. The ongoing TN-SHORE project underscores the commitment to restoring coastal resources and bolstering defences against erosion. Additionally, the government's collaboration with the Central Water Commission (CWC) and advocacy for a standardized SOP on coastal data collection reflect proactive steps towards effective coastal management.

The Government of Puducherry has made significant strides in coastal protection and salinity ingress management within the Union Territory. The coastline of the U. T. of

Puducherry is spanning approximately 42.88 km along the Bay of Bengal and Arabian Sea. With nearly half of the coast impacted by erosion, identified hotspots like Pillaichavady and Auroville beach underscore the urgency of action. Recognizing the threats posed by high salinity and sodium hazards due to seawater intrusion, the government has implemented coastal management plans aimed at mitigating erosion and salinity issues. Ongoing projects focusing on beach restoration, sand nourishment, and the construction of check dams demonstrate a proactive approach towards safeguarding coastal resources. Additionally, robust monitoring systems are in place to track erosion rates and water quality, with post-evaluation mechanisms guiding future actions. Looking ahead, the government emphasizes continued collaboration with national and state authorities to prevent further erosion and effectively address coastal challenges, ensuring the sustainability and resilience of Puducherry's coastal areas.

The Department of Ocean Engineering, IIT Madras, has significantly contributed to coastal protection and salinity ingress management in Tamil Nadu and the Union Territory of Puducherry. Their studies underscored the multifaceted challenges posed by coastal hazards and human alterations, emphasizing the need for adaptive strategies and interdisciplinary approaches to ensure coastal resilience. Moreover, their collaboration in initiatives like the Global Water and Climate Adaptation Centre - ABCD-Centre demonstrates a commitment to tackling global climate change challenges, with a specific focus on water security and climate adaptation in coastal regions. The establishment of a proposed "National Centre for Coastal Water and Climate Adaptation & Mitigation" through IIT Madras further underscores their dedication to knowledge transfer, capacity building, and community engagement, aiming to educate and empower future leaders in water and environmental management.

The National Institute of Ocean Technology (NIOT) has played a crucial role in coastal protection and salinity ingress management in Tamil Nadu and the Union Territory of Puducherry. Through a wide array of coastal engineering projects, NIOT has addressed various challenges while promoting sustainable coastal development. Their systematic approach, encompassing thorough reconnaissance, meticulous data collection, and advanced numerical model studies, has resulted in the implementation of effective solutions to mitigate erosion, enhance biodiversity, and promote ecological sustainability. Initiatives such as beach restoration projects along the Poothura coast in Kerala and the sustainable opening of river mouths like the Adyar River in Chennai demonstrate NIOT's commitment to preserving coastal ecosystems and infrastructure resilience. Additionally, their collaboration with stakeholders like the Tamil Nadu Public Works Department ensures the successful implementation of these projects, further highlighting NIOT's significant contribution to coastal management in the region. Furthermore, NIOT's development of innovative tools and databases, along with their provision of technical assistance during statutory clearances and construction phases, underscores their comprehensive approach towards coastal protection and management.

The National Centre for Coastal Research (NCCR), under the Ministry of Earth Sciences, has made substantial contributions to coastal protection and salinity ingress management in Tamil Nadu and the Union Territory of Puducherry. Through its comprehensive research programs and initiatives, NCCR has addressed critical coastal hazards such as erosion and floods. Notable achievements include the development of the Chennai Flood warning system and Marine Spatial planning, which involve extensive data collection and the creation of Geo-Databases. NCCR's research on Coastal Erosion Scenarios along the coasts of Tamil Nadu, Puducherry, Kerala, and Andhra Pradesh has provided valuable insights into shoreline dynamics and vulnerability assessments. Furthermore, the organization's efforts in preparing Shoreline Management Plans (SMP) for various coastal regions, including Tamil Nadu and forthcoming ones for Kerala, underscore its commitment to tailored coastal management strategies. By delving into the impacts of sea level rise and implementing innovative solutions like the Probabilistic Coastal Recession Model and natural solutions in Kerala, NCCR demonstrates a proactive approach towards addressing coastal challenges through data-driven strategies and innovative solutions.

Also, the Central Ground Water Board (CGWB) has played a pivotal role in addressing the concerning issue of groundwater depletion in Tamil Nadu and the Union Territory of Puducherry. Through its proactive initiatives and technical interventions, CGWB has focused on promoting sustainable water management practices to ensure water security in the region. By highlighting the significant decline in groundwater levels and emphasizing the urgent need for conservation measures, CGWB has underscored the gravity of the situation and the necessity for immediate action. The board's emphasis on community involvement and raising awareness among the local population about the consequences of groundwater depletion reflects a holistic approach to tackling the issue. Furthermore, CGWB's proposed technical interventions, such as rainwater harvesting, artificial recharge structures, and water-efficient irrigation techniques, aim to replenish groundwater resources and mitigate the adverse effects of depletion. Additionally, CCWB has advocated for policy support and regulatory measures to manage groundwater effectively, calling for stricter regulations on extraction and the implementation of policies promoting sustainable water use practices. By collaborating with government agencies, civil society organizations, and stakeholders, CGWB seeks to address the complex challenges associated with groundwater management, contributing significantly to safeguarding water resources for future generations in the coastal regions of Tamil Nadu and Puducherry.

3. Coastal/ Shoreline Management Plan

The shoreline represents the interface between land and water, characterized by its dynamic and intricate nature shaped by natural phenomena, human interventions, and climatic conditions. Serving as a vital boundary, shorelines are pivotal for maintaining the ecological equilibrium of coastal ecosystems and hold significant importance from both environmental and socio-economic perspectives. A Shoreline Management Plan (SMP) offers a comprehensive framework for strategically managing coastal regions. By delineating the characteristics of shorelines, assessing risks such as erosion and flooding, and considering human activities, an SMP paves the way for sustainable coastal management. Through this approach, the aim is to achieve a harmonious balance between preserving natural coastal processes and meeting the needs of coastal communities and industries.

The National Centre for Coastal Research (NCCR) has made significant strides in coastal management by completing the Shoreline Management Plans (SMPs) for Tamil Nadu and Andhra Pradesh, with ongoing preparations for Kerala and Puducherry. Backed by comprehensive resources such as the Shoreline Change Atlas covering the entire Indian coast till 2018 and site-specific atlases, including Coastal Structures and Geomorphological Atlases, NCCR ensures a detailed understanding of coastal dynamics. Additionally, the Digital Web Application, National Shoreline Assessment System (N-SAS), facilitates real-time assessment with digital maps, reports, and infographics. Coastal Management Plans (CMPs) play a pivotal role by identifying current resources, anticipating future changes, and providing the foundation for sustainable management strategies. Through detailed scientific studies under the Coastal Management Information System (CMIS), NCCR aims to devise dynamic CMPs, acknowledging the evolving nature of coastal environments, thus ensuring effective and adaptive management practices over time.

A Coastal Management Plan is indispensable for ensuring the sustainable management of coastal areas. It serves multiple crucial purposes, including the identification of present resources and assets along the shoreline while anticipating future changes. By providing a comprehensive framework, Coastal Management Plans lay the groundwork for implementing sustainable management strategies tailored to the unique needs of coastal regions. Detailed scientific studies conducted under the Coastal Management Information System (CMIS) enable the development of dynamic CMPs, which evolve in response to changing environmental conditions and human activities. Recognizing the dynamic nature of coastal ecosystems, Shoreline/Coastal Management Plans require periodic updates to remain relevant and effective in safeguarding coastal resources and promoting resilience in the face of evolving challenges.

4. Coastal Protection & Development Advisory Committee (CPDAC)

Recognizing the pressing need for comprehensive coastal planning and cost-effective solutions to combat coastal erosion, the Government of India established the Beach Erosion Board (BEB) in 1966, initially focusing on anti-sea erosion efforts in Kerala under the guidance of the Chairman of the Central Water Commission (CWC, formerly CW&PC). Subsequently, in 1971 and again in 1989, the BEB was reconstituted, extending its jurisdiction to cover the entire coastline of the country. As development surged in protected coastal zones and population pressures intensified in densely populated coastal areas, the BEB underwent further restructuring and was renamed the "Coastal Protection and Development Advisory Committee" (CPDAC) in April 1995. This committee, with its secretariat housed within the CWC, is a high-level inter-ministerial body comprising coastal engineering experts and representatives from Coastal States and relevant Central Departments. Its primary mandate is to identify and harness the diverse resource potential available within protected coastal areas for sustainable development. One of the main functions of CPDAC is "to organise a co-ordinated programme of collection, compilation, evaluation and publication of data relating to various natural phenomena in coastal processes, which affect the coastline, through Coastal Engineering Research Centre and other State organisations"

Following the decision made during the 6th Meeting of the Coastal Protection and Development Advisory Committee (CPDAC), a sub-committee was established to evaluate the performance of coastal protection works. Initially constituted on June 3, 2004, as per CWC Letter No. 4(5)/2004-CED/354, this committee underwent reconstitution on November 19, 2019, per CWC O.M No. T-23079/1/2019-CM DTE/762-68. The reconstituted committee comprised various members including representatives from CWC, CWPRS, NIO, SAC, NCCR, concerned State/UT, and the Director of the Beach Erosion Directorate, CWC, Kochi, serving as the Member-Secretary. Over the years, the sub-committee conducted eight meetings across different coastal states/UTs, namely Kochi (Kerala), Mangalore, Goa, Kavaratti (Lakshadweep), Chennai, Surat (Gujarat), Mangalore (Karnataka) and Ratnagiri (Maharashtra) to assess the effectiveness of coastal protection measures and strategies.

5. Role of Central Institutions

Various central institutions play a crucial role in coastal protection and salinity ingress management across Tamil Nadu, the Union Territory of Puducherry, and the Andaman & Nicobar Islands. The Department of Water Resources, River Development & Ganga Rejuvenation, along with the Central Water Commission (CWC), actively spearhead initiatives to mitigate coastal erosion and salinity intrusion in Tamil Nadu, U. T. of Puducherry and other coastal areas. Through the Coastal Management Information System (CMIS), CWC facilitates data collection and analysis vital for scientific planning and designing of site-specific coastal protection structures, enhancing resilience against coastal hazards. Similarly, the Department of Ocean Engineering at IIT Madras significantly contributes to coastal protection and salinity ingress management in Tamil Nadu and Puducherry through interdisciplinary approaches and collaborations with institutions like the Global Water and Climate Adaptation Centre - ABCD-Centre, aiming to address climate change challenges with a focus on water security.

Additionally, the National Institute of Ocean Technology (NIOT) and the National Centre for Coastal Research (NCCR) play crucial roles in coastal protection and management through comprehensive research programs and initiatives. NIOT's systematic approach to coastal engineering projects, including beach restoration and river mouth management, promotes sustainable coastal development while enhancing biodiversity and infrastructure resilience. Similarly, NCCR's research on coastal hazards and shoreline dynamics, coupled with the development of Shoreline Management Plans (SMP), underscores a proactive approach towards addressing challenges associated with erosion and floods. Furthermore, the Central Ground Water Board (CGWB) focuses on promoting sustainable water management practices to ensure water security amidst groundwater depletion in the region, highlighting the importance of community involvement and policy support in safeguarding water resources for future generations.

6. Measures

6.1 CMIS(Coastal Management Information System)

To comprehensively address the impacts of both natural phenomena and human activities in coastal areas, a multidisciplinary approach is essential, recognizing the interconnectedness of various processes within the coastal system. In line with this objective, the establishment of the Coastal Management Information System (CMIS) was included as a component in the 12th Five Year Plan (2012-17), under the Plan Scheme of "Development of Water Resource Information System (DWRIS)" by the Government of India. CMIS aims to gather data essential for effective shoreline management, providing insights crucial for oceanographers and engineers. The Ministry of Jal Shakti, Department of Water Resources, Ganga Rejuvenation, and River Development approved the establishment of CMIS under the DWRIS scheme. The implementation of CMIS follows a three-tier model involving the Central Water Commission (CWC) as the Project Implementer, an Expert Agency as the Project Executor, and the concerned Maritime State Government as the Project Facilitator. IIT Madras was selected as the Project Executor for CMIS, with tri-partite MoUs signed between CWC, IIT Madras, and the respective State Governments of Tamil Nadu, Kerala, and Puducherry. The project entails the collection of various coastal data, including wave patterns, tide levels, bathymetry, river currents, and meteorological parameters. While the CMIS project with IIT Madras as the Project Executor concluded in May 2021, CWC initiated data collection at CMIS sites since June 2021, focusing on parameters such as beach profiles, shoreline changes, wind patterns, tidal variations, and sediment analysis both onshore and offshore.

6.2 CMIS Parameters for Data Collection

CMIS Parameters to be collected and its frequency is provided in Table below:

Table 1: CMIS Parameters and Frequency of observation

Sl No	Parameters Collected	Frequency
1	Shoreline Monitoring (High Tide Line, Low Tide Line)	Monthly
2	Beach profile	Monthly
3	Wind velocity, direction, Rain fall, Temperature & Relative humidity	Continuous
4	Wave	Hourly Data for 120 days
5	Tidal data	Continuous
6	Bathymetry a) Offshore b) Near Shore	Once in Pre-Monsoon & Post-Monsoon
7	Offshore Current	Hourly Data for 120 days
8	River Current & CTD	Monthly
9	Sediment samples a) onshore Sediment b) Suspended c)Seabed Sediment	a) Monthly b) & c) Once in Pre-Monsoon, Monsoon & Post Monsoon

6.3 CMIS sites under C&SRO, CWC

Three vulnerable coastal sites were identified by officials from IITM, CWC, and the respective state governments for the implementation of CMIS by the CWC. The CMIS sites in Tamil Nadu, Kerala, and the Union Territory of Puducherry are listed below. Currently, these three CMIS sites are under the purview of the Beach Erosion Directorate, Kochi, under C&SRO, CWC, where data collection is ongoing.

a. Ponnani, Kerala.
b. Karaikal, U.T. of Puducherry.
c. Devaneri, Tamil Nadu.

Table 1. List of Parameters and Frequency of data collection at CMIS sites

Sl No	Parameters Collected	Instruments	Ponnani, Kerala	Karaikal, U.T. of Puducherry	Devaneri, Tamil Nadu	Frequency
1	Shoreline Monitoring (High Tide Line, Low Tide Line)	RTK GPS / Total Station (TS)	✓	✓	✓	Monthly
2	Beach profile	RTK GPS / Total Station (TS)	✓	✓	✓	Monthly
3	Wind velocity, direction, Rain fall, Temperature & Relative humidity	Automatic Weather Station (AWS)	✕	✕	✕	Continuous
4	Wave	Directional Wave recorder (DWR)	✕	✕	✕	Hourly Data for 120 days
5	Tidal data	Tide Gauge	✓	✓	✕	Continuous
6	Bathymetry a) Offshore b) Near Shore	Single Beam Echo Sounder (SBES)	✕	✕	✕	Once in Pre-Monsoon & Post-Monsoon
7	Offshore Current	(Acoustic Doppler Current Profiler) ADCP	✓	✓	✕	Hourly Data for 120 days
8	River Current & CTD	Current Meter & CTD probe	✓ ✓	✕ ✓	N. A N. A	Monthly
9	Sediment samples	Grab Sampler, Niskin Water	(a) ✓	(a) ✓	(a) ✓	a) Monthly

	a) onshore b)Suspended Sediment c)Seabed Sediment	Sampler, Sieve Shaker/Sampler	(b) ✓ (c) ✓	(b) ✕ (c) ✕	(b) ✕ (c) ✕	b) & c) Once in Pre-Monsoon, Monsoon & Post Monsoon

6.4 Status of Coastal Erosion and Salinity Ingress in the state of Tamil Nadu

With a total length of over 338 km affected by erosion, Tamil Nadu has been proactive in implementing coastal protection measures to safeguard vulnerable areas. These measures include the construction of groynes, rubble mound sea walls, and the rehabilitation of existing structures to mitigate the adverse effects of erosion on coastal infrastructure and communities.

In addition to completed projects, Tamil Nadu has several ongoing coastal protection initiatives, reflecting the state's commitment to addressing the persistent threat of erosion. These projects, with a projected cost of over Rs 1,000 crore, involve the construction of additional groynes, sea walls, and river mouth training works. The government's proactive approach to coastal protection is evident in its identification of new initiatives, including the use of innovative techniques such as hybrid models of living shorelines and advanced training walls, to further strengthen the resilience of the state's coastline against the impacts of sea erosion and climate change.

Kanyakumari district, with a coastline of over 69 km, has been particularly affected by sea erosion, with 17.35 km of coastline impacted. Extensive coastal protection measures have been undertaken in this region, including the construction of rubble mound sea walls, groynes, and the rehabilitation of existing structures. These measures have yielded positive outcomes, resulting in a significant reduction in the extent of sea erosion and the protection of valuable coastal infrastructure and communities.

Thoothukudi district has also witnessed significant coastal protection efforts, including the construction of groynes, sea walls, and training walls to prevent erosion and regulate the flow of water at river mouths. These measures have been effective in protecting vulnerable areas along the coastline, such as Periyathalai and Veerapandiapattinam. Regular monitoring and evaluation ensure the effectiveness of these measures and enable necessary adjustments to be made as required.

Similarly, Nagapattinam district has seen extensive construction of rubble mound sea walls and river mouth training works to protect its coastline from erosion. Ongoing and proposed projects aim to further strengthen the resilience of the district's coastline against future erosion events. The collaborative approach between various government agencies and local authorities has been crucial for the successful implementation of coastal protection projects, reflecting the state's commitment to safeguarding its coastal regions for future generations.

The extent of sea erosion/salinity ingress problem in the State, district-wise, the details of the various coastal protection work executed in the last 10 years in affected areas/districts of the state of Tamil Nadu and the details of the Ongoing/Proposed Protection Works proposed during next 5 years in the state of Kerala are furnished in the **Annexure-IV, V & VI** respectively.

7. Brief on Quarterly Dialogue

As per the directions of Chairman, CWC the 1st Quarterly Dialogue in FY 2024-25 was organised by C&SRO, CWC, Coimbatore on the subject **"Coastal Area Management"**, on 25.04.2024 at IIT, Madras, Chennai. The officials of CWC, CGWB, Water Resource Department of Tamil Nadu, U.T Of Puducherry and A & N Islands and various stakeholders (Academia, Central / State Govt. agencies, Research Institutes etc.) concerned with coastal area management have participated in the meeting.

The meeting took place in hybrid mode at the Conference Hall of IIT Madras, Ocean Engineering Department, Chennai on 25th April 2024 from 10.00 AM onwards. The list of participants, the photographs and presentations taken during the meeting are given in the **Annexure I, II & III** respectively.

Shri, R, Thangamani, Director (Monitoring), CWC, Chennai delivered the welcome address and gave brief account and background about the quarterly dialogues between CWC & CGWB with States / U.T's

Sh. T.K. Sivarajan, Chief Engineer, CSRO, CWC extended a warm welcome to all participants, both those present physically and joining virtually. He briefed the participants on the Chairman CWC's initiative to conduct Quarterly Dialogues, aiming to increase interaction between Central and State Departments for coordinated development of water resources, benefiting various stakeholders. He also informed that, as a result of the Quarterly Dialogues held in the previous year (2023-24), many important issues could be discussed and actions taken for resolving them. It also resulted in mutual exchange of ideas and effective co-ordination with the States and UTs.

He highlighted the background of initiative in selecting the subject matter for discussion by Chairman, CWC on "**Coastal Area Management**. He emphasized that the discussions and outcomes should serve as a practical roadmap for addressing major issues in coastal management and would help framing appropriate schemes for implementation.

He highlighted the initiation of **Costal Management Information System (CMIS)** by Government of India, DoWR, RD &GR to collect coastal data and create integrated data bank. He expressed that this meeting will assess the scope for improvement under CMIS and address problems related to salinity ingress.

Sh. M. Sivakumar, Director, Central Ground Water Board (CGWB), extended a warm welcome. He emphasized the importance of sensitization on ground water depletion based on routine monitoring practices. He mentioned about the CGWB activities of preparation of aquifer maps for entire State of Tamil Nadu, including coastal areas, focusing on aquifer health and water quality assessments. He also stated about the establishment of climate response monitoring stations to identify vulnerable areas to monitor groundwater and water quality along the Tamil Nadu coast. He sought collaboration from various departments for these initiatives. He suggested focusing surveillance in sensitive areas (over exploited, urban exploitation, coastal ingress, industrial parks etc.,) and concentrating efforts in these areas. He stressed the importance of addressing overexploited areas at the block and panchayat levels, emphasizing convergence of policy making and effective ground-level policy implementation by state agencies.

Thereafter, presentations were made by various Departments according to the scheduled programme.

Central Water Commission

A PowerPoint presentation on Coastal Management/Salinity Ingress was made by Mr. Ashish Kumar Ranjan, Deputy Director, Coastal Management Directorate , CWC, New Delhi. During the presentation, Mr. Ranjan elaborated on the coastal features of Tamil Nadu, Puducherry & Andaman & Nicobar Islands. He shared the details about coastline length re-assessed by the Coastal Protection and Development Advisory Committee (CPDAC) in association with the National Hydrographic Office (NHO), Dehradun. Specific attention was drawn to the revised coastal lengths of Tamil Nadu, Puducherry, and the Andaman & Nicobar Islands, underscoring the diverse ecosystems and environmental significance of these regions. He further mentioned about the objectives of the CMIS program in general and its implementation in the maritime states. Out of the total eight coastal sites established under CMIS in India, 2 no's are operational, one each in Tamilnadu (Devaneri) and Puducherry (Karaikal)

He further informed that Coastal Protection Schemes are eligible for central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR, with CWC as the appraising agency for schemes proposed for central external funding. He also briefed about the '*Guidelines for preparation of DPR for Coastal Management Projects under Climate Change Scenario*' published by CWC in the year 2020 to standardize the DPR preparation for funding. Regarding salinity ingress, he emphasized the need for action by the respective State Governments, with discussions held on the way forward to address this issue. He mentioned that the '*Guidelines for preparation of DPRs related to Salinity Ingress Management Projects in Coastal Areas*' are under finalization.

Government of Tamilnadu

Sh. Jaya Shanmugam, Director, Institute of Hydraulics and Hydrology (IHH), WRD, and Sh. Sai Sharan, Assistant Engineer, Water Resources Department made presentation on behalf of Government of Tamilnadu. The highlights of the presentation are as follows:

- The Tamil Nadu coastline stretches approximately 1,076 kilometers across 14 no's of districts, including Chennai.
- Noteworthy river mouths requiring attention include Pulicat-Arani, Ennore-Kosasthalayar, Cooum, Adayar, Vellar, Vellaiyar, Punnakayal-Tamiraparani, and Thengapattinam-Tamiraparani.
- Features of Tamilnadu coast, highlighting two monsoons annually: SW (June to September) and NE (October to December), with varying wave heights and tidal ranges.
- Coastal areas have witnessed both erosion and accretion over time, prompting the implementation of protective measures. These include soft measures such as beach nourishment and vegetation, alongside hard measures like coastal protection structures such as groynes, which trap sediment and dissipate wave energy.
- Ongoing coastal protection works involve the construction of groynes, reinforced concrete walls, and river training works.
- The TN-SHORE project aims to restore coastal resources and shield against erosion.
- TN WRD under IHH is collecting costal data for 36 sites along the east and west coast of Tamilnadu.

During the discussion, the representatives from Govt. of Tamilnadu requested CWC to create a SOP on coastal data collection, for which it was responded that under CPDAC, the SOP had already been framed and would be shared.

They also requested the Ministry of Jal Shakti/CWC to explore the possibility of funding for the upgradation of existing coastal data collection sites of Tamilnadu.

Further, the issues related to Mean Sea Level (MSL) and Chart Datum (CD) in the implementation of coastal projects/structures was discussed in detail along with the impact of Chennai Port Trust on accretion & erosion of Chennai coastline, coastal restoration mission using hybrid models and knowledge transfer from the institutions to government departments.

Government of Puduecherry

Dr. M. Dhinadhayalan, Chief Engineer, Public Works Department (PWD) and their team of officials participated in the discussion. Sh. R.Radhakrishnan, Executive Engineer, PWD made presentation on behalf of Government of Puducherry. The presentation covered pointwise replies for the brief agenda points that was circulated for the meeting. The highlights of the presentation are as follows:

- Geography and Coastline: Puducherry Union Territory comprises four regions with a coastline spanning approximately 42.88 km along the Bay of Bengal and Arabian Sea. Erosion impacts 48% of the coast, affecting livelihoods and property, with identified hotspots including Pillaichavady, Auroville beach, and Pondi Marina beach.

- Salinity Ingress and Natural Hazards: Puducherry faces natural hazards such as floods, cyclones, and earthquakes. High salinity and sodium hazard due to seawater intrusion affect groundwater quality. Coastal management plans aim to mitigate erosion and salinity issues.

- Ongoing Measures: Projects focus on beach restoration, sand nourishment, and the construction of check dams. Monitoring systems are in place to track coastal erosion and water quality, with post-evaluation of projects guiding future actions.

- Future Agenda: The agenda includes continued monitoring of erosion rates, shoreline changes, and efforts to protect coastal infrastructure. Collaboration with national and state authorities is prioritized to prevent further erosion and address coastal challenges effectively.

Department of Ocean Engineering, IIT Madras

Prof. S. A. Sannasiraj, Department of Ocean Engineering, Indian Institute of Technology Madras made a presentation on Coastal Area Management. The presentation highlighted the areas of coastal hazards, human alterations, and challenges in coastal management, emphasizing the need for adaptive strategies and interdisciplinary approaches to ensure coastal resilience. It also discusses predictions for erosion rates, groundwater status, and the roles of academia and community involvement in dynamic coastal management. Summary of the presentation is as below:

- Coastal Hazards: Rapid-onset hazards such as coastal flooding, storm surge, and tsunamis, alongside slow-onset hazards like coastal erosion, land subsidence, and saltwater intrusion, pose significant challenges.

- Human Alterations on Coastal Areas: Dams impacting sediment flow and artificial structures such as groins and jetties affecting sediment transport underscore the human impact on coastal dynamics.

- Challenges in Coastal Area Management: Urbanization, climate change, and economic inequality exacerbate issues like coastal flooding, accelerated erosion, and sea level rise, emphasizing the importance of monitoring shoreline and beach profiles.

- Data Requirement: Requirement of Primary and secondary data, Shoreline and Beach profile mapping. Shoreline change monitoring including future prediction using remote sensing data. Future Prediction for Kattupalli Region of Chennai, Tamilnadu indicate an erosion rate of 280-320m by 2030, with climate change exacerbating coastal challenges.

- Coastal Protection Strategies: Various materials like rubble stones, geosynthetics, and vegetation are considered, with a focus on availability, functionality, and environmental impact.

- Groundwater Status in Chennai District: Critical groundwater depletion in areas like Vepery contrasts with high groundwater recharge in coastal areas.

- Coastal Resilience: Building adaptive capacity to recover from hazards requires interdisciplinary approaches and community involvement.

- Roles and Responsibilities: Academia, research, and community participation play crucial roles alongside engineering projects in dynamic coastal management.

Further, Prof. S. A. Sannasiraj highlighted about the "Global Water and Climate Adaptation Centre" – ABCD-Centre (Aachen, Bangkok, Chennai, Dresden). The ABCD-Centre, a collaborative effort between RWTH Aachen University, Asian Institute of Technology Bangkok, Indian Institute of Technology Madras, UNU-FLORES, and Technische Universität Dresden, aims to tackle global climate change challenges, emphasizing water security and climate adaptation. Their mission aligns with achieving SDG-6, ensuring water availability and sanitation for all, through academic exchange and innovative cooperation for lasting societal impact.

He elaborated on the new Joint Master's Program on "Water Security and Global Change" started by IITM in this academic year 2024-25 and invited officers from CWC to join the program. He also further mentioned about the various knowledge transfer program conducted by ABCD- Centre.

Finally, Prof. S. A. Sannasiraj urged CWC to create "National Centre for Coastal Water and Climate Adaptation & Mitigation" as a National Hub for Coastal waters through IIT Madras and regional offices of CWC. The center can aims to educate responsible future water and environmental leaders facilitating transfer the knowledge through science and society such as Capacity Building, summer & winter school, Transfer and training Workshop, seminars, symposium, Conference, Community awareness and policy recommendation.

National Institute of Ocean Technology (NIOT)

Ms D. Shymala Varthini, Scientist F presented with brief introduction on NIOT. She highlighted about the wide array of coastal engineering projects handled by NIOT addressing various challenges and promoting sustainable coastal development. These projects encompass a systematic approach that involves thorough reconnaissance, meticulous data collection, in-depth analysis, and the utilization of advanced numerical model studies. She also highlighted about the NIOT's expertise on detailed engineering design and analysis of coastal, port, and harbor structures, showcasing a commitment to ensuring the resilience and functionality of critical coastal infrastructure.

The presentation covered, restoration and management of coastal areas, including beach restoration projects along the Poothura coast in Kerala and the sustainable opening of river mouths like the Adyar River in Chennai. She elaborated that these initiatives involve a combination of scientific studies, numerical modeling, and field execution to implement effective solutions that mitigate erosion, enhance biodiversity, and promote ecological sustainability. The presentation also highlighted about collaboration with various stakeholders, such as the Tamil Nadu Public Works Department, to ensure the successful implementation of these projects.

Furthermore, she discussed about the efforts extend to the development of innovative tools and databases to support engineering design for coastal infrastructure. These tools include a mobile app for predicting tides, a wave atlas covering specific regions, and a Decision Support Tool for evaluating shoreline responses to environmental loadings.

In addition to project-specific interventions, she said about providing technical assistance during the statutory clearances process and construction phases of coastal projects. This includes conducting field measurements, alignment verification, construction reviews, and monitoring activities to ensure compliance with regulatory requirements and environmental standards.

National Centre for Coastal Research (NCCR)

Dr. M V Ramana Murthy, Director of the National Centre for Coastal Research (NCCR) under the Ministry of Earth Sciences, delivered a presentation on Coastal Area Management. He began by providing an overview of NCCR's major research programs, focusing on coastal hazards such as erosion and floods. Dr. Murthy highlighted initiatives like the Chennai Flood warning system and Marine Spatial planning, which involve extensive data collection and the development of Geo-Databases. He discussed Coastal Erosion Scenarios along the coasts of Tamil Nadu, Puducherry, Kerala, and Andhra Pradesh, referencing reports from 1990 to 2022. Notable achievements included the release of N-SAS West Coast and N-SAS Lakshadweep atlases and the publication of shoreline change atlas for the Indian Coast up to 2018, along with site-specific atlases for Kerala, Tamil Nadu, and Andhra Pradesh until 2022.

Dr. Murthy informed about the ongoing development of a Digital Atlas incorporating shoreline change data from 1990 onwards, updated annually by NCCR. He outlined general coastal management strategies, focusing on the Holding Line strategy in Chellanam Coast, Kerala, and elaborated on the Shoreline Management Plan (SMP) by NCCR & INCOIS. Components of SMP covered various aspects such as Geo Morphology, Coastal River/Inlet, Socio-Economic Conditions, Stakeholder Interaction, among others. He noted the preparation of SMP reports for Tamil Nadu and forthcoming ones for Kerala. Design considerations for coastal protection strategies were discussed, with examples from Chellanam and the restoration of Puducherry beach, emphasizing the importance of site-specific solutions tailored to design water levels.

Dr. Murthy delved into the impacts of sea level rise on shorelines, introducing the Probabilistic Coastal Recession Model and its application for the Indian Coast. Mention was made of the well-designed Chellanam Seawall Construction and plans for implementing natural solutions in Kerala under the World Bank project. The presentation concluded with a reaffirmation of commitment to addressing coastal challenges through data-driven strategies and innovative solutions.

Central Ground Water Board (CGWB)

Sh. M. Sivakumar, Regional Director, South Eastern Coastal Region, Chennai made presentation on behalf of Central Ground Water Board. The highlights of the presentation are as follows:

The presentation focused on the concerning issue of groundwater depletion in the region, highlighting the significant decline in groundwater levels over recent years. It emphasized the urgent need for conservation measures and sustainable water management practices to ensure water security.

Emphasizing community involvement, Mr Sivakumar stressed the importance of raising awareness among the local population about the consequences of groundwater depletion and promoting individual participation in conservation efforts. The role of education and outreach programs in engaging communities in water conservation initiatives were underscored.

He highlighted the technical interventions proposed by CGWB, including rainwater harvesting, artificial recharge structures, and the promotion of water-efficient irrigation techniques to replenish groundwater resources, were covered. These measures aim to mitigate the adverse effects of groundwater depletion and ensure the long-term sustainability of water sources in the region.

Additionally, he emphasized the necessity of policy support and regulatory measures to manage groundwater effectively. He called for stricter regulations on groundwater extraction and the implementation of policies promoting sustainable water use practices. Collaboration among government agencies, civil society organizations, and stakeholders was highlighted as crucial for addressing the complex challenges associated with groundwater management.

In conclusion, the presentation reiterated the gravity of the situation and the need for immediate action to address groundwater depletion. Participants at the meeting committed to supporting and actively contributing to comprehensive solutions aimed at safeguarding water resources for future generations.

Shri.K.V. Prasad, Director, Beach Erosion Directorate, C&SRO, CWC, Kochi delivered vote of thanks and appreciated the sincere efforts taken by all the participating agencies for the detailed and valuable contributions.

8. Conclusion/Summary

1 Requesting proposal to MoJS/CWC(Hqs) to devise new central funding scheme for anti-sea erosion works and modernization/ operation & maintenance of coastal data collection sites owned by State Governments.

2 IITM proposes National Centre for Coastal Water and Climate Adaptation & Mitigation under the CWC as a National Hub for Coastal waters.

3 State/U. Ts requested capacity building and knowledge transfer from various agencies.

4 Exploration of Coastal Data collection through remote sensing was emphasized by IITM and NIOT.

5 The Shoreline Management Plan (SMP) for Tamil Nadu prepared by NCCR has been appreciated for its extensive coverage and quality.

6 Importance of addressing the issue of Salinity Ingress was highlighted by all agencies and appropriate action plan needs to be implemented.

9. Way Ahead

Developing a cohesive approach for coastal protection and management in Tamil Nadu, U.T. of Puducherry, and Andaman & Nicobar Islands requires a systematic and collaborative effort.

1. **Survey & Identification of Vulnerable Areas**: Initiate detailed surveys to identify areas vulnerable to coastal erosion and salinity ingress in Tamil Nadu, U.T. of Puducherry, and Andaman & Nicobar Islands. Utilize remote sensing technologies, field assessments, and community engagement to gather data on shoreline dynamics, erosion hotspots, and salinity intrusion patterns.

2. **Creation of Comprehesive Data Base**: Compile a comprehensive dataset comprising historical erosion data, bathymetric surveys, sediment transport dynamics, coastal land use patterns, demographic information, and climate change projections. Collaborate with relevant agencies, research institutions, and local stakeholders to ensure data availability, quality, and accessibility for informed decision-making.

3. **Comprehensive Action Plan**: Formulate a comprehensive action plan under the leadership of the state governments of Tamil Nadu and U.T. of Puducherry, and the administration of Andaman & Nicobar Islands. The action plan should outline strategies for coastal protection, ecosystem restoration, community resilience building, and policy interventions. Ensure stakeholder participation, including coastal communities, government agencies, NGOs, and academia, to foster ownership and inclusivity.

4. **Studies to be Planned**: Identify priority areas for further studies and research to enhance understanding of coastal processes and vulnerabilities. Plan studies to assess the socio-economic impacts of coastal erosion and salinity ingress, evaluate the effectiveness of existing coastal management measures, and explore innovative adaptation strategies. Foster collaboration between research institutions, government agencies, and local communities to promote knowledge exchange and capacity building.

5. **Preparation of Coastal Management Plan**: Develop a comprehensive coastal management plan integrating various aspects such as hazard mitigation, land use planning, biodiversity conservation, and infrastructure development. Align the management plan with principles of sustainable development, ecosystem-based management, and climate resilience to ensure the long-term sustainability of coastal ecosystems and communities.

6. **Identification of Nodal Agency**: Establish a dedicated nodal agency or coordinating body responsible for overseeing and implementing coastal protection and management activities. Ensure that the agency has the mandate, resources, and expertise to coordinate efforts across different levels of government and sectors. Foster collaboration and partnerships with relevant stakeholders, including central government agencies, state governments, local authorities, community groups, and private sector entities.

7. **Support/Financial Assistance from Central Government and its Institutions**: Advocate for support and assistance from the Central Government and its institutions to strengthen coastal protection & management efforts and Salinity Ingress Management in Tamil Nadu, U.T. of Puducherry, and Andaman & Nicobar

Islands. Seek funding support, technical expertise, and policy guidance from central agencies. Collaborate with central institutions and research organizations to leverage their capabilities and resources for addressing coastal challenges effectively.

8. **GIS Mapping of Erosion Prone & Salinity Affected Areas**: Develop GIS-based maps highlighting erosion-prone and salinity-affected areas in the coastal regions. Integrate spatial data on coastal geomorphology, hydrology, land use, and socio-economic factors to create accurate and informative maps. These maps will serve as vital tools for spatial planning, risk assessment, and decision-making.

By following this structured approach and fostering collaboration between various stakeholders, Tamil Nadu, U.T. of Puducherry, and Andaman & Nicobar Islands can develop resilient coastal management strategies to safeguard their coastal ecosystems and communities against the impacts of erosion and salinity ingress.

List of officers participated of 1st Quarterly Dialogue for the Year 2024-25 Between Central Water Commission (CWC), Central Ground Water Board (CGWB) & Various Central Agencies/Institutions With Governments Of Tamil Nadu, Puducherry & A&N Islands on 25.04.2024

A. Officers attended in the physical mode

Sl. No.	Name, Designation and Organisation of the officer (Shri/Smt/Ms)
Central Water Commission	
1.	Sh. T.K. Sivarajan, Chief Engineer, CSRO, Coimbatore
2.	Sh. R. Thangamani, Director, Monitoring Directorate, Chennai
3.	Sh. K.V Prasad, Director, Beach Erosion Directorate, Kochi
4.	Sh. P. Karthigayan, Deputy Director, Monitoring Directorate, Chennai
5.	Sh Adarsh M S, Deputy Director, Beach Erosion Directorate, Kochi
6.	Sh Ashish Kumar Ranjan, Deputy Director, Coastal Management Dte, CWC, Delhi
7.	Sh. Prakash S, Assistant Director, O/o Chief Engineer, CSRO, Coimbatore
8.	Sh. Ashraf Basha Y, Assistant Director, Monitoring Directorate, Chennai
9.	Sh. Rahul P R, Assistant Director- II, Beach Erosion Directorate, Kochi
10.	Sh. Prabhu M, Assistant Director- II, O/o Chief Engineer, CSRO, Coimbatore
Government of Tamilnadu	
1.	Sh. P Sundararajan, Joint Chief Engineer, DRCS, WRD, Tamilnadu
2.	Sh. A Jayashunmugam, Superintending Engineer, IHH Poondi, WRD, Tamilnadu
3.	Sh. B Arulson Brigesh, Executive Engineer, WRD, Tamilnadu
4.	Sh. S Marimuthu, Executive Engineer, Cauvery Basin Division, WRD, Tamilnadu
5.	V Rajanikanth, Assistant Executive Engineer, WRD, Tamilnadu
6.	V Vijaya Kumar, Assistant Executive Engineer, WRD, Tamilnadu
7.	M Vijaya Lakshmi, Assistant Executive Engineer, O/o CE (DR&CS), WRD, Tamilnadu
8.	K Hepzibah Premshiya, Assistant Geochemist, SG & SWRDC, WRD, Tamilnadu
9.	S Sozharaja, Assistant Engineer, Anti Erosion, WRD, Tamilnadu
10.	Sh P Rajasekaran, Assistant Engineer, WRD, Tamilnadu
11.	C Prabakar, Assistant Engineer, IHH Poondi, WRD, Tamilnadu
12.	S Pradeesh, Assistant Executive Engineer, IHH Poondi, WRD, Tamilnadu
13.	Sai Charan, Assistant Engineer, IHH Poondi, WRD, Tamilnadu
Government of Puducherry	
1.	Sh. R Radhakrishanan, Executive Engineer, PWD, Puducherry
2.	Sh. A. Selvarasu, Assistant Engineer, PWD, Puducherry

National Institute of Ocean Technology (NIOT)	
1.	Dr. A.S.Kiran, Scientist - E, NIOT, Chennai
2.	D Shaymala Varthini, Scientist - E, NIOT, Chennai
National Centre for Coastal Research (NCCR)	
1.	Dr. M.V.Ramana Murthy, Director, NCCR, Chennai
Indian Institute of Technology, Madras	
1.	Dr.S.A. Sannasiraj, Professor, Ocean Engineering Department, IITM, Chennai
2.	S.Vasanthakumar, Ph.D Scholar, Ocean Engineering Department, IITM, Chennai
3.	Danish D.R, Senior Project Scientist, Global water and climate adaptation centre, IITM, Chennai
Central Ground Water Board (CGWB)	
1.	Sh.M.Sivakumar, Director, South Eastern Coastal Region, CGWB, Chennai
2.	D.Dhayamalar, Scientist -E, CGWB, Chennai
3.	Dr.M.Senthil Kumar, Scientist - D, CGWB, Chennai
4.	Athira R, Scientist -C, CGWB, Chennai
5	Dr.K.Pramasivam, Scientist B, CGWB, Chennai

B. Officers attended in the virtual mode through VC

Central Water Commission	
1.	Sh. Deepak Kumar, Director, Costal Management Directorate, New Delhi
2.	Smt. Anju O.R, Assistant Director-II, Beach Erosion Directorate, Kochi
3.	Sh. Ramesh M, Sub Divisional Engineer, Cauvery Delta Sub Division, Karaikal
4.	Sh. Kakasaheb Mestri, Sub Divisional Engineer, Upper Krishna Division, Pune
Government of Puducherry	
1.	Dr.M. Dhinadhayalan, Chief Engineer, PWD, Puducherry
Andaman Public Works Department (APWD)	
1.	Mr Kanak Das, Assistant Engineer, APWD, Port Blair
National Centre for Sustainable Coastal Management (NCSCM)	
1.	Dr. V. Ramanatham,

Annexure-II

Photographs: 1st QD for FY 2024-25 Central Water Commission (CWC) and Central Ground Water Board (CGWB)with State of Tamil Nadu, U. T. of Puducherry & Andaman Nicobar Islands

1. Introduction

India's expansive coastline spanning approximately 7517 kilometres (currently under revision) is a vital natural asset, harbouring diverse ecosystems and supporting millions of livelihoods. Along this coastline, Kerala and Lakshadweep emerge as maritime states of significant ecological and economic importance.

Kerala, nestled along the southwestern tip of India, boasts a coastline stretching from Kasargod to Thiruvananthapuram, approximately 570 kilometres in length. This coastal stretch encompasses a rich tapestry of landscapes, including beaches, cliffs, islands, estuaries, and deltas. The state is endowed with forty-four rivers, predominantly originating from the Western Ghats, contributing to its lush biodiversity and fertile plains. The Kerala Backwaters, an interconnected system of brackish water lakes and estuaries, further enhance the ecological diversity of the region.

Lakshadweep, situated 200 to 470 kilometres off the Kerala coast, comprises a chain of 36 islands characterized by well-developed coral reefs. Among these islands, 10 are inhabited, supporting unique ecosystems and marine life. The geographical significance of Lakshadweep lies in its coral reefs, contributing to the region's ecological resilience and marine biodiversity.

The coastal areas of Kerala and Lakshadweep serve as hubs for diverse economic activities, ranging from fisheries to tourism. Fishing communities rely heavily on the coastal resources for their sustenance, contributing significantly to the state's economy. Additionally, tourism thrives on the picturesque beaches, vibrant marine life, and cultural heritage of these regions, attracting both domestic and international visitors.

Looking ahead, the coastal areas of Kerala and Lakshadweep hold immense potential for sustainable development and conservation. However, they face pressing challenges such as erosion and accretion, threatening the stability of coastal ecosystems and livelihoods. To address these challenges, comprehensive coastal management strategies are imperative.

Key strategies include; Identification of vulnerable coastal areas prone to erosion and accretion, Data collection and analysis to inform evidence-based decision-making, Formulation of Coastal Management Plans tailored to the specific needs of each state, Evaluation of past coastal protection projects to assess efficacy, Mobilization of funding from both state and central governments for future initiatives, Establishment of nodal agencies to oversee and coordinate coastal protection efforts and Strengthening inter-departmental coordination to ensure synergy in coastal management efforts. By adopting these strategies and leveraging their coastal assets sustainably, Kerala and Lakshadweep can safeguard their natural heritage, promote economic growth, and ensure the well-being of coastal communities. These initiatives align with the broader vision of the Government of India for coastal conservation and sustainable development.

2. Overview

The Shoreline Change Atlas of the Indian Coast (2021), published by ISRO, offers valuable insights into the dynamics of Kerala and Lakshadweep's coastlines. Through an analysis of shoreline changes, significant patterns of erosion and accretion along the 585-kilometer stretch of Kerala's coast are revealed. In summary, approximately 137 kilometres of the Kerala coast are experiencing erosion, while 121 kilometres are undergoing accretion, leaving 327 kilometres relatively stable. These transformations have profound implications for the region's environmental and socio-economic aspects.

The Kerala coastline is segmented into three sectors based on district boundaries:

i. Northern Sector: Encompassing Kasaragod, Kannur, and Kozhikode districts, this area experiences both erosion and accretion. Notable changes are observed at river mouths such as the Chittari and Valapattanam rivers. Erosion hotspots include areas north of the Mogral River and Kottikulam.

ii. Central Sector: Covering Malappuram, Thrissur, and Ernakulam districts, this sector witnessed erosion and accretion along the coast. Particularly noteworthy is the coastal stretch between the Bharathapuzha and Periyar rivers, with severe erosion observed in Ponnani and Putiyirutti.

iii. Southern Sector: Encompassing Alappuzha, Kollam, and Thiruvananthapuram districts, this area is experiencing erosion, notably at Panmana, Nirkunnam, and Purakkad. The construction of coastal breakwaters near Kottamkulangara has influenced erosion and accretion dynamics.

Detailed mapsheet-wise analyses further illustrate the spatial distribution of erosion and accretion along the coast, with notable sites including Parappanagadi, Tanur, and Azhikod. Overall, the shoreline change analysis underscores the complex interplay of natural processes, human interventions, and coastal management practices. Understanding these dynamics is critical for sustainable coastal development and the implementation of effective adaptation strategies to mitigate the impacts of erosion and accretion on coastal communities and ecosystems.

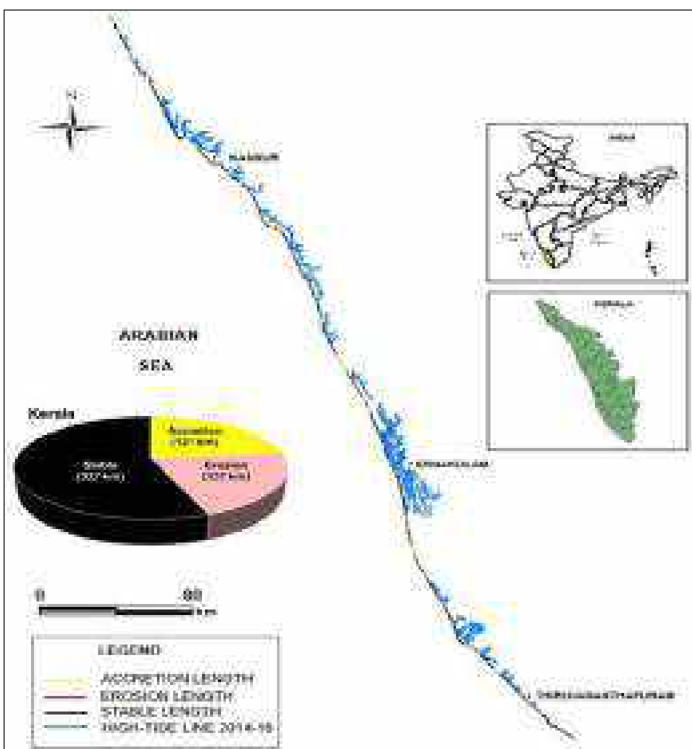

Figure 1. Shoreline Changes in Kerala (SAC ISRO, 2021).

The Lakshadweep Islands, located between 200 to 470 kilometres off the Kerala coast, form a chain of coral atolls renowned for their well-developed coral reefs. Among the 36 islands, only 10 are inhabited, with Minicoy marking the southernmost point, separated by a vast expanse of sea. The islands exhibit relatively flat terrain, with elevations ranging from 3 to 9 meters above sea level. Coral formations predominantly take the shape of atolls, featuring ring-shaped reefs enclosing lagoons, and host a diverse array of coral fauna, comprising over a hundred species.

A shoreline change analysis spanning 141 kilometres of Lakshadweep's coast reveals dynamic coastal processes. Approximately 12 kilometres of the coast are undergoing erosion, while 13 kilometres are experiencing accretion, leaving the remaining 116 kilometres stable. This analysis, depicted in the Shoreline Change Atlas, emphasizes the critical importance of understanding coastal dynamics for sustainable development and management of these delicate ecosystems.

Erosion is widespread across most of the islands, with notable exceptions such as Chetlat, Amini, and Kavaratti. However, the southern coast of Bangaram Island and Cheriyakara Island's erosion, along with shoreline changes at Minicoy, illustrate the localized impacts of coastal processes within the Lakshadweep archipelago. The data further elucidates the spatial distribution of erosion and accretion across various map sheets, providing valuable insights for coastal management strategies.

The loss of 16.6 hectares of land due to erosion contrasts with the 18.4 hectaresgained through accretion, underscoring the dynamic nature of coastal environments in the Lakshadweep Islands. This comprehensive analysis, based on the Shoreline Change Atlas of the Indian Coast, highlights the importance of ongoing monitoring and management efforts to safeguard the ecological integrity and resilience of the Lakshadweep coastline amidst evolving environmental conditions.

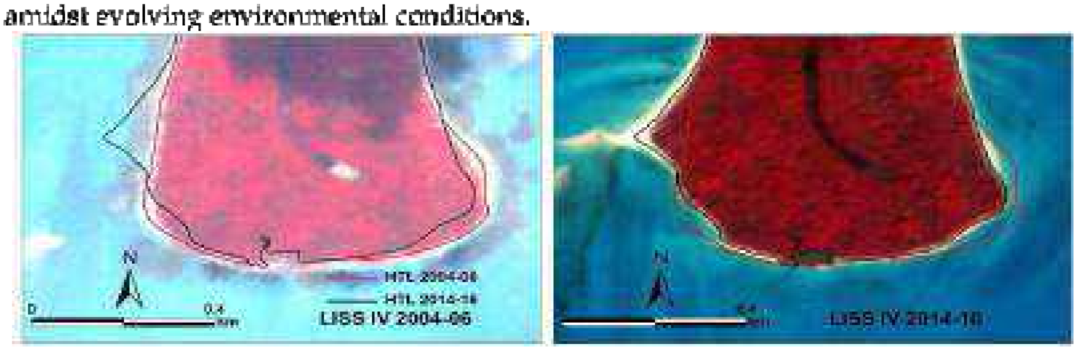

Figure 2. Shoreline Changes in Bangaram Island, Lakshadweep (SAC ISRO, 2021).

Figure 3. Shoreline Changes in Cheriyakara Island, Lakshadweep (SAC ISRO, 2021).

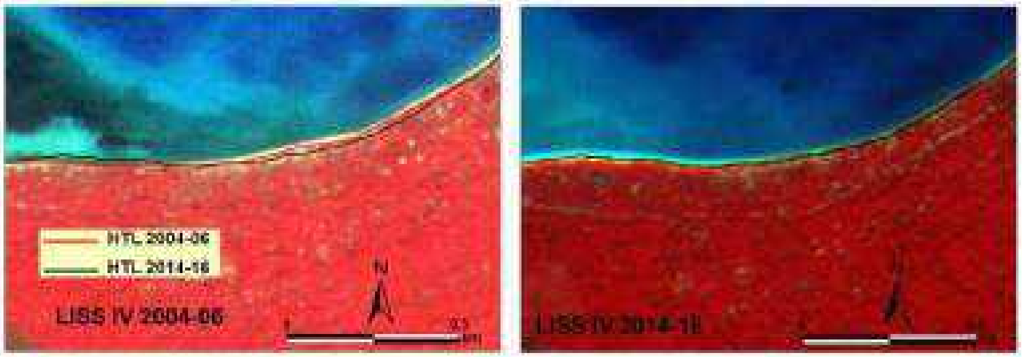

Figure 4. Shoreline Changes in Minicoy Island, Lakshadweep (SAC ISRO, 2021).

Also, Salinity ingress poses a significant threat to the coastal regions of Kerala and the Lakshadweep Islands, as evidenced by various studies and reports. In Kerala, sea water intrusion has been observed in multiple rivers and estuaries, including the Karamana River in Thiruvananthapuram District, Kallada River in Kollam District, and Muvattupuzha River in Kottayam District, among others. The intrusion of sea water into these freshwater systems has been attributed to factors such as sea level rise, tidal variations, and human activities.

Studies conducted by organizations like the Directorate of Environment and Climate Change and the Centre for Water Resources Development and Management (CWRDM) further highlight the severity of salinity intrusion in Kerala. These studies aim to identify the extent of salinity, seasonal variations, and suitable management strategies to mitigate its impact. Additionally, computer models such as FEFLOW, SUTRA, and MODFLOW are utilized to understand and predict the consequences of sea level rise on salinity intrusion.

In Lakshadweep, the low-lying nature of the islands exacerbates the vulnerability to salinity ingress. Sea water intrusion threatens freshwater sources and ecosystems, impacting both human settlements and fragile coral reef ecosystems. The unique geography of the region, characterized by coral atolls and lagoons, heightens the risk of salinity intrusion, necessitating comprehensive monitoring and management efforts.

Overall, salinity ingress poses a multifaceted challenge to the coastal regions of Kerala and Lakshadweep, requiring coordinated action at the local, regional, and national levels to safeguard freshwater resources, biodiversity, and coastal communities.

2.1 Agencies and Key Role in Coastal Issues

The Department of Water Resources, River Development & Ganga Rejuvenation, under the Ministry of Jal Shakti, is instrumental in addressing coastal challenges in Kerala and Lakshadweep. Central Water Commission (CWC), mandated with managing sea erosion, actively spearheads initiatives to mitigate coastal erosion and salinity intrusion. The implementation of the Coastal Management Information System (CMIS) by CWC serves as a pivotal platform for collecting, processing, and analysing near shore data vital for coastal protection measures. This comprehensive system enables scientific planning and design of site-specific coastal protection structures, enhancing the region's resilience against coastal hazards. Additionally, the Irrigation Department of Kerala extends its traditional functions to engage in coastal engineering, exemplified by significant endeavours like the construction of anti-erosion sea works in Chellanam in 2021. Furthermore, the Centre for Water Resources Development and Management (CWRDM), Department of Irrigation, conducts vital studies for identifying and mitigating coastal issues, including salinity intrusion analysis in prominent river basins like Kadalundi, Anjarakkandi, and Pallikkal. These concerted efforts contribute to a better understanding of coastal dynamics and the implementation of effective mitigation strategies in the region.

Moreover, agencies such as the Harbour Engineering Department of Kerala, National Centre for Earth Science Studies (NCESS), and National Institute of Technology Calicut (NIT Calicut) significantly contribute to coastal management through their respective initiatives. The Harbour Engineering Department of Kerala focuses on addressing coastal erosion by adopting eco-friendly concepts like geo-tube protected islands and geo-bag bunds, which have proven effective in safeguarding coastal areas. NCESS plays a crucial role in coastal monitoring through various advanced systems like Such as Video Beach Monitoring, CoastSnap, and CoastSat, enabling precise shoreline monitoring and management. Additionally, NIT Calicut conducts extensive research and projects, including the design of Sand-Based Climate Resilient Solutions for Coastal Protection, contributing to innovative approaches in coastal engineering and mitigation.

Furthermore, the National Centre for Coastal Research (NCCR), National Institute for Ocean Technology (NIOT), and National Institute of Technology Calicut (NIT Calicut) play indispensable roles in coastal management through their distinct contributions. NCCR is pivotal in coastal research, releasing atlases like N-SAS West Coast and N-SAS Lakshadweep, based on comprehensive data collection and analysis. Their ongoing development of a Digital Atlas incorporating shoreline change data, along with their assistance in preparing Shore Management Plans (SMPs) and designing Coastal Structures, significantly enhances coastal resilience and management efforts. Similarly, NIOT conducts essential coastal studies, identifying and proposing suitable solutions for various coastal issues. Their research contributes to the development of innovative strategies and technologies for coastal protection and adaptation. Additionally, NIT Calicut's research and projects, including the design of Sand-Based Climate Resilient Solutions for Coastal Protection, contribute to sustainable coastal development and resilience in the region. Through collaborative efforts, these agencies collectively strive to ensure the sustainable management and protection of Kerala and Lakshadweep's coastal ecosystems and communities.

3. Coastal/ Shoreline Management Plan

The shoreline represents the interface between land and water, characterized by its dynamic and intricate nature shaped by natural phenomena, human interventions, and climatic conditions. Serving as a vital boundary, shorelines are pivotal for maintaining the ecological equilibrium of coastal ecosystems and hold significant importance from both environmental and socio-economic perspectives. A Shoreline Management Plan (SMP) offers a comprehensive framework for strategically managing coastal regions. By delineating the characteristics of shorelines, assessing risks such as erosion and flooding, and considering human activities, an SMP paves the way for sustainable coastal management. Through this approach, the aim is to achieve a harmonious balance between preserving natural coastal processes and meeting the needs of coastal communities and industries.

The National Centre for Coastal Research (NCCR) has made significant strides in coastal management by completing the Shoreline Management Plans (SMPs) for Tamil Nadu and

Andhra Pradesh, with ongoing preparations for Kerala and Puducherry. Backed by comprehensive resources such as the Shoreline Change Atlas covering the entire Indian coast till 2018 and site-specific atlases, including Coastal Structures and Geomorphological Atlases, NCCR ensures a detailed understanding of coastal dynamics. Additionally, the Digital Web Application, National Shoreline Assessment System (N-SAS), facilitates real-time assessment with digital maps, reports, and infographics. Coastal Management Plans (CMPs) play a pivotal role by identifying current resources, anticipating future changes, and providing the foundation for sustainable management strategies. Through detailed scientific studies under the Coastal Management Information System (CMIS), NCCR aims to devise dynamic CMPs, acknowledging the evolving nature of coastal environments, thus ensuring effective and adaptive management practices over time.

A Coastal Management Plan is indispensable for ensuring the sustainable management of coastal areas. It serves multiple crucial purposes, including the identification of present resources and assets along the shoreline while anticipating future changes. By providing a comprehensive framework, Coastal Management Plans lay the groundwork for implementing sustainable management strategies tailored to the unique needs of coastal regions. Detailed scientific studies conducted under the Coastal Management Information System (CMIS) enable the development of dynamic CMPs, which evolve in response to changing environmental conditions and human activities. Recognizing the dynamic nature of coastal ecosystems, Shoreline/Coastal Management Plans require periodic updates to remain relevant and effective in safeguarding coastal resources and promoting resilience in the face of evolving challenges.

4. Coastal Protection& Development Advisory Committee (CPDAC)

Recognizing the pressing need for comprehensive coastal planning and cost-effective solutions to combat coastal erosion, the Government of India established the Beach Erosion Board (BEB) in 1966, initially focusing on anti-sea erosion efforts in Kerala under the guidance of the Chairman of the Central Water Commission (CWC, formerly CW&PC). Subsequently, in 1971 and again in 1989, the BEB was reconstituted, extending its jurisdiction to cover the entire coastline of the country. As development surged in protected coastal zones and population pressures intensified in densely populated coastal areas, the BEB underwent further restructuring and was renamed the "Coastal Protection and Development Advisory Committee" (CPDAC) in April 1995. This committee, with its secretariat housed within the CWC, is a high-level inter-ministerial body comprising coastal engineering experts and representatives from Coastal States and relevant Central Departments. Its primary mandate is to identify and harness the diverse resource potential available within protected coastal areas for sustainable development. One of the main functions of CPDAC is "to organise a co-ordinated programme of collection, compilation, evaluation and publication of data relating to various natural phenomena in coastal processes, which affect the coastline, through Coastal Engineering Research Centre and other State organisations".

Following the decision made during the 6th Meeting of the Coastal Protection and Development Advisory Committee (CPDAC), a sub-committee was established to evaluate the performance of coastal protection works. Initially constituted on June 3, 2004, as per CWC Letter No. 4(5)/2004-CED/354, this committee underwent reconstitution on November 19, 2019, per CWC O.M No. T-23079/1/2019-CM DTE/762-68. The reconstituted committee comprised various members including representatives from CWC, CWPRS, NIO, SAC, NCCR, concerned State/UT, and the Director of the Beach

Erosion Directorate, CWC, Kochi, serving as the Member-Secretary. Over the years, the sub-committee conducted eight meetings across different coastal states/UTs, namely Kochi (Kerala), Mangalore, Goa, Kavaratti (Lakshadweep), Chennai, Surat (Gujarat), Mangalore (Karnataka) and Ratnagiri (Maharashtra) to assess the effectiveness of coastal protection measures and strategies.

5. Role of various Central Institutions

Various central institutions such as the National Centre for Coastal Research (NCCR), National Institute for Ocean Technology (NIOT), and National Institute of Technology Calicut (NIT Calicut) play pivotal roles in coastal management, particularly in the states of Kerala and Lakshadweep. NCCR, with its comprehensive research and data analysis capabilities, releases vital atlases like N-SAS West Coast and N-SAS Lakshadweep, providing invaluable insights into coastal dynamics. Their ongoing development of a Digital Atlas and assistance in crafting Shore Management Plans (SMPs) and Coastal Structures significantly bolster coastal resilience efforts. Similarly, NIOT conducts essential coastal studies, proposing innovative solutions for various coastal challenges, thereby contributing to coastal protection and adaptation strategies. Additionally, NIT Calicut's research, including the design of Sand-Based Climate Resilient Solutions for Coastal Protection, enhances sustainable coastal development and resilience. Through collaborative endeavours, these institutions collectively advance the sustainable management and safeguarding of Kerala and Lakshadweep's coastal ecosystems and communities, ensuring their long-term viability and resilience in the face of dynamic environmental pressures.

6. Measures

6.1 CMIS (Costal Management Information System)

To comprehensively address the impacts of both natural phenomena and human activities in coastal areas, a multidisciplinary approach is essential, recognizing the interconnectedness of various processes within the coastal system. In line with this objective, the establishment of the Coastal Management Information System (CMIS) was included as a component in the 12th Five Year Plan (2012-17), under the Plan Scheme of "Development of Water Resource Information System (DWRIS)" by the Government of India. CMIS aims to gather data essential for effective shoreline management, providing insights crucial for oceanographers and engineers. The Ministry of Jal Shakti, Department of Water Resources, Ganga Rejuvenation, and River Development approved the establishment of CMIS under the DWRIS scheme. The implementation of CMIS follows a three-tier model involving the Central Water Commission (CWC) as the Project Implementer, an Expert Agency as the Project Executor, and the concerned Maritime State Government as the Project Facilitator. IIT Madras was selected as the Project Executor for CMIS, with tri-partite MoUs signed between CWC, IIT Madras, and the respective State Governments of Tamil Nadu, Kerala, and Puducherry. The project entails the collection of various coastal data, including wave patterns, tide levels, bathymetry, river currents, and meteorological parameters. While the CMIS project with IIT Madras as the Project Executor concluded in May 2021, CWC initiated data collection at CMIS sites since June 2021, focusing on parameters such as beach profiles, shoreline changes, wind patterns, tidal variations, and sediment analysis both onshore and offshore.

6.2 CMIS Parameters for Data Collection

CMIS Parameters to be collected and its frequency is provided in Table below:

Table 1: CMIS Parameters and Frequency of observation

Sl No	Parameters Collected	Frequency
1	Shoreline Monitoring (High Tide Line, Low Tide Line)	Monthly
2	Beach profile	Monthly
3	Wind velocity, direction, Rain fall, Temperature & Relative humidity	Continuous
4	Wave	Hourly Data for 120 days
5	Tidal data	Continuous
6	Bathymetry a) Offshore b) Near Shore	Once in Pre-Monsoon & Post-Monsoon
7	Offshore Current	Hourly Data for 120 days
8	River Current & CTD	Monthly
9	Sediment samples a) onshore b) Suspended Sediment c)Seabed Sediment	a) Monthly b) & c) Once in Pre-Monsoon, Monsoon & Post Monsoon

6.3 CMIS Sites under C&SRO, CWC

Three vulnerable coastal sites were identified by officials from IITM, CWC, and the respective state governments for the implementation of CMIS by the CWC. The CMIS sites in Tamil Nadu, Kerala, and the Union Territory of Puducherry are listed below. Currently, these three CMIS sites are under the purview of the Beach Erosion Directorate, Kochi, under C&SRO, CWC, where data collection is ongoing.

a. Ponnani, Kerala.
b. Karaikal, U.T. of Puducherry.
c. Devaneri, Tamil Nadu.

Table 1. List of Parameters and Frequency of data collection at CMIS sites

Sl No	Parameters Collected	Instruments	Ponnani, Kerala	Karaikal, U.T. of Puducherry	Devaneri, Tamil Nadu	Frequency
1	Shoreline Monitoring (High Tide Line, Low Tide Line)	RTK GPS / Total Station (TS)	✓	✓	✓	Monthly
2	Beach profile	RTK GPS / Total Station (TS)	✓	✓	✓	Monthly
3	Wind velocity, direction, Rain fall, Temperature & Relative humidity	Automatic Weather Station (AWS)	×	×	×	Continuous
4	Wave	Directional Wave recorder (DWR)	×	×	×	Hourly Data for 120 days
5	Tidal data	Tide Gauge	✓	✓	×	Continuous
6	Bathymetry a) Offshore b) Near Shore	Single Beam Echo Sounder (SBES)	×	×	×	Once in Pre-Monsoon & Post-Monsoon
7	Offshore Current	(Acoustic Doppler Current Profiler) ADCP	✓	✓	×	Hourly Data for 120 days
8	River Current & CTD	Current Meter & CTD probe	✓	×	N. A	Monthly
			✓	✓	N. A	

9	Sediment samples	Grab Sampler, Niskin Water Sampler, Sieve Shaker/Sampler	(a) ✓ (b) ✓ (c) ✓	(a) ✓ (b) ✕ (c) ✕	(a) ✓ (b) ✕ (c) ✕	a) Monthly
	a) onshore b)Suspended Sediment c)Seabed Sediment					b) & c) Once in Pre-Monsoon, Monsoon & Post Monsoon

6.4 Status of Coastal Erosion and Salinity Ingress in the state of Kerala

Coastal erosion and salinity ingress are significant environmental challenges facing several districts in the State. In Thiruvananthapuram, significant erosion is observed in Varkala, Chirayinkeezhu, and other areas, with a total of 25 kilometres of coastline affected out of 72.15 kilometres. In Kollam, Alappad Village bears the brunt with 11 Kilometres affected out of 45.588 Kilometres. Alappuzha and Ernakulam districts also face notable erosion, with 10.912 Kilometres and 26.254 Kilometres affected respectively. Thrissur and Malappuram districts witness erosion along 21.928 Kilometres and 35.698 Kilometres of coastline respectively. Kozhikode and Kannur districts also report erosion, albeit to a lesser extent.

Salinity ingress, though less prevalent, is a concern particularly in certain areas. Notably, Pathalam Regulator cum Bridge with Lock, Purappillikaavu Regulator cum Bridge with Lock, and Anti-salinity bund at Kanakkankadavu contribute to controlling salinity ingress. However, Hosdurg, Koyippadi, Perward, and other areas report salinity ingress, with a total of 19.17 Kilometres affected.

Coastal erosion and salinity ingress pose significant threats to the ecological balance and livelihoods of communities along the coast. Efforts must be intensified to address these challenges through sustainable coastal management practices, including the implementation of erosion control measures and salinity regulation infrastructure. Collaboration between government bodies, local communities, and environmental organizations is essential to mitigate the adverse effects and ensure the long-term resilience of coastal regions.

The Government of Kerala has embarked on an extensive endeavour to safeguard its coastal regions through a variety of erosion control measures. In Trivandrum District, a range of initiatives including sea walls, geo bags, groynes, and gabion sea walls have been implemented to mitigate erosion threats. Similarly, in Kollam District, the focus has been on gabbion box structures, rubble, and sea wall reformation, while Alleppey District has seen significant efforts in constructing sea walls using granite stone and geo bags. Notably, in Ernakulam District, the completion of a substantial 6.64 Km Tetrapod Sea wall in Chellanam panchayat stands out as a major accomplishment facilitated by the Project Management Unit (PMU). Thrissur, Malappuram, Kozhikode, Kannur, and Kasargod Districts have also witnessed targeted interventions tailored to their specific erosion challenges, showcasing the government's commitment to holistic coastal protection.

Furthermore, the Government of Kerala has recognized the pressing need to combat salinity ingress, particularly in Malappuram and Ernakulam Districts. These regions have seen focused efforts aimed at preventing the intrusion of saline water into freshwater sources, vital for sustaining agricultural activities and ensuring environmental balance. By prioritizing salinity ingress prevention alongside erosion control measures, the government demonstrates a comprehensive approach to safeguarding Kerala's coastal communities, ecosystems, and economic activities, all funded through state resources.

The extent of sea erosion/salinity ingress problem in the State, district-wise, the details of the various coastal protection work executed in the last 10 years in affected areas/districts of the state of Kerala and the details of the Ongoing/Proposed Protection Works proposed during next 5 years in the state of Kerala are furnished in the **Annexure-IV, V & VI** respectively.

7. Brief on Quarterly Dialogue

As per the directions of Chairman, CWC the 1st Quarterly Dialogue in FY2024-25 was organised by C&SRO, CWC, Coimbatore on the subject "**Coastal Area Management**", on 29.04.2024 at Kerala. The officers of CWC, CGWB, Water Resource Department of Government of Kerala, U.T Of Lakshadweep and all other stakeholders (Academia, Central /State Govt Depts., institutes etc.) working in the field of coastal area management participated in the meeting.

The meeting took place in hybrid mode at the Conference Hall of Hycinth Hotels, Trivandrum on 29th April 2024 from 10.00 AM onwards. The programme schedule and list of participants, the photographs and the presentations taken during the meeting are given in the **Annexure I, II and III** respectively.

The session began with a prayer song, lighting of the lamp and inaugural function of the Quarterly Dialogue.

Shri. Priyesh.R, Chief Engineer, IDRB, delivered the welcome address, providing a brief account of the quarterly dialogues conducted by CWC & CGWB with State of Kerala & U.T of Lakshadweep. In his speech, Shri. Priyesh.R underscored the broadened focus of the Irrigation department, extending beyond its traditional function as a nodal office. He touched upon the department's involvement in harbour engineering, particularly citing the construction of anti-erosion sea works in Chellanam in 2021 as a significant endeavour. He also highlighted the importance of understanding the dynamics of the sea and the unique challenges in coastal area management. He expressed the department's readiness to collaborate with other agencies, acknowledging the multifaceted nature of the tasks related to coastal management. He concluded his speech by extending invitations to all dignitaries to contribute to the ongoing efforts in Coastal Area Management.

Sh. Sivadasan, Chief Engineer, I&A, Government of Kerala, presented the keynote address. He acknowledged the beneficial outcomes of the quarterly dialogues held in the past year, resulting in the submission of four proposals under the RRR & SMI schemes to SLCC for approval, with subsequent submission to CWC for Central Assistance. He provided a detailed overview of Kerala's coastal line spanning nine districts, and highlighted prevalent coastal hazards, notably significant erosion impacting 40% of the shoreline due to anthropogenic causes, with 53km identified as highly vulnerable. He emphasized that the Irrigation Department has been entrusted with coastal protection responsibilities, actively engaging in protective measures utilizing scientific solutions through physical and numerical studies. He underscored the department's collaboration with NCCR through an MOU and the initial identification of 10 hotspots. Stressing the importance of partnerships with national and international organizations for climate-resilient strategies, he commended the dedicated efforts of the teams at KERI and IDRB in leading coastal protection initiatives, with specific focus on the construction of special structures. Urging urgent action to safeguard the coastal lines' beauty and significance, Sh. Sivadasan extended best wishes for success in these endeavours.

Shri. Ashok Kumar Singh, IAS, Principal Secretary, Water Resources Department, Government of Kerala, extended a cordial welcome to all attendees, highlighting the forum's significance as a gathering of all stakeholders involved in coastal management. He emphasized the rarity of such an opportunity for stakeholders to both listen and express themselves, envisioning the meeting as the formulation of a comprehensive vision document. Mr. Singh stressed the daunting nature of coastal management, noting its substantial cost and the importance of prioritizing sustainable solutions over short-term fixes. He pointed out the recent initiation of a World Bank project and urged institutions to step forward for the preparation and appraisal of DPRs, providing necessary technical expertise and support for the design, management, and construction processes. Mr. Singh concluded by reiterating his warm welcome to all participants.

Smt. D. Dharmalashri, IAS, Director, Ground Water Department, GoK reiterated the importance of the ongoing dialogue, emphasizing the need to address coastal management issues comprehensively. She echoed the sentiment that we stand at a crucial juncture, where proactive measures must be taken to rectify past mistakes and ensure the sustainability of our coastal regions. She encouraged active participation from all stakeholders, underscoring the value of their insights in shaping a robust vision for coastal management in Kerala. Smt. Dharmalashri expressed confidence that by working together and leveraging the collective wisdom, we can develop effective strategies to conserve our coastal resources for future generations.

Shri D.P. Mathuria, Chief Engineer, Planning and Development Organisation, CWC, New Delhi in his address informed that the Quarterly Dialogue (QD) is a highly significant initiative by Chairman, CWC, and it characterized as an exclusive subject-oriented dialogue with the states. CWC's endeavour has been to engage all coastal and maritime states in discussions surrounding the formulation of a comprehensive coastal management plan, addressing concerns such as erosion-prone areas, accretion regions and stable zones. The objective is to gather sufficient data and information. He informed that each state operates through various central and state agencies, resulting in fragmented data collection and knowledge. To address this issue, there is a pressing need to collate and consolidate data, transforming it into actionable insights. CWCs vision includes establishing a country-wide status paper and implementing a handholding mechanism for states, providing both financial and technical support. Initiatives such as CPDAC and CMIS play a pivotal role, with data serving as the backbone of these efforts. He also highlighted the current status of CMIS and stressed the importance of data-driven decision-making in advancing the coastal management strategies.

Shri.T.K. Sivarajan, Chief Engineer, Cauvery & Southern Rivers Organsiation, CWC provided a comprehensive overview of the discussions held during the previous quarterly dialogues. He highlighted the successful conduct of four quarterly dialogues in the previous financial year, emphasizing its role in addressing various issues in water resources. These dialogues also facilitated collaboration between various departments, resulting in the preparation of DPRs for RRR / SMI projects in Kerala. He outlined the Chairman, CWC's directive to focus on coastal management and salinity ingress issues, underscoring the importance of today's dialogue in addressing these challenges. He reiterated the need for clear, actionable outcomes and emphasized the significance of coastal protection schemes which are presently funded under the FMBAP scheme. He also emphasized the critical nature of coastal erosion and salinity issues, urging proactive measures to mitigate their impact on our coastal regions. He concluded by expressing gratitude for the participants' contributions and encouraged everyone to engage in productive discussions.

Dr.M.V.Ramanamoorthy, Director, National Centre for Coastal Research (NCCR) expressed gratitude to the Central Water Commission, the Irrigation Department of the Government of Kerala, and other esteemed dignitaries for their participation and contributions. Reflecting on previous dialogue with the state of Tamilnadu, he emphasized the importance of addressing Kerala's specific planning needs, particularly focusing on water level problems and coastal erosion. Dr. Ramanamoorthy highlighted the significance of monitoring in understanding coastal erosion, noting the advancements in satellite technology as a valuable tool in this regard. He underscored the establishment of observatories along the Indian coastline as a collaborative effort to gather essential data and reduce duplication of resources. Stressing the need for unity among institutions, he emphasized the workshop's role in fostering collaboration towards common goals. Dr. Ramanamoorthy urged immediate action and funding coordination for mitigation measures, especially in hotspot erosion sites. He commended the Principal Secretary, Government of Kerala for his efforts in building capacity within Kerala's construction sector. Regarding the Chellanam case, he emphasized the need for innovative approaches and adaptation to climate change challenges. Dr. Ramanamoorthy concluded by expressing gratitude to all stakeholders and reaffirming NCCR's commitment to contributing to coastal resource management efforts.

Smt. Bindu.J. Viju, Chemist, Central Ground Water Board, expressed her gratitude to the organizers for convening such a vital discussion on coastal area management. She emphasized the urgent need to address the challenges posed by climate change, particularly in vulnerable coastal regions like Kerala. With a coastline spanning around 600 kilometers and a dense population, effective management of these areas is paramount. Smt. Viju highlighted the dual concerns of coastal erosion and sea water ingress, noting the subtle yet significant indicators observed, such as rising water levels in wells. She stressed the importance of vigilant monitoring and proactive measures to safeguard coastal regions in the face of climate-induced sea level rise and uncertain aquifer recharge patterns. Commending the organizers for providing a platform for collaboration and knowledge sharing, Smt. Viju looked forward to productive exchanges and the formulation of actionable strategies to address these pressing challenges.

The Inaugural session ended with Vote of thanks by Shri. Sunil Raj D, Superintending Engineer, Irrigation Department, Government of Kerala.

Thereafter, presentations were made by various departments / agencies according to the scheduled programme.

7.1 Central Water Commission (CWC)

A PowerPoint presentation on Coastal Management/Salinity Ingress was made by Shri.T.K.Sivarajan, Chief Engineer, Cauvery & Southern Rivers Organsiation, CWC , Coimbatore. During the presentation, Sh. Sivarajan elaborated on the coastal features of Kerala and Lakshadweep. He shared the details about the coastline length re verified by the Coastal Protection and Development Advisory Committee (CPDAC) in association with the National Hydrographic Office (NHO), Dehradun. He further mentioned about the objectives of the CMIS program in general and its implementation in the maritime states. Out of the total eight coastal sites established under CMIS in India, one is operational in Kerala (Ponnani).

He further informed that Coastal Protection Schemes are eligible for central assistance under Flood Management & Border Area Program (FMBAP) of DoWR, RD & GR, with CWC as the appraising agency for schemes proposed for central funding. He also briefed about the 'Guidelines for preparation of DPR for Coastal Management Projects under Climate Change Scenario published by CWC in the year 2020 to standardize project proposal preparation for funding. Regarding salinity ingress, he emphasized the need for action by the respective State Governments, with discussions held on the way forward to address this issue. He mentioned that the 'Guidelines for preparation of DPRs related to Salinity Ingress Management Projects in Coastal Areas' are under finalization.

7.2 Coastal Engineering Field Studies Division (CEFS), KERI

Ms. Beena, Joint Director,CEFS, Thrissur, made a presentation titled "Role of Irrigation Department in Coastal Protection.' She provided an overview of the current coastal scenario in Kerala, highlighting aspects such as coastal population density, terrain characteristics, and the coastal districts of the state. Ms. Beena elaborated on the involvement of the Irrigation Department in the construction and maintenance of coastal protection infrastructure, as well as its role in coastal data collection. She, outlined a range of activities undertaken by the Irrigation Department in coastal protection such as periodic measurement of shoreline changes, assessments of coastal damage, setting up of electronic self-leveling staff gauges, maintaining coastal survey stones, analyzing beach samples for grain size, and studying profile changes before and after the monsoon season. Additionally, she highlighted initiatives like beach profiling at Kollam Beach and planting mangroves at Puthenkadappuram and Thiruvatra Beach. She mentioned collaborations with organizations like NCCR for designing solutions, identifying critical hotspots, and assisting in shoreline management plans. Moreover, she touched upon external funding sources from entities like the World Bank and ADB, as well as the establishment of a Mission Directorate under the Secretary of WRD for managing external funding projects.

7.3 Superintending Engineer, Field Studies Circle, IDRB

Ms. Sudha MS, SE & Principal Investigator, made a purpose-driven study titled 'SEA WATER INTRUSION IN COAST OF KERALA STATE," funded by the National Hydrology Project. The study focused on three river basins: Anjarakkandi, Kadalundi, and Pallikal. Objectives included identifying salinity extent, seasonal variation in intrusion, locating barriers, studying circulation phenomena, developing predictive models, and analyzing freshwater requirements for managing saltwater intrusion. The presentation detailed the location of data collection, parameters collected, data analysis methods, and hydro-meteorological analysis of the Kadalundi basin. It also covered water quality and salinity analysis, along with validation using MIKE HYDRO River software.

The presentation revealed that the analysis divulges significant variations in tidal range and salinity intrusion across different river basins in Kerala. Tidal range increases from the southern to the northern coastal areas, with notable differences in maximum heights recorded at various estuaries. Mean salinity tends to occur around 0.6-0.7 meters below the surface, with observations indicating well-mixed conditions during lean flow seasons and a tendency for two-layer flow during heavy flow seasons.

It was informed that salinity intrusion extends differently across the studied river basins, with Pallikkal River experiencing intrusion up to 18-21 km during sampling periods. In Kadalundy River basin, distinct variations were noted, particularly in 2021 due to summer showers, leading to salinity intrusion of 14-16 km. Similarly, in Anjarakandy River basin, salinity intrusion varied from 21-24 km, with the highest extent recorded in 2019. Modified Ketchum's method was utilized to estimate flushing times, with Pallikkal River basin having a flushing time of 18-32 days in the non-monsoon season, Kadalundy River basin with a maximum flushing time of 35 days, and Anjarakandy River basin with a range of 8-14 days. These findings provide valuable insights for understanding and managing saltwater intrusion in Kerala's river systems.

7.4 Harbour Engineering Department (HED)

Mr. Mohamed Ansari, Chief Engineer of the Harbour Engineering Department (HED), presented an overview of HED's role in sustainable Coastal Zone Management in Kerala. The presentation commenced with HED's philosophy, mission, and vision, highlighting its dedication to coastal management. He emphasized Notable aspects of HED which included the use of advanced tools like mathematical modelling and collaborations with esteemed organizations. HED's specialization in designing coastal structures and its contributions to coastal conservation through initiatives like the Shoreline Management Plan were highlighted. Additionally, the department's efforts in addressing coastal erosion and its adoption of eco-friendly concepts, such as geo-tube protected islands and geo-bag bunds, were underscored. The unique characteristics of Kerala's coast, along with analogies and contradictions, were briefly touched upon, providing context to HED's coastal management strategies.

7.5 National Centre for Earth Science Studies (NCESS)

Dr. L. Sheela Nair, Scientist G & Head of the Marine Geoscience Group at NCESS, presented on "Coastal Monitoring for Indian Coast." The presentation highlighted various coastal monitoring systems utilized by NCESS for shoreline monitoring in India. These include the such as Video Beach Monitoring System, CoastSnap - a smartphone-based application for citizen science programs, and CoastSat - a system for mapping shorelines using available satellite imagery. Dr. Nair briefly explained each system's functionality and its significance in coastal monitoring efforts.

Additionally, the presentation addressed coastal management problems in India, including coastal flooding, increasing trends in coastal erosion, and the presence of rip currents. These challenges underscored the importance of effective coastal monitoring and management strategies to mitigate risks and protect coastal communities and ecosystems.

7.6 National Institute of Technology (NIT), Calicut

During the meeting, Dr. Santosh G Thampi, Senior Professor, NIT Calicut delivered a comprehensive presentation on the coastal environment of Kerala, highlighting the institution's pivotal role in understanding and mitigating coastal challenges. He discussed the diverse physiographic zones of Kerala and emphasized the various protection works implemented along the coast. Additionally, Dr. Thampi delved into observations regarding coastal erosion and accretion, emphasizing the significance of sustainable management practices. He also addressed the implications of climate change, particularly sea-level rise, and its potential impacts on coastal ecosystems. Dr. Thampi underscored the need for site-specific strategies and innovative engineering solutions to adapt to climate change and effectively protect coastal areas. Furthermore, an overview of the work undertaken by NIT Calicut, including studies and projects, was provided, culminating in a discussion on the design of Sand-Based Climate Resilient Solutions for Coastal Protection.

7.7 Directorate of Environment and Climate Change (DOECC)

Shri. P. Kalaiarasan, Environmental Engineer Department of Environment, Government of Kerala, made a presentation on "Conservation of Kerala Coastal Ecosystem". He provided insights into the topography of Kerala, including its profile and climate change scenarios, emphasizing the significance of understanding the Indian coast and its coastal districts. Shri. Kalaiarasan discussed primary sediment cells, sub-sediment cells, and shoreline profiles of Kerala, while also addressing salinity limits in coastal districts. Proposed activities for conservation included measures for Coastal and Marine Bio-resource conservation, Coastal Pollution Abatement, and infrastructure upgrades. Additionally, he emphasized ensuring the livelihood security of coastal communities and the importance of capacity building and implementing Integrated Coastal Zone Management Plans (ICZMP). The presentation concluded with an overview of schemes, projects, policies, and legislations aimed at conserving the Kerala Coastal Ecosystem.

7.8 Centre for Water Resources Development and Management (CWRDM)

Dr. C.P. Priju, Senior Scientist, Hydrology and Climatology Research Group, CWRDM, Kozhikode presented on Coastal Hydrology of Kerala and Lakshadweep.

He provided a comprehensive presentation on the physiographical processes and hydrogeology of Kerala. The presentation included schematic cross-sections of Kerala's landscape, depicting the geological sequence and aquifer geometry in both coastal marine and island environments. He explained on the interaction between groundwater and seawater intrusion, highlighting maps of river basins, drainage patterns, rainfall distribution, geology, geomorphology, geological cross-sections etc.. He emphasized the significance of major aquifers, including the alluvium and laterite aquifer systems, and discussed groundwater quality across the region.

Furthermore, Dr. C.P. Priju provided insights into the wetlands of Kerala, particularly coastal wetlands, and their classification according to Ramsar guidelines. The presentation delineated the coastal and geomorphological characteristics of wetlands in Kerala, shedding light on their ecological importance and conservation status. Through detailed maps and classifications, he underscored the need for integrated management approaches to safeguard Kerala's diverse wetland ecosystems.

Overall, the presentation offered a holistic understanding of Kerala's physiographical processes, hydrogeological features, and the ecological significance of its wetlands.

His presentation on Lakshadweep Islands, focused on various aspects of its geography and ecological features. He delved into the details of the islands, including submerged sandbanks, coral reefs, and the intricate wetland ecosystem. He provided comprehensive maps depicting the distribution of wetlands across the islands, along with estimates of their respective areas. He explained on the geomorphology of the diverse islands in Lakshadweep. He presented pre-monsoon and post-monsoon wetland maps, illustrating the seasonal variations in wetland distribution and extent. The presentation concluded by addressing the water quality of dug wells in the region.

7.9 National Centre for Coastal Research (NCCR)

Dr. M V Ramana Murthy, Director, NCCR, Ministry of Earth Sciences, presented online on Coastal Area Management. He commenced with an overview of Coastal Erosion Scenarios along the coasts of Tamil Nadu, Puducherry, Kerala, and Andhra Pradesh, referring SAC reports spanning 1990-2022. Key highlights included the release of N-SAS West Coast and N-SAS Lakshadweep atlases based on collected data. He informed about the publication of shoreline change addresses for the Indian Coast up to 2018 and site-specific atlases for Kerala, Tamil Nadu, and Andhra Pradesh until 2022.

He mentioned about the ongoing development of a Digital Atlas incorporating shoreline change data from 1990 onwards, updated annually by NCCR. He also outlined general coastal management strategies, spotlighting the Holding Line strategy in Chellanam Coast, Kerala and elaborated on the Shoreline Management Plan (SMP) by NCCR & INCOIS. Components of SMP encompassed various aspects such as Geo Morphology, Coastal River/Inlet, Socio-Economic Conditions, Stakeholder Interaction, among others were also noted. He noted the preparation of SMP reports for Tamil Nadu and forthcoming ones for Kerala. Design considerations for coastal protection strategies were discussed with examples from Chellanam, Varkala, Shangumugham, Kollemcode and Vypin, emphasizing the importance of site-specific solutions tailored to design water levels.

Dr. Murthy explained the impacts of sea level rise on shorelines, introducing the Probabilistic Coastal Recession Model and its application for the Indian Coast. He described about the well-designed Chellanam Seawall Construction and plans for implementing natural solutions in Kerala under the World Bank project. The presentation concluded with a reaffirmation of commitment to addressing coastal challenges through data-driven strategies and innovative solutions.

7.10 National Institute for Ocean Technology (NIOT)

Dr. Kiran A S, Scientist E, NIOT, Ministry of Earth Sciences presented online on Coastal Area Management. He provided an overview of NIOT's activities and expertise in coastal engineering, emphasizing their approach to coastal engineering projects.

Key projects discussed included Coastal Protection Studies for Poonthura Coast, Thiruvananthapuram, where severe erosion prompted NIOT to propose a geo-textile-based solution after conducting field data collection and numerical modelling with Mike 21 software. A submerged breakwater made of sand-filled geosynthetic tubes were recommended, with the layout finalized through numerical modelling and field installation undertaken by the Government of Kerala, monitored by NIOT.

He mentioned about the other projects in Tamil Nadu, Andhra Pradesh, and Odisha, along with NIOT's involvement in sustainable inlet management and the Indian Coastal Inlet Restoration Programme (ICIRP), aimed at restoring coastal inlets.

Dr. Kiran further discussed the Puthuponnani project in collaboration with the Harbour Engineering Department of Kerala State, where NIOT conducted numerical modelling based on field data collected by the department to develop appropriate solutions.

The presentation concluded with insights into the Indian Coastal Ocean Radar Network (ICORN) and EEZ shallow water bathymetry survey on the east coast of India, showcasing NIOT's comprehensive approach to coastal management and research.

8. Conclusion / Summary

1 State/U. Ts requested capacity building and knowledge transfer from various agencies.

2 Exploration of Coastal Data collection through remote sensing was emphasized by NCCR and NIOT.

3 Shoreline Management Plan (SMP) for Kerala is under finalization by NCCR

4 Importance of addressing the issue of Salinity Ingress was highlighted by all agencies and appropriate action plan needs to be implemented.

5 Requesting proposal to MoJS/CWC(Hqs) to devise new central funding scheme for anti-sea erosion works and modernization/ operation & maintenance of coastal data collection sites owned by State Governments.

Shri. Sivadasan, CE, I&A, Kerala delivered vote of thanks and appreciated the sincere efforts taken by all the participating agencies for their detailed and valuable contributions.

The meeting ended with vote of thanks to the Chair.

9. Way Ahead

To address coastal protection and management in Kerala and Lakshadweep, a comprehensive approach is needed, encompassing various aspects from surveying vulnerable areas to implementing action plans.

1. **Survey & Identification of Vulnerable Areas**: Conduct detailed surveys to identify regions prone to coastal erosion and salinity ingress. Utilize advanced GIS mapping techniques to precisely map erosion-prone and salinity-affected areas, taking into account factors such as shoreline changes, land use, and sea level rise projections.

2. **Creation of Comprehesive Data Base:** Collate comprehensive data sets including historical coastal erosion data, sea level rise projections, soil salinity levels, coastal land use patterns, and socio-economic factors. This data will serve as the foundation for informed decision-making and planning.

3. **Comprehensive Action Plan**: Develop a robust action plan in collaboration with relevant stakeholders including local communities, government agencies, research institutions, and environmental organizations. The action plan should include strategies for shoreline protection, ecosystem restoration, sustainable land use practices, and community resilience building measures.

4. **Studies to be Planned**: Conduct specialized studies to assess the impacts of coastal erosion and salinity ingress on biodiversity, agriculture, fisheries, and human settlements. These studies will provide valuable insights for designing targeted interventions and adaptation strategies.

5. **Preparation of Coastal Management Plan**: Formulate a comprehensive coastal management plan integrating various components such as hazard mitigation, habitat conservation, tourism management, and infrastructure development. The plan should prioritize ecosystem-based approaches that enhance natural coastal resilience while safeguarding livelihoods and cultural heritage.

6. **Identification of Nodal Agency**: Establish a dedicated nodal agency or task force responsible for coordinating coastal protection and management activities. This agency should facilitate inter-departmental collaboration, streamline decision-making processes, and ensure effective implementation of policies and projects.

7. **Support/Financial Assistance from Central Government and its Institutions**: Advocate for support and assistance from the Central Government and its institutions to strengthen coastal protection & management efforts and Salinity Ingress Management in Kerala and U.T. of Lakshadweep. Seek funding support, technical expertise, and policy guidance from central agencies. Collaborate with central institutions and research organizations to leverage their capabilities and resources for addressing coastal challenges effectively.

   In conclusion, the effective protection and management of Kerala and Lakshadweep's coastlines require a multi-faceted approach encompassing scientific research, community engagement, policy formulation, and institutional coordination. By leveraging available data, engaging stakeholders, and mobilizing resources, a sustainable coastal management framework can be established to mitigate the impacts of coastal erosion and salinity ingress while promoting resilience and sustainable development.

Ist Quarterly Dialogue for the FY 2024-25 between CWC, CGWB with state of Kerala &UT of Lakshadweep on 29.04.2024 at Thiruvanathapuram

List of Participants

SL. No.	Name (Sh/Smt/Ms)	Designation	Office
		Central Water Commission	
1	T.K.Sivarajan	Chief Engineer	Cauvery & Southern Rivers Organisation
2	D.P.Mathuria	Chief Engineer	Planning and Development Organisation
3	R Thangamani	Director	Mon Dte, CWC Chennai
4	KV Prasad	Director	Beach Erosion Dte, Kochi
5	Adarsh M.S	Deputy Director	Beach Erosion Dte, Kochi
6	Prakash S	Assistant Director	O/o CE, CSRO , CWC, Coimbatore
7	Anoopraj P.S	Sub Div Engineer	South Western Rivers Sub Div, Kochi
8	Vishnu V.V	AD-II	Coastal Management Dte, New Delhi
9	Rahul P.R	AD-II	Beach Erosion Dte, Kochi
10	Anju O.R	AD-II	Beach Erosion Dte, Kochi
11	Prabhu M	AD-II	O/o CE, CSRO , CWC, Coimbatore
		Central Ground Water Board	
1	Mini Chandran	HOD	Trivandrum
2	Roopesh G Krishnan	Scientist-D	Trivandrum
3	Bindhu	Scientist D	Trivandrum
		Water Resources Department, Govt. of Kerala	
1	Shri. Ashok Kumar Singh, IAS	Principal Secretary	WRD, Govt. of Kerala
2	Priyesh R	Chief Engineer	IDRB
3	Sivadasan M	Chief Engineer	Irrigation and Administration
4	Sreedevi P	Director	IDRB
5	Sreekala CK	CE	IN&KP
6	Shini K.K	Director,(in charge)	KERI Peechi
7	Ramesan S.K	SE,ICC,TSR	ICC,TSR
8	Soudha M.S	SE	FSC Thrissur
9	Sunil Raj D	SE, ISC	ISC TVM
10	Beena N	Joint Director	Coastal Engineeering Field Studies, Thrissur
11	Sili Thankam	JD,IDRB	IDRB TVM
12	Sandhya S.G	JD,IDRB	IDRB
13	Manju S	JD,IDRB	IDRB
14	Sindhu R	JD,IDRB	IDRB
15	Suhair K	Deputy Director	Vikas bhavan
16	Anugeetha B	DD, PBD	IDRB
17	Suneera R	Ex.Engineer	O/o CE(I&A) TVM
18	Bindu S	Ex.Engineer	Mjor Irrigation Division
19	Suja SS	Ex.Engineer	Irrigation Dpt
20	Jyothi Mary Chacko	Ex.Engineer	O/o CE(I&A) TVM
21	Dr.CP Priju	Sr Scientist	CWRDM
22	Sheeba GR	Sr Scientific Officer	O/o CE(I&A) TVM
23	Suneer KM	AD	CEFS, Thrissur
24	Parvathi MM	AD, PBD	IDRB
25	Anusree A	AD	CES TVM
26	Shibu George	PA to SE	FSC Thrissur
27	Abdul Muneer P	AEE (PA to EE)	Irrigation Division Malappuram
28	Priya B.S	Asst Ex.Engineer	O/o CE(I&A) TVM
29	Deepa KS	Asst Ex.Engineer	O/o CE(I&A) TVM
30	Aswathi MP	Asst Ex.Engineer	O/o CE(I&A) TVM
31	Sheeba Abraham	Asst Ex.Engineer	O/o CE(I&A) TVM

32	Sajikumar	AE	O/o CE(I&A) TVM
33	Bindu SS	AE	Irrigation Dpt
34	Subha RV	AE	Irrigation Dpt
35	Anoop SR	AE	O/o CE(I&A) TVM
36	Maneesh M	AE	O/o CE(I&A) TVM
37	Indulatha ML	Sr Gr Typist	O/o CE(I&A) TVM
38	Valsala John G	IInd Gr Draftsman	O/o CE(I&A) TVM
	Ground Water Department, Govt. of Kerala		
1	Smt. D. Dharmalashri, IAS	Director	Ground Water Department, Govt. of Kerala
2	Anjali S	Hydrogeologist	GWB Alapuzha
3	Dr.Vidya G.S	JH	GWD Kollam
4	Bushra A	JH, GWD	GWD
5	Indu P Nair	JH. GWD	GWD
Public Works Department, U.T of Lakshadweep			
1	C N Shajahan	Superintending Engineer	Kavaratti (through online mode)
Harbour Engineering Department, Govt. of Kerala			
1	Mohd Ansari	Chief Engineer	Harbour Engineering Department
2	Vibin V	Asst Ex.Engineer	Harbour Engineering Department
National Institute of Technology (NIT), Calicut			
1	Dr. Santhosh G Thambi	Professor	Department of Civil Engineering
National Centre for Earth Science Studies (NCESS)			
1	Dr.L. Sheela Nair	Scientist G, Group Head	Marine Geoscience Group (MGG)
2	Ramesh Madipali	Scientist D	Marine Geoscience Group (MGG)
Directorate of Environment and Climate Change (DOECC)			
1	P Kalairasan	Environmental Engineer	Dept. of Environment, Govt. of Kerala
2	Santhy SR	Hydrogeologist	Dist Office TVM
National Centre for Coastal Research (NCCR)			
1	Dr.M.V.Ramana Murthy	Director	Through Online Mode
National Institute for Ocean Technology (NIOT)			
1	Dr. Kiran A S	Scientist E,	Through Online Mode

Introduction

The Coastal Zone represents a complex environmental entity, which is in constant interaction with the marine and terrestrial processes. The coastal zone has been receiving increased attention due to the immense anthropogenic pressure and inevitable development activities related to trade and transport. The coast is bestowed with rich bio-diversity and fragile ecosystems like mangroves and coral reefs that are highly sensitive to any climatic and environmental changes. The coastal region, due to the influence of natural and anthropogenic forces and the sporadic events like cyclones undergo severe erosions leading to loss of human livelihood and crucial bio-diversity besides critically damaging the coastal constructions and aesthetic quality that attracts huge economic benefits. Quantifying coastal change is essential for calculating trends in erosion, evaluating processes that shape coastal landscapes and predicting the response of coast to future storms and sea-level rise. The dynamic nature of the coast prompts for frequent monitoring and comprehending the coastal erosion activities. India has more than 7500 km. long coastline with diverse coastal ecosystem and hence, Coastal Zone in India, assumes its importance, more so because of high population pressure, development of various industries, spurt in recreational activities, exploitation of renewable and non-renewable natural resources, discharge of waste effluents and municipal sewage etc. The Indian shoreline is also dotted with vital coastal habitats like mangrove and coral reefs, ecological sensitive and biologically diverse regions and archaeologically and culturally important places. The natural and anthropogenic activities change the equilibrium of sediment transport along the coast and induce coastal erosion, thereby threating the valuable resources. In view of its dynamic nature, frequent monitoring of the coast is also required and that can be achieved only through satellite- based methods.

The West Bengal coast extends from 21° 36' N to 21° 56' N and 87° 27' E to 89° 8' E. The land–sea boundary of the Purba Medinipur district is wave dominated and is relatively less indented with characterized sand dunes, beaches, aquaculture/salt pans activities, longshore currents, minor river discharges, less turbid but high saline sea water influence and cuspate delta of the Subarnarekha. This part of the coast is largely inhabited and cultivated.

The Sundarban area is fed with numerous rivers, which form network of creeks. These are affected by the daily tides. Many small sandy islands and mudflats mark the river channels and the coast and most of them are completely inundated during high tide. The mangroves in the West Bengal coast mainly colonies in the Sundarban area, which forms the largest single block of tidal
halophytic mangroves of the world.

The coastal areas of West Bengal serve as hubs for diverse economic activities, ranging from fisheries to tourism. Fishing communities rely heavily on the coastal resources for their sustenance, contributing significantly to the State's economy. Additionally, tourism thrives on the beaches in West Midnapore district and cultural heritage of these regions, attracting both domestic and international visitors.

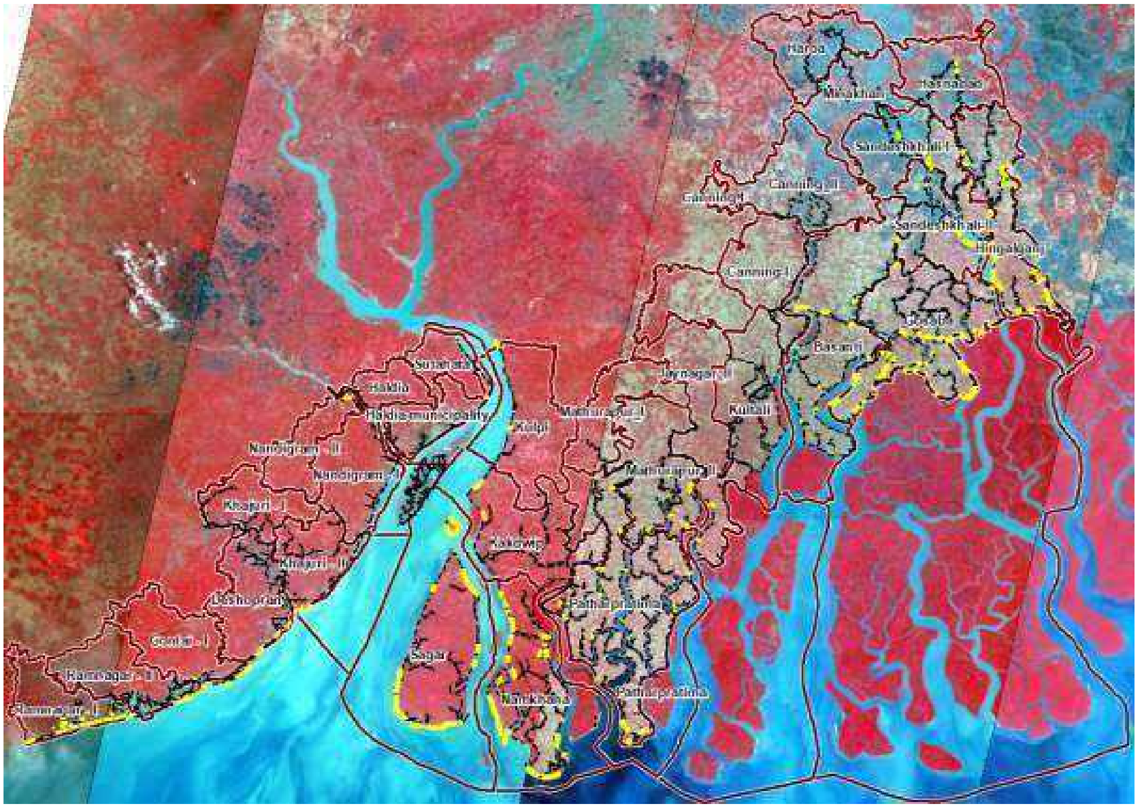

Figure 1: Coastal Length of West Bengal (approx. 157 Km)
(Source: IESWM, Dept. of Environment, Govt. of West Bengal)

2.0 Overview

The Shoreline Change Atlas of the Indian Coast (2021), published by ISRO, offers valuable insights into the dynamics of West Bengal's coastlines. Through an analysis of shoreline changes, significant patterns of erosion and accretion along the 157-kilometer stretch of West Bengal"s coast are revealed.

In summary, approximately 56 kilometres of the West Bengal coast are experiencing **erosion**, while 34 kilometres are undergoing **accretion**, leaving 67 kilometres relatively **stable**. These transformations have profound implications for the region's environmental and socio-economic aspects. An area of around 394 ha of the land have eroded and about 141 ha of area have been accreted due to deposition of sediment.

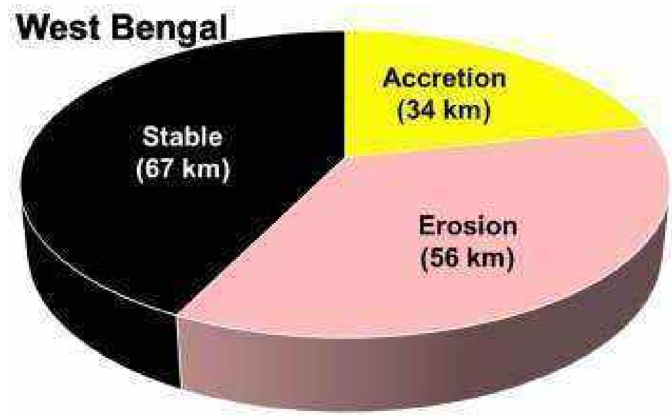

Figure 2: Shoreline changes in West Bengal (SAC, ISRO, 2021)

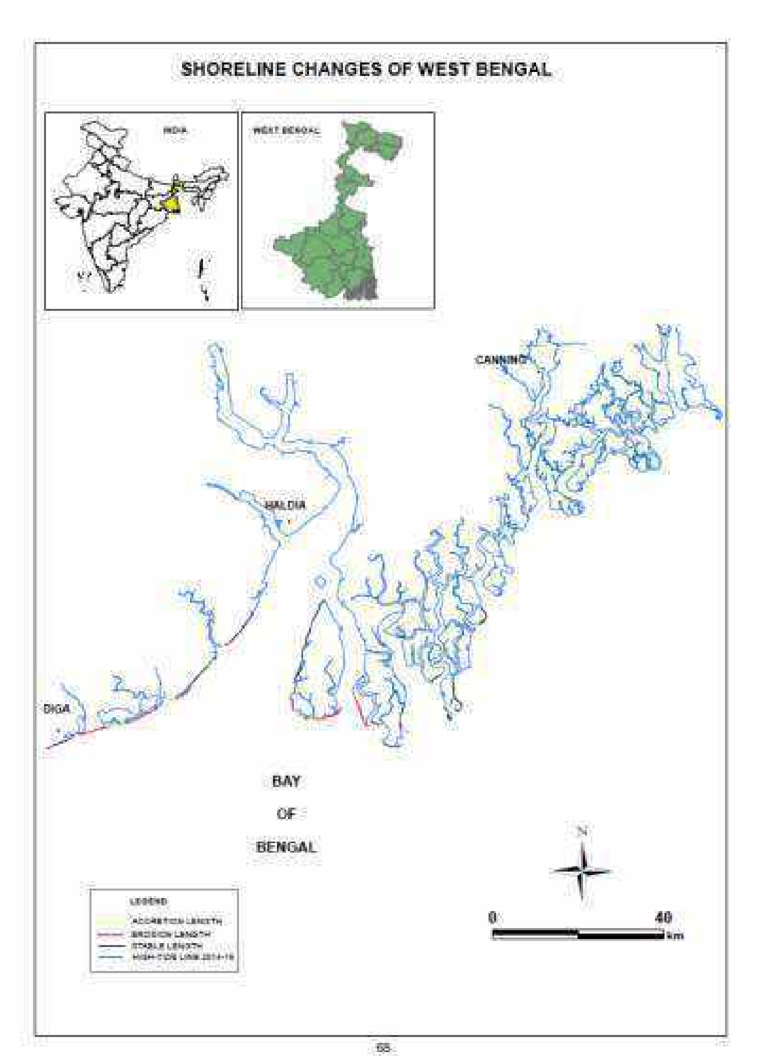

Figure3: Shoreline change Map of West Bengal (SAC, ISRO, 2021)

Shoreline change analysis of West Bengal is carried out by dividing the shoreline into two based on the coastal geomorphology and district administrative boundary; the western part comprising of the Purba Medinipur District and the eastern part comprising the South 24 Parganas District. In Purba Medinipur District, Coastal erosion happened along 26 km, Accretion is along 20 km and 19 km of the coast is under stable condition. In South 24 Parganas District, the coastal erosion at is along 31 km while accretion is along 14 km and 48 km of the coast is stable in nature.

3.0 Coastal/ Shoreline Management Plan

The shoreline represents the interface between land and water, characterized by its dynamic and intricate nature shaped by natural phenomena, human interventions, and climatic conditions. Serving as a vital boundary, shorelines are pivotal for maintaining the ecological equilibrium of coastal ecosystems and hold significant importance from both environmental and socio-economic perspectives. A **Shoreline Management Plan (SMP)** offers a comprehensive framework for strategically managing coastal regions. By delineating the characteristics of shorelines, assessing risks such as erosion and flooding, and considering human activities, an SMP paves the way for sustainable coastal management. Through this approach, the aim is to achieve a harmonious balance between preserving natural coastal processes and meeting the needs of coastal communities and industries.

Institute of Wetland Studies & Wetland Management (IESWM) under Department of Environment, Govt. of West Bengal has made significant strides in coastal management by completing the Coastal Zone Management Plan (on scale 1:25000), based on CRZ Notification 2011 which has been approved by MoEF&CC in June 2020. Updation of CZMP-2011 based on CRZ Notification 2019 is ongoing.

A **Coastal Management Plan** is indispensable for ensuring the sustainable management of coastal areas. It serves multiple crucial purposes, including the identification of present resources and assets along the shoreline while anticipating future changes. By providing a comprehensive framework, Coastal Management Plans lay the groundwork for implementing sustainable management strategies tailored to the unique needs of coastal regions. Detailed scientific studies conducted under the **Coastal Management Information System (CMIS)** enable the development of dynamic CMPs, which evolve in response to changing environmental conditions and human activities. Recognizing the dynamic nature of coastal ecosystems, Shoreline/Coastal Management Plans require periodic updates to remain relevant and effective in safeguarding coastal resources and promoting resilience in the face of evolving challenges.

4. Coastal Protection & Development Advisory Committee (CPDAC)

Recognizing the pressing need for comprehensive coastal planning and cost-effective solutions to combat coastal erosion, the Government of India established the **Beach Erosion Board (BEB) in 1966**, initially focusing on anti-sea erosion efforts in Kerala under the guidance of the Chairman of the Central Water Commission (CWC, formerly CW&PC). Subsequently, in 1971 and again in 1989, the BEB was reconstituted, extending its jurisdiction to cover the entire coastline of the country. As development surged in protected coastal zones and population pressures intensified in densely populated coastal areas, the **BEB underwent further restructuring and was renamed** the "Coastal Protection and Development Advisory Committee" (CPDAC) **in April 1995**.

This Committee, with its Secretariat housed within the CWC, is a high-level inter-ministerial body comprising coastal engineering experts and representatives from Coastal States and relevant Central Departments. Its primary mandate is to identify and harness the diverse resource potential available within protected coastal areas for sustainable development. One of the main functions of CPDAC is "to organise a co-ordinated programme of collection, compilation, evaluation and publication of data relating to various natural phenomena in coastal processes, which affect the coastline, through Coastal Engineering Research Centre and other State organisations".

Till date, 18 Meetings of CPDAC has taken place. 19th Meeting of CPDAC is scheduled to be held in Kolkata during 24th - 25th June 2024.

5.0 Role of Central Institutions

National Centre for Sustainable Coastal Management (NCSCM) was established by the Ministry of Environment, Forest and Climate Change (MoEF&CC) **in 2011**, as an autonomous institution to support the protection, conservation, rehabilitation, management, and policy advice of the coast.

NCSCM supports the nationwide adoption of the **Integrated Coastal Zone Management (ICZM)** approach by utilizing decision support systems (DSS) based on cutting-edge science and knowledge and through networking with communities, government structures, and relevant reputable national and international institutions. One of the major accomplishments of NCSCM has been the completion of the Integrated Coastal Zone Management Plan (ICZMP) for two coastal stretches of West Bengal, (i) Digha–Sankarpur and (ii) Sagar Island. This Plan has been accepted by the West Bengal Government for implementation.

Central Soil Salinity Research Institute (CSSRI) is a premier Research Institute dedicated to pursue interdisciplinary research on salinity/ alkalinity management and use of poor quality irrigation waters in different agro-ecological zones of the country. The Regional Research Station, Canning Town is located right on the climatically vulnerable coastal region of Ganges delta to cater the research and management needs of coastal salt affected soils. The research station is geographically situated at about 46 km south –east of Kolkata. The Institute has achieved significant progress in Soil Management, Water Management and Multiple crop cultivation and diversification through land shaping.

6.Measures

6.1 CMIS (Coastal Management Information System)

To comprehensively address the impacts of both natural phenomena and human activities in coastal areas, a multidisciplinary approach is essential, recognizing the interconnectedness of various processes within the coastal system. In line with this objective, the establishment of the Coastal Management Information System (CMIS) was included as a component **in the 12th Five Year Plan (2012-17), under the Plan Scheme of "Development of Water Resource Information System (DWRIS)"** by the Government of India. CMIS aims to gather data essential for effective shoreline management, providing insights crucial for oceanographers and engineers.

The Ministry of Jal Shakti, Department of Water Resources, Ganga Rejuvenation, and River Development approved the establishment of CMIS under the DWRIS scheme. The implementation of **CMIS follows a three-tier model** involving the Central Water Commission (CWC) as the **Project Implementer**, an Expert Agency as the **Project Executor**, and the concerned Maritime State Government as the **Project Facilitator**.

IIT Madras was selected as the Project Executor for CMIS, with tri-partite MoUs signed between CWC, IIT Madras, and the respective State Governments of Tamil Nadu, Kerala, and Puducherry. The project entails the collection of various coastal data, including wave patterns, tide levels, bathymetry, river currents, and meteorological parameters. While the CMIS project with IIT Madras as the Project Executor concluded in May 2021.

CWC initiated data collection at CMIS sites since June 2021, focusing on parameters such as beach profiles, shoreline changes, wind patterns, tidal variations, and sediment analysis both onshore and offshore.

At present, 8 sites is being maintained by CWC. 4 new CMIS sites are proposed to be opened which includes one in West Midnapore District and one in South 24 Parganas District.

6.2 CMIS Parameters for Data Collection

S.No	Parameters Collected	Frequency
1	Shoreline Monitoring (High Tide Line, Low Tide Line)	Monthly
2	Beach profile	Monthly
3	Wind velocity, direction, Rain fall, Temperature & Relative humidity	Continuous
4	Wave	Continuous
5	Tidal data	Continuous

6	Bathymetry a) Offshore b) Near Shore	Once in Pre-Monsoon & Post-Monsoon
7	Offshore Current	Hourly Data for 120 days
8	a)River Current b) Conductivity Temperature Depth (CTD)	a) Once in Pre-Monsoon, Monsoon & Post Monsoon b) Monthly
9	Sediment samples a) onshore b) Suspended Sediment c) Seabed Sediment	a) Monthly b) & c) Once in Pre-Monsoon, Monsoon & Post Monsoon

6.3 Status of Coastal Erosion and Salinity Ingress in the state of West Bengal

As per the information obtained from Irrigation and Waterways Department, Government of West Bengal, the Extent of sea erosion/ salinity ingress problem in the State, district-wise is given at **Annexure-I.** List of Coastal Protection Works including Salinity Ingress executed in the last 10 years in affected areas/district is given in **Annexure-II.** List of Ongoing/Proposed Coastal Protection Works including Salinity Ingress proposed during next 5 years is given at **Annexure-III.**

7.0 Brief on Quarterly Dialogue

As per the direction of Chairman CWC the 1st Quarterly Dialogue in Financial year 2024-25 was organized by T&BDBO, Kolkata on the subject "Coastal Area Management" on 09/05/2024 at Jalsampad Bhawan, Government of West Bengal. The officials of the following Departments participated in the said Dialogue. List of participants is given at **Annexure-IV**.

1. Central water Commission
2. Central Ground Water Board
3. Jadavpur University, Kolkata
4. Institute of Environmental Studies and Wetland Management (IESWM)
5. Irrigation & Waterways Department, Govt. of West Bengal
6. State Water Investigation Directorate
7. Central Soil and Salinity Research Institute, Canning

The meeting took place in hybrid mode under the Chairmanship of Chief Engineer T&BDBO and Secretary, I&WD, Government of West Bengal.

Shri Subhrangshu Biswas, Chief Engineer T&BDBO delivered the welcome address and gave a brief account and background about the Quarterly Dialogue between CWC and CGWB states of West Bengal and Sikkim. He Stated that Chairman CWC has Stressed upon holding Quarterly Dialogue in association with Central Ground Water

Board and State Governments for creating synergy between the work done by CWC, CGWB and State Governments for serving the needs of the State.

Further, he highlighted the background of initiative in selecting the subject matter for discussion by Chairman, CWC on "Coastal Area Management". Coastal Area Management is one of the important subject matter for coastal states and the ongoing activities of different Organisations / Planned by the States would be key in understanding the various aspects in this regard.

Thereafter, presentation were made by various Departments according to the scheduled programme.

(A) Central Water Commission

A Powerpoint Presentation on Coastal Management /Salinity Ingress was made by Shri. Ashish Kumar Ranjan, Deputy Director, Coastal Management Directorate, CWC, New Delhi during the presentation, he shared the details about coastal length measured by Coastal Protection and Development Advisory Committee (CPDAC) in association with National Hydrographic Office (NHO), Dehradun. He emphasized that the revised coastal length of West Bengal has been revised to 721.02 Km as against the earlier length of 662.90 Km.

He then gave a brief overview about the change of Shoreline changes in West Bengal as per the Shoreline changes in Atlas of Indian Coast for 2004-2016 conducted by SAC, ISRO. He suggested that as significant part of Coastal area of West Bengal is either under accretion or erosion; different measures may be undertaken by State Govt. of West Bengal.

He also highlighted the role of DOWR, RD&GR in coastal management. A brief overview of the constitution and function of coastal protection and development advisory committee (CPDAC) was also presented.

Further, a broad overview on the Coastal Management Information System (CMIS) was also deliberated upon upon by him. The objective, background, utility of CMIS and developments undertaken by CWC was discussed in details. He informed the participants that 8 coastal sites have already been established. Moreover 12 additional sites are proposed to be established by 2026.

Then regarding salinity ingress, the implication with respect to salinity ingress and actions needed to be undertaken by States was deliberated upon he mentioned that Guidelines for preparation of DPR related to Salinity Ingress Management projects in coastal areas are under finalization.

(B) Central Water Power Research Station,Pune

Then CWPRS gave a presentation on role of CWPRS in coastal development involvement of CWPRS in Coastal Protection and Coastal Management System. CWPRS also informed about the different physical model facilities available at CWPRS like (a) Random & Regular sea wave flumes (b) Multipurpose Wave Basin (c) Wave Basin for port and harbour models (d) Tidal Basis for port & harbour models which are utilized for studies on Coastal Management. They are also equipped with field equipments involving bathymetry Survey and salinity temperature depth unit. Also a brief overview of coastal protection works incorporating both the Soft Solutions like vegetation, beach nourishment, dune care zoning and hard solutions like Sea wall/Revetment/Groynes/Offshore reefs and Detached Sea Walls was discussed in the Dialogue.

Further, how the tools of remote sensing GIS field data collection and modelling techniques are being used for coastal vulnerability studies, shoreline mapping and monitoring coastal processes were also discussed upon.
Finally, some examples of coastal management works undertaken by CWPRS in West Bengal was shared with the participants detailed discussion was held on the works undertaken by CWC with respect to Improvement of navigability in Mandarmani Tidal Inlet.

(C) Irrigation & Waterways Department, Govt. of West Bengal

Director, River Research Institute gave a brief presentation on the "Coastal Area Management" in West Bengal. He informed the participant about the oceanography and metrological parameters at Digha coasts which are being observed by government of West Bengal. Vacation of coastline at the Digha was also deliberated upon by him. Subsequently, the different type of protection structures adopted by Government of West Bengal was discussed upon.

Regarding control of Sea Erosion and Salinity Ingress, the measure undertaken by Government of West Bengal depicting the works related to Coastal Management was shared to the participants by Director, RRI. Finally the damages caused by Super Cyclone YAAS in 2001 on the coastal protection works was discussed.

(D) Jadavpur University

Dr Gopinath Bhandari, Professor, Jadavpur University gave a presentation on physical aspects of Integrated Coastal Zone Management-Physical The presentation highlighted the basic aspects of shore protection, methods for artificial shore protection. A brief overview of different commonly used shore protective structure like Bulkhead, Sea wall, Revertment, groins, breakwater was discussed. Functions, uses, applicability, merit and demerits of all the shore protective structures where deliberated upon in depth. Moreover the role of coastal defence in Integrated Coastal Zoning Plan was also discussed. Care studies of coastal protective work at Digha Coast, Mandarmani, Old Digha, were also deliberated upon.

(E) Central Groundwater Board

Sh. Indranil Roy, Sc 'D' CGWB prosecuted on Coastal Aquifers of West Bengal -a brief overview. The presentation covered a vivid description about the coastal tract of West Bengal, land-use pattern hydrology and aquifer characterizes of the West Bengal coast.

The presentation focused on the aquifer characterizes of the Coastal tracts of West Bengal. Variation of water level in coastal tracts of West Bengal in pre monsoon and post monsoon of the year 2020 was also highlighted to the participants.

Moreover, the variation of chemical parameters like Total Hardness ,Nitrogen, Fluorides etc. in braklsh/saline ground water of coastal Aqurfers of West Bengal during pre and post monsoon was also deliberated upon to the attendees.

Additionally, he emphasized the policy support and regulatory measures to manage ground water efficiently.

(F) State Water Investigation Directorate (SWID),Govt. of West Bengal

Dr. Debatri Bagchi Roy, Senior Geologist, State Water Irrigation Directorate presented upon the Principal activities of SWID in West Bengal. A brief overview of the water level Monitoring Station of West Bengal maintained by Govt. of West Bengal encompassing the no of tubewells and number of pitot tubes was deliberated upon.

The major activities undertaken by SWID under National Hydrology Project was presented. A brief overview of the Real Time Groundwater level Monitoring Network installed under NHP, SWID was also deliberated upon.

Dr. Bagchi Roy then stressed upon the importance of the West Bengal Ground Water Act 2005 and role of geophysical wing of SWID.

In conclusion she emphasized on the policy support and regulatory measures to manage ground Water efficiently collaboration among government agencies ,Civil society Organisation and stakeholders was highlighted as crucial for addressing the complex challenges associated with groundwater management.

(G) Institute of Environmental Studies and Wetland Management

Smt. Ena Sen and Smt. Paramita Singha Roy Project Scientist Institute of Environment Studies and Wetland Management Govt. of West Bengal presented an overview of Coastal Zone Management Plan. The presentation covered a brief about the coastal zone management plan 2011 and 2019 and integrated Coastal Zone Management Plan. It was learnt that Integrated Coastal Zone Management Plan(ICZMP) was undertaken by IESWM under World Bank assistance for two coastal stretches of West Bengal Digha Sankarpur in Purba Mednipur district and Sagar Island in South 24 Parganas. The project also involved active participation from National Centre for Sustainable Costal Managemant (NSCM) Chennai. The Plan suggested a template of development interventions consistent with promoting coastal sustainability and s intended as a planning tool for development bodies and administration in coastal areas.

She also gave a pictorial representation of the clarification of Coastal Regulation Zone as per Coastal regulation Zone Notification 2019.

(H) Sunderban Development Board

The final presentation of the Dialouge was presented by Sh Parta Pratim Tiwari, Forest Officer, Sunderban Development Board, on an overview of the Sunderbans. The presentation covered about the demographic profile of blocks under Sunderban area; their socioeconomic status; details of irrigated area and livelihood in Sunderban area. It was also learnt that Water Resources Investigation and Development Department, Government of West Bengal was assigned to execute the project West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP) financed by World Bank. The objectives of the project; institutional activities of the water uses Association under WBADMIP in Sunderban Blocks was discussed upon. It was emphasized by Sunderban Development Board that WBADMIP had significant impact on the livelihood, good agriculture practices, of the people of Sunderban.

The futuristic opportunities for the development of socio-economic condition of the inhabitants of Sunderban was also discussed.

Shri. Sudipta Sarkar, Deputy Director, CWC, Kolkata the delivered a vote of thanks and appreciated the sincere efforts taken by all the participating Agencies for their detailed and valuable contributions.

The meeting ended with vote of thanks to the Chair. Photographs of the event are at **Annexure-V**. Presentations of various Organisations are at **Annexure-VI.**

8.0 Conclusions

- Different Departments of Central and State Govt of West Bengal interacted on this topic for the first time and requested capacity building and knowledge transfer from each other.

- Exploration of Coastal Data collection through remote sensing was emphasized by CWPRS.

- Institute of Wetland Studies & Wetland Management (IESWM), Department of Environment, Govt. of West Bengal has made significant strides in coastal management by completing the Coastal Zone Management Plan (on scale 1:25000), based on CRZ Notification 2011 which has been approved by MOEF&CC in June 2020. Updation of CZMP-2011 based on CRZ Notification 2019 is ongoing.

- Importance of addressing the issue of Salinity Ingress was highlighted by all agencies and appropriate action plan needs to be implemented.

9.0 Way Ahead

To address coastal protection and management in West Bengal, a comprehensive approach is needed, encompassing various aspects from surveying vulnerable areas to implementing action plans.

1. **Survey & Identification of Vulnerable Areas**: Conduct detailed surveys to identify regions prone to coastal erosion and salinity ingress. Utilize advanced GIS mapping techniques to precisely map erosion-prone and salinity-affected areas, taking into account factors such as shoreline changes, land use, and sea level rise projections.

2. **Data Requirement**: Collate comprehensive data sets including historical coastal erosion data, sea level rise projections, soil salinity levels, coastal land use patterns, and socio-economic factors. This data will serve as the foundation for informed decision-making and planning.

3. **Comprehensive Action Plan**: Develop a robust action plan in collaboration with relevant stakeholders including local communities, government agencies, research institutions, and environmental organizations. The action plan should include strategies for shoreline protection, ecosystem restoration, sustainable land use practices, and community resilience building measures.

4. **Studies Planning:** Conduct specialized studies to assess the impacts of coastal erosion and salinity ingress on biodiversity, agriculture, fisheries, and human settlements. These studies will provide valuable insights for designing targeted interventions and adaptation strategies.

5. **Preparation of Coastal Management Plan**: Formulate a comprehensive coastal management plan integrating various components such as hazard mitigation, habitat conservation, tourism management, and infrastructure development. The plan should prioritize ecosystem-based approaches that enhance natural coastal resilience while safeguarding livelihoods and cultural heritage.

6. **Identification of Nodal Agency**: Establish a dedicated nodal agency or task force responsible for coordinating coastal protection and management activities. This agency should facilitate inter-departmental collaboration, streamline decision-making processes, and ensure effective implementation of policies and projects.

7. **Support from Central Government**: Support and funding from the central government and its institutions for implementing coastal protection and management initiatives.

In conclusion, the effective protection and management of West Bengal's coastlines require a multi-faceted approach encompassing scientific research, community engagement, policy formulation, and institutional coordination. By leveraging available data, engaging stakeholders, and mobilizing resources, a sustainable coastal management framework can be established to mitigate the impacts of coastal erosion and salinity ingress while promoting resilience and sustainable development.

Minutes of 1 st Quarterly Dialogue (FY-2024-25) with the States/UTs – With the State of Odisha

Record of Discussions of Quarterly Dialogue with the State/ UTs on the subject of Coastal Area Management

Chairman, CWC directed that the 1st Quarterly Dialogue in FY 2024-25 for coastal states shall be held on the subject "Coastal Area Management". Accordingly, 1st Quarterly Dialogue with the State/ UTs on the subject of "Coastal Area Management" was organised through Hybrid Mode under the chairmanship of Shri Bhakta Ranjan Mohanty, Engineer-in-Chief, Water Resources Department (WRD), G/ disha in presence of Shri A.K. Pradhan, Chief Engineer (CE), Mahanadi & Eastern Rivers Organization(MERO), Central Water Commission (CWC), Bhubaneswar on **29.05.2024** from **1030 hrs** onwards in the Dam Safety Conference Hall of O/o the Engineer-in-Chief, WR, Odisha, Bhubaneswar.

All the stakeholders (State Govt organisations, Central Govt organisations, Academic Institutions, Research Institutes, etc) working in the field of coastal area were invited to participate in this Quarterly Dialogue to share their studies, research, work done on coastal sites etc. The main objective was to share latest development in the field of coastal management and to know the State Govt. perspective on the same. Accordingly, various stakeholders working in the field in the said State were invited to share their perspective.

Officers/ Engineers / Scientists from following organisations participated in the meeting:

- Central Water Commission (CWC)
- Water Resources Department (WRD), Govt. of Odisha
- Central Ground Water Board (CGWB)
- Central Water Commission (HQ), New Delhi **(Online)**
- Central Water Power & Research Station (CWPRS), Pune**(Online)**
- Water and Power Consultancy Services (WAPCOS), Bhubaneswar
- ICAR- Indian Institute of Water Management, Bhubaneswar **(Online)**
- Indian Institute of Technology (IIT), Bhubaneswar
- National Institute of Oceanography (NIO) Goa**(Online)**
- National Institute of Ocean Technology (NIOT) Chennai**(Online)**
- National Centre for Coastal Research (NCCR) Chennai **(Online)**
- Chilika Development Authority, Bhubaneswar

A list of participants is enclosed at **Annexure-I.**

Introduction:

At the outset, Shri Bhakta Ranjan Mohanty, Engineer-in-Chief, Water Resources Department (WRD), Govt. Of Odisha welcomed all the participants attending the dialogue physically as well as online (Hybrid)with greeting wishes to all. A brief introduction of self by all the members physically present in the Conference Hall concluded in few minutes.

In initiating the discourse on "Coastal Area Management" in Odisha context Shri BhaktaRanjanMohanty,EIC, WR expressed the importance of the 575 Km long coast line in terms of economic benefit. He extended his request to all participating members for making a successful dialogue to address salinity ingress and coastal protection.

Thereafter, Shri A K Pradhan, CE, CWC Bhubaneswar gave an outline of the studies intended to be taken up by Government of India through Central Water Commission, New Delhi and role of Coast Line States to achieve a better Coastline Management. He informed that:

- Two organizations under Ministry of Jal Shakti namely CWC and CGWB are having pan India presence and supposed to work in close tandem with concerned State/ U.T. Govt. for implementation of various schemes, projects, policy matters etc. There is a dire need of close co-ordination between Central and State Govt. for effective implementation of any scheme. In this backdrop, Shri Kushvinder Vohra, Chairman, CWC has put forth the idea of having a quarterly dialogue between regional offices of CWC in collaboration with CGWB with the concerned State Govt. As a part of this initiative, 4 quarterly dialogues have been held during FY 2023-24. This 1st quarterly dialogue for the FY 2024-25 is organized by WRD, Govt. Of Odisha focused for one particular technical area that is **Coastal Management**.
- CWC & CGWB (offices under Ministry of Jal Shakti) are implementing many flagship schemes of Govt. of India related to water resources development and management as well coastal area management in Odisha.
- India is having a vast coast line area & we are facing an issue of coastal erosion and also salinity ingress at numerous places, and these issues are closely connected with the Socio- Economical development of the coastal region. The main importance of this dialogue designing, constructing & maintaining the coastal erosion measures. There are many departments working on various aspects of coastal issues like as Coast Guard, Coastal zone regulatory authorities, Maritime Boards & various institutes like NIOT, NIO, NCCR, IIT's, CSIR etc. but there is one aspect that is missing is Coastal data, (i.e. Wave Data, Riverine data, tide data, current data etc.). This data is very fundamental before we take up any anti erosion measures or for design of coastal erosion structures. In this regards Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation in 12th plan formulated a scheme **CMIS (Coastal Management Information System)** basically to collect the data vulnerable of

sites & also to create a comprehensive central data base, so that all stakeholders who require that data, they can access it.

- There are many Organisations, Academic Research, State Government Department as well as Central Government Organisation working in this field of coastal management, but there are hardly any linkages among them. So, this particular occasion is an opportunity for all of us to come together to discuss the works that we are doing, discuss the studies research and all the schemes we are implementing and learn from each other's experiences & expertise.

Thereafter, detailed presentations were made by each of the organisations covering their expertise and the projects they have done.

Presentation by DoWR, Govt. of Odisha:

A PPT on Coastal Area Management was presented by Shri Bijaya Kumar Samal, Chief Engineer, Drainage, DoWR of GoO. He informed that the length of the coastline has been re-verified by CPDAC in association with NHO, Dehradun (which is yet to be released) and for Odisha, the coastline length has increased from 480 km to 574.71 km due to addition of offshore islands and closing of river mouths &creeks. He stated that there are 22 blocks comprising six coastal districts namely Balasore, Bhadrak, Kendrapada, Jagatsinghpur, Puri and Ganjam along the coast line of Odisha.

Further he explained that, the coastal plain occupies the outfall regions of Major Rivers like Mahanadi, Brahmani, Baitarani, Subarnarekha & Rushikulya. The delta region is having thickly populated habitations and coastal population is nearly 36% of the total population of the State. The Livelihood support of coastal People - Agriculture, Fishing &Animal Husbandry.

A MoU has been signed between Department of Water Resources, Odisha and NIOT, Chennai on 10th Aug 2022 which will remain valid for 5 years. The NIOT, Chennai shall provide technical guidance for disaster resilient coastal protection works for DoWR, Odisha. During the subsequent years studies carried out by NIOT on Coastal Erosion at different sites of coastal Odisha determines the details of various plans to be implemented by Government of Odisha.

Thereafter, the Status of Coastal Management Plan & Shoreline Management Plan was discussed. There are two stretches of major coastline protection works under Integrated Coastal Zone Management Project (ICZMP), namely Gopalpur to Chilika and Paradeep to Dhamara has been completed under World Bank assistance. The State Sector Scheme "Mukhya Mantri Dissaster Resilient Saline Embankment Projects" (MDRSEP) has been launched for a period of of 3 years i.e. from FY 2022-23 to 2024-25 with an outlay of Rs.728.57 Cr for 35 numbers of work to raise and strengthen the Saline Embankments of total length 182.25 Km to sustain the impact of severe cyclones in order to protect the adjacent landmass and habitation from flood, saline ingress and tidal surge of Bay of Bengal in four nos. of coastal districts of the State i.e. Balasore, Bhadrak, Kendrapara and Puri.

The foremost challenge is Saline Ingress in coastal area which spreads around 8500 sq. Km in six coastal districts. Excess exploitations (use) of ground water in adjacent area of sea coast face saline ingress issue. A pilot project for arresting saline ingress and artificial recharge of ground water in parts of Basudevpur and Chandbali Block was carried out by Central Ground Water Board (CGWB).**In-stream Storage Structure** at Choudhurygada-Tikiri (River Paika,Mahanadi) ISS Luna- Kalapada, Chitrotpala-Nrayanpur (River Mahanadi) and Baliguali (Gabkund-Mahanadi) are taken up to increase fresh water storage at u/s & arrest saline ingress to countryside. Pondage of water will resist saline ingress to countryside Baliguali-Dayabhargavi. **Groundwater Recharge Shafts** are being constructed at Baliapal, Bhograi, Dhamnagar, Naugaon, Dasarathpur, Binjharpur, Aul, Garadpur, Kendrapara, Pattamundai and Kakatpur blocks by Ground Water Department, GoO.Two schemes – Community Harnessing and Harvesting Rainwater Artificially from Terrace to Aquifer **(Chhata)** and Artificial Recharge to Underground Aquifer **(Arua)**– has been planned to increase the groundwater level

The Government of Odisha has planned to construct 'Saline Embankments' of length 1636.00 Km for control of Sea Erosion and Salinity Ingress. So far, under National Cyclone Risk Mitigation Project (NCRMP) scheme, 58.10 Km and under Rural Infrastructure Development Fund (RIDF) scheme, 87.05 Km and from assistance of Asian Development Bank 10.6 Km i.e a total of 156.17 Km of Saline Embankment is strengthened. Further it is planned to strengthen 416.01 Km afoot.

Further, the achievements of Government of Odisha under ICZMP at Pentha Coastline in Kendrapara District where sand accretion is started in front of geo-tube embankments are shown in photographs. The photograph of anti-sea erosion work taken up at Talasari–Udaypur of Balasore which was damaged due to YASS CYCLONE in May 2021 is shown. The temporary restoration at Siali Beach in Jagatsinghpur and construction of embankments in Ramayapatana Shoreline in Ganjam District are discussed. The achievement of Chandipur Sea Beach with support from NABARD in 2022 is shown with photographs. The Satabhaya village erosion and measures taken by Revenue and Disaster Management Department, GoO to resettle 530 families to a new colony at Bagapatia in Kendrapada District with a probable cost of ₹22.50 Cr is well explained by Shri B K Samal,Chief Engineer.

Presentation of DoWR, Govt. Of Odisha is enclosed as **Annexure-II**.

Presentation by NIO Goa:

Dr. R. Mani Murali, Senior Principal Scientist, National Institute of Oceanography, Council of Scientific and Industrial Research (CSIR)has presented virtually on behalf of NIO in 1st Quarterly Dialogue, CWC meeting. He welcomed Shri Ajaya Kumar Pradhan, CE, M&ERO, Shri Bhakta Ranjan Mohanty Engineer-in-Chief, WR, and all the stakeholders of water sector related department of State Government and Academics present in the meeting online.

He has taken Gahiramatha coastline as his study area for analysis of the coastline by using Remote Sensing and Modeling. It has a coastline of 150 km extended from Devi to Dhamra River. The study duration taken by him is from 1973 to 2015. He showed in his analysis that in the year 1973 - 1999, the Ekakukla spit has decreased its coastline upto 1.8 km and in the years 1999 - 2008 and 1999 - 2015 the spit length has increased upto 2.7 km and 4 km respectively.

Dr. R. Mani Murali has concluded at the end of the presentation that Mahanadi delta is no more progressive delta region. Human intervention in hinterland affects the coastal systems. Damming and sea level rise effect is observed along the coast and reducing the delta region. Floods and cyclones cause the severe geomorphologic changes. Increased agricultural activity has reduced the sediment flux. Decreased sediment flux, cyclones and floods are the main causes of erosion in this region.

As per the agenda of CWC the subject of discussion is well explained by Dr. R. Mani Murali, Senior Principal Scientist, NIO, Goa. The PPT of NIO is enclosed at **Annexure-III**.

Presentation by NIOT Chennai

Thereafter, a presentation on "Coastal Area Management-" was delivered by, NIOT, Ministry of Earth Science, Govt of India in virtual mode.

He explained that as a part of CZMP-Odisha Project, NCSCM requested NIOT to provide suitable erosion mitigation measures at Ramayapatanam, Puri, Ramachandi, and Pentha.

As part of Short-term studies, Kushabadra River mouth dynamics and shoreline changes were studied using historical satellite imageries. Topographic, hydrographic, and oceanographic observations were carried and suggested hybrid solution consists of sand nourishment, dredging, and construction of training wall.

As per the presentation the on-going project erosion mitigation at Eco Retreat Konark&Siali, Odisha for design vetting for strengthening of Saline embankments along Odisha coast. Shoreline Change Analysis and Coastal erosion monitoring for Krishnapatnam Coast, Andhra Pradesh.Coastal erosion Mitigation Measures and Shoreline Management Plan for Visakhapatnam. Design and Establishment of Coastal Observatory along Chennai Coast. Shoreline Management Plan for Goa and to suggest Erosion mitigation measures at 3 locations to development of Shoreline Response Evaluation System for Odisha, Goa, Tamilnadu. Stability of Coastal Inlets in Tamil Nadu and Kerala State. The PPT of NIOT is enclosed at **Annexure-IV**.

Presentation by NCCR, Chennai

Thereafter, a presentation on "Coastal Area Management-" was delivered by, NCCR, Ministry of Earth Science, Govt of India in virtual mode.

NCCR has taken a study timeline from 1990 to 2018. Most of the coastal districts of Odisha shows an accreting trend for the past 28 years of shoreline change analysis. The coastal districts which are included in this study such as Ganjam, Puri, Jagatsinghpur, Kendrapara and Balasore.

Total coastal length of Odisha is 549.5 km from where 51% of total coast line is in accreting condition and rest 25.6% and 23.4% are in eroding and stable condition respectively. Coastal projects along Odisha coast by NCCR are Puri, Konark, Pentha, Dhamra and Ramayapatna Projects. Latest sensors used for analysis of the coastline by NCCR are Resourcesat-2 & 2A-(LISS-IV).

NCCR has concluded that a different approach is needed in comparison to other states like Tamil Nadu, Andhra Pradesh, Puducherry and Kerala for management of shoreline of Odisha. This is because of its high expected increase in the sea level rise compared to other parts and high littoral drift rate compared to other parts of east coast. Gopalpur, Dhamra, Paradeep are some of the Major ports and need structures to be constructed for its protection. The PPT of NCCR is enclosed at **Annexure-V.**

<u>Presentation by CWPRS Pune:</u>

Thereafter, a presentation on "Coastal Area Management" was delivered by Shri Prabhat Chandra, Additional Director, CWPRS Pune. CWPRS has been rendering services on the Coastal protection works to all the Coastal states. Shri Chandra said that CWPRS suggested remedial measures for Coastal erosion problems for more than 60 sites in Gujarat with the collaboration of Narmada, Water Resources, Water Supply and Kalpsar Department, Government of Gujarat.

Shri Chandra presented about the methodology adopted by CWPRS in Coastal protection, future challenges in Coastal Protection, CMIS & other activities related to Coastal Management.

Shri Chandra also shared a presentation on the contribution of CWPRS in the field of coastal area management and coastal protection works done in Gujarat at Tithal, Dwarka, Somnath, Dumas-Sultanabad, Surat coast etc. Shri Chandra also shared soft and hard solutions on Coastal Protection works like vegetation, Beach Nourishment, Dune Care, Sand Bypassing, Sand Back-passing, Flood proofing, Zoning, Retreat, Seawall, Revetment, Groynes, Offshore reefs, Detached Sea wall etc. The Presentation of CWPRS is enclosed as **Annexure-VI.**

<u>Presentation by CWC:</u>

Shri Deepak Kumar, Director, Coastal Management Directorate, CWC, New Delhi initiated the discourse with welcome notes as the center head and nodal officer for Coastal Area Management. He emphasized the plan perspective of GoI for better economy by good management of East and West Coast of India in the context of increasing population which makes a lot of pressure to improvise the economic plan / activities for sustainable development. He has appreciated the informative PPT presented by DoWR and expressed his happiness after knowing good initiatives taken up by State Government (Odisha) for Coastal Management in terms of controlling Salinity Ingress and Coastal

Erosion. To achieve better Coastal Protection a good volume of Data is required. To meet this demand the Ministry of Jal Shakti, GoI has initiated Coastal Management Information System (CMIS) in 12th Plan. At present there are 8 numbers of CMIS stations are grounded and 4 new stations are in pipe line. Further he requested Shri Ashis Ranjan to present the PPT.

Thereafter, a PPT on Coastal Management / Salinity Ingress was presented by Shri Ashis Ranjan. He stated that the coast length of India was 7516.00 Km before and revision of coastal length has been undertaken by CPDAC in association with NHO, Dehradun. The revised length, as calculated by NHO and verified by SoI, now stands at 11098.81 km. (Which is yet to be released). As per National Assessment of Shoreline Changes along the Indian Coast by NCCR, for the timeframe 1990-2018, Odisha is having Erosion in 45.6%, Accretion of 47% and Stable coast for 7% of its coastal length.

Coastal Protection & Development Advisory Committee (CPDAC) – Re-constituted in 1995 to guide and implement the programme of anti-sea erosion works & to consider the development potential in the protected coastal zone under Member (RM), CWC. This is a high-level body of experts in the field of coastal engineering, which provides a common platform to all maritime States/UTs & Institutions (total 27 Members) to discuss and solve the coastal erosion problems.
The Main Functions of CPDAC is: -

- Co-ordinated programme of collection, compilation, evaluation and publication of coastal data
- Lay down principles in construction techniques of coastal protection measures
- Draw up long-term and short-term plans for coastal protection and development of the coastal zone
- Identify the coastal zone to be developed behind the coastal protection works with the help of State Governments

He explained about Coastal Management Information System (CMIS)

The objectives of CMIS is

- Collection, transmission, processing & analysis of near shore data for coastal protection measures. Nine Parameters are collected i.e. Wave, Current, Tide, Riverine Data, Wind, Coastal Sediment, Beach Profile, Bathymetry and Shoreline Change.
- To create an integrated data bank to tackle coastal engineering problems in a scientific manner along with challenges of climate change
- Collection of data on coastal processes is relevant for evolving long term coastal management plans and coastal protection measures.

Till date 8 Coastal CMIS sites already established and 12 additional sites are proposed to be established by 2026. Data being collected are being shared with to all the Maritime States / U.T as per their request.

Further, he stated that, in the coastal tract of Odisha, a considerable area of around 5400 sq. km falling in the districts of Balasore, Bhadrak, Jajpur, Kendrapara, Jagatsinghpur, Cuttack, Puri and

Khorda suffers from groundwater salinity hazard.

The Remedial Measures taken to be

1. Construction of Saline Embankments facing to the Bay of Bengal and adjacent to the river mouths.
2. Construction of Sea Wall at vulnerable reaches of the coast line to check the inundation of the adjoining area from storm surge.

In summary, way forward to all State / U.Ts recommended as

- Survey & Identification of area vulnerable to Coastal Erosion and salinity ingress
- GIS Mapping of Erosion Prone & Salinity Affected Area
- Data Requirement
- Comprehensive Action Plan of State Government
- Studies to be planned
- Preparation of Coastal Management Plan
- Identification of Nodal agency for such activities
- Support from Central Government and its institutions

The Presentation of CWC is enclosed as **Annexure-VII.**

Presentation by CGWB:

Thereafter, a presentation on "Coastal Area Management-" was delivered by, B.K Sahoo, Regional Director, CGWB, Bhubaneswar. He confirmed that the Coastal Area of 20,870 sq.km (approx. 13% of State Area) spread in 9 districts in 85 blocks (Completed & Partial). The GW Resources available Resource is 5.1076 BCM (32% of the state) with annual Draft of 2.8822 BCM (39% of the state).

The Groundwater exploration by CGWB started since 1972 in the objective of delineation of aquifers both vertically and horizontally, determination of aquifer parameters i.e. transmissivity & stativity & assessment of groundwater quality through construction of wells. There are 371 Wells from which 228 Nos. of Exploratory Wells (EW) in-house, 81 Nos. Deposit Wells (DP), 32 nos Accelerated Exploratory Drilling Programme, 17 nos. Wells through Outsourcing, 13 nos.Slime hole.

The Coastal Aquifers of Saline water overlying fresh water in Balasore, Bhadrak, Kendrapara, Jagatsinghpur, Jajpur districts. Fresh water overlying saline water Puri, parts of Jagatsinghpur, Kendrapara districts. Alternating fresh water zones in Parts of Kendrapara district. Saline water at all depths up to 600m in Puri, parts of Jagatsinghpur, Kendrapara districts. The Coastal Salinity areas fully affected 6blocks & partially affected in 36 blocks.

He defined that the reasons of Ground Water Issues are Groundwater salinity, decline water level trend, Water Logging, Localized higher iron concentration beyond permissible limit.

The Groundwater is saline both in phreatic as well as confined/semi-confined aquifers. Blocks i.e. Ersama, Kujanga, Brahmagiri etc. upper phreatic aquifer is saline. Majority blocks in Puri, Jagatsinghpur, Kendrapara, Cattack, Bhadrak, and Balasore deeper confined/semi confined aquifers are saline. Salinity in phreatic aquifer is attributed due to topography, poor drainage, overflowing creeks; Salinity in deeper aquifers is due to inland salinity (paleo-sea water trapped in finer sediments) and sea-water ingress.

As per the statement of CGWB proper studies have not been carried out for establishing the extent of sea water ingress. But during NHP Advance programme, CGWB is planning to install series of piezometers with quality probe all along the coast to monitor the extent of ingress. In case of paleo-sea water, there is no method to solve salinity problem only fresh aquifer can be put to use.

The Presentation of CGWB is enclosed as **Annexure-VIII.**

Presentation by ICAR- IIWM, Bhubaneswar:

Thereafter, a PPT on Assessment of Seawater Intrusion in Coastal Aquifers of Puri District using GALDIT Model was presented by Shri S. Mohanty, Principal Scientist, ICAR-IIWM, Bhubaneswar in which he elaborated about the role of ICAR-IIWM in the field of Coastal district in presentation. He also explained about the Seawater intrusion vulnerability analysis in the coastal district of Puri in Odisha was studied using GALDIT model.

Presentation of ICAR-IIWM, Bhubaneswar is enclosed as **Annexure-IX**.

After every presentation there were many questions from the participants, which were comprehensively answered by the presenters. The presentations and interaction were highly enriching for all the participants. CE, M&ERO appreciated the initiatives taken by WRD, GoO for the salinity Ingress & Coastal Erosion works and emphasized that the main objective this quarterly dialogue is to meet the all agencies, stakeholder, academics and research institutes, to share the ideas, experiences, problems etc. It is asked from State Govt. officers that after seen all the presentations what they expect from Central Agencies, Academics Institutes, Research Organisation & all other stakeholders who are working in coastal studies to help in designing the coastal protection works, researches, modelling, capacity building etc in Odisha State.

EIC, WRD, Govt. Of Odisha appreciated the initiatives taken by CWC & CGWB. He assured that Govt. Of Odisha will take all the efforts to control the coastal erosion & Salinity Ingress for the development of Coastal protection work.

The meeting ended with vote of thanks to the Chair.

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Annexure-I

Date: 29.05.2024 (Wednesday)

Venue: Dam Safety Conference Hall of O/o the Engineer-in-Chief, WRD, Odisha, Bhubaneswar,

Topic: "Quarterly Dialogue with the State/ UTs on the subject of Coastal Area Management"

List of participants (Physical presence)

M & ERO, CWC, Bhubaneswar

Sl. No.	Name(Mr./Mrs./Miss)	Designation	Mobile No.
1	Ajaya Kumar Pradhan	Chief Engineer	9583455111
2	Sushant Kumar Samal	Director (M& A)	9937166235
3	Dillip Kumar Jena	Superintending Engineer	8895112192
4	G. Anant Sai	Executive Engineer	7382180454
5	Krushana Chandra Swain	AD-II	9836822421
6	Soumya Ranjan Behera	Junior Engineer	9348116774

IIT Bhubaneswar

Sl. No.	Name	Designation	Mobile No.
1	Dr. Bankim Chandra Mahanta	Assistant professor	9167768410
2	Dr. S. D. Sahoo	Assistant professor	8249786892

Water and Power Consultancy Services (WAPCOS)

Sl. No.	Name	Designation	Mobile No.
1	Prafulla Kumar Pattnaik	Sr. Chief Project Consultant	9438037307
2	Sailendra Kumar Halwai	Additional Chief Engineer	852754327
3	Dinesh Kumar Verma	Sr. Engineer	9717991864

Chilika Development Authority (CDA)

Sl. No.	Name	Designation	Mobile No.
1	Dr. R. N. Samal	Scientific officer	9437414381

Central Ground Water Board, Bhubaneswar (CGWB)

Sl. No.	Name	Designation	Mobile No.
1	Dr. B. K. Sahoo	Regional Director	9893900766
2	Sambit Samantaray	Scientist-D	7008509066
3	Prahllad Das	Scientist	7655883001
4	Gourab Kumar Swain	Geologist, Directorate of Ground Water Development	8280684850
5	Sabyasachi Das	Geologist, Directorate of Ground Water Development	7504343652

Water Resources Department, Odisha, Bhubaneswar

Sl. No.	Name	Designation	Mobile No.
1	Er. Bhakta Ranjan Mohanty	Engineer-in-Chief, Water Resources	
2	Er. Lingaraj Gouda	Engineer-in-Chief, Planning & Design	7008455761
3	Er. Mukul Chandra Bera	Engineer-in-Chief-cum-Special Secretary-I, Scheme & Monitoring	9437211962
4	Er. Dillip Rout	CE &BM , MKS, Bhubaneswar	9437071994
5	Er. Sagar Mohanty	CE , Planning, Bhubaneswar	9437002903
6	Er. Sashi Bhusan Nanda	CE , Design, Bhubaneswar	9861588790
7	Er. Chitta Ranjan Naik	CE , Monitoring, Bhubaneswar	7978939337
8	Er. Bijay Kumar Samal	CE , Drainage, Cuttack	9437225809
9	Er. Kailash Chandra Sahoo	CE &BM , Baitarani Basin, Keonjhar	9437413142
10	Kailash Chandra Mallick	Director, CEM	7609914006
11	Jugal Kishor Khatua	Director, FF, FM & GIS	9777217674
12	Er. Ananta Kumar Mohanty	Asst. to EIC, WR	9437301408
13	Er. Swagatika Mohanty	Addl. Director-II, Monitoring	9438657169
14	Er. Sangitarani Sahoo	Addl. Director-I, Monitoring	9438471310
15	Er. Madhusmita Behera	Addl. Director, Planning	9437595075
16	Bichitra Kumar Samal	Addl. Director, Mahanadi, Planning	9437102685
17	Er. G. B. Pattanaik	Addl. Director, S & B	9861212343
18	SandhyaraniSethy	Addl. Director, B & B, Planning	98666925539
19	Kailash Chandra Sethi	Addl. Director, RBVN Basin	7978614564

20	Akshaya Kumar Sahoo	Addl. Director, CEM	91437125081
21	Er. Sandeep Kumar Singh	Addl. Director, CC	9938509899
22	Er. Rupasree Panda	DD, GIS	9337072285
23	Er. Rajibakumar Sethi	DD, GIS	9178145264
24	Amiya Kumar Mudali	DD, CEM-II	9078066554
25	Er. Lingaraj Nath	DD, DL Updation& Modelling	7830044558
26	Er. Sony rout	DD, CC	815992280
27	Er. Supriya Nayak	ADD, CEM-II	9348657356
28	Er. Dillip Kumar Nayak	AE, CEM	9348206969

List of participants (Through VC)

Central Water Commission, New Delhi

Sl. No.	Name(Mr./Mrs./Miss)	Designation
1	Shri Deepak Kumar,	Director, Coastal Management Directorate, CWC, New Delhi
2.	Shri Ashis Ranjan	Dy. Director, CWC, New Delhi

Central Water Power & Research Station, Pune

Sl. No.	Name(Mr./Mrs./Miss)	Designation	Mobile No.
1	Dr. Prabhat Chandra	Additional Director	9373317260

NIO, Goa

Sl. No.	Name(Mr./Mrs./Miss)	Designation
1	Dr. R. Mani Murali	Senior Principal Scientist, NIO, GOA

NIOT, Chennai

Sl. No.	Name(Mr./Mrs./Miss)	Designation
1	Dr. Basant Kumar Jena	Director, NIOT, Chennai

NCCR, Chennai

Sl. No.	Name(Mr./Mrs./Miss)	Designation&Nameof Department
1	Dr M.V Raiman Murthy	Scientist-G, Director NCCR
2	Shri S. K Raju Aluri	Scientist-E, NCCR
3	Mr V. Ramanathan	Scientist-E, NCCR
4	MrSondi Sudhir	Scientist-C, NCCR
5	Mr Arun Kumar	Scientist, NCCR