DRAFT REPORT ON

COASTAL ZONE MANAGEMENT PLAN (CZMP) FOR KOLLAM DISTRICT – KERALA

(Prepared as per CRZ Notification 2019)

Prepared for

Department of Environment

Government of Kerala

NATIONAL CENTRE FOR EARTH SCIENCE STUDIES

Ministry of Earth Sciences, Government of India

Thiruvananthapuram - 695 011, Kerala

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CONTENTS

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1. INTRODUCTION

Coastal zone is the transitional zone, where land meets the sea and is influenced by both terrestrial and marine components. Intense interaction characterizes the coastal zone which varies from open sea to semi closed (creeks, lagoons) coastal waters and they exhibit a substantial diversity in environmental and demographic features. Here, land and ocean-dominated global processes converge and interact, characterized by multiple biogeochemical environmental gradients. The balance of these relationships provides a distinct domain of gradient-dependent ecosystems, climate, geomorphology, human habitation and most crucially regimes of highly dynamic physical, chemical and biological processes. Terrestrial processes are primarily governed by hydrological regimes and horizontal flows which provide mechanisms for energy gradients and transfer of materials (nutrients, contaminants, sediments), offering a range of conditions for material transformations and biological sustenance. Oceanic processes are similarly dominated by hydrological and physical factors that regulate the transit of materials and energy regimes, often in contrast with the land-dominated factors. The resultant equilibrium of terrestrial and oceanic processes yields regional and local heterogeneity in physical and ecological structure and supports the dynamics of ecosystem function and biogeochemical cycling in the coastal domain. Thus, mass and energy are constantly exchanging and as a result of these interactions created a unique ecosystem (Shailesh Nayak, 2017).

Coastal zones throughout the world have historically been among the most heavily exploited areas because of their rich resources. Coastal regions provide fish, shellfish, seaweeds and host ports for trading and commerce. In addition, several biota are sources of fertilizer, drugs, cosmetics and household products. Moreover, coastal wetlands also store and cycle nutrients, filter pollutants and help in the protection of the shoreline against erosion and storms. Thus, the richness and diversity of resources found in coastal regions have led to a corresponding concentration of human activities

and settlement along coasts and estuaries throughout the world. In coastal countries today an estimated half of the total populations live in coastal zones and migration from inland areas to the coast is increasing. Not surprisingly, there is also a sharp conflict between the need for immediate consumption or use of coastal resources and the need to ensure the long-term supply of those resources. In many countries this conflict has already reached a critical stage, with large parts of the coastal zone polluted from local or upland sources, fisheries severely degraded or destroyed, wetlands drained, coral reefs dynamited and beaches long since ruined for human enjoyment. If these coastal resources are to be maintained and restored, effective action is urgently needed. It is also obvious that the coastal zone will be expected to sustain the livelihoods of a very large proportion of the human population and will remain an important asset to people worldwide for the foreseeable future. The sustainability of the coastal environment is continuously impacted by pollution, eutrophication, industrialization, urban development, land reclamation, agricultural production, overfishing and exploitation. Moreover, the poor understanding of the dynamics of land-ocean interactions, coastal processes and the impact of poorly planned and managed human interventions makes the sustainability of human economic and social progress vulnerable to natural and human-induced hazards. Humans are increasingly influencing these regions, which resulting in measurable changes directly within the coastal domain and through feedback, indirectly within the terrestrial, oceanic and atmospheric compartments of the Earth system (Steffen et al., 2004). So, the major challenge that humans face today is how to manage the use of this area so that future generations can also enjoy its visual, cultural and societal resources. We need to ensure robust health of coastal ecosystems through sustainable management, so that they continue to provide various goods and services for future generations, as well.

According to a recent evaluation of the impacts of marine pollution from land-based sources, the degradation of the marine ecosystem is still occurring and, in many places has intensified (GESAMP, 2001). Hence, policies and legislations to reduce conflicts over uses in the coastal zone, protect coastal resources and support livelihood activities of local communities as well as to address the development requirements of the coast to meet economic and societal requirements are essential. Integrating environmental, economic and human activities to ensure pollution-free coastal waters and healthy ecosystems to sustain livelihood and coastal economy necessitates effective integration of science and public policy is very much needed. Due to various development schemes of private

and public, legal and illegal, large-scale modifications and damages to coastal morphology and ecosystems by way of reclamation of tidal flats, destruction of mangroves, leveling of sand dunes, mining of beach sand, construction activities for settlement, establishment of industries, dumping of waste and discharge of pollutants. Rapidly changing landuse due to the immense pressure for development in the coastal zone has adversely affected the coastal ecosystems, coastal morphology and livelihood resources of the coastal areas.

Coastal zone management depends on the information available on various aspects of coastal habitats, coastal processes, natural hazards and their impacts, water quality and living resources. The effective management techniques depend on such information and suitable response by concerned government agencies. Keeping these facts in view, Government of India on the recommendation of Ministry of Environment and forest (MoEF) passed a legislation called Coastal Regulation Zone (CRZ) in the year 1991. Under this legislative act, one of the most cost-effective long - term solutions to control various ecologically destructive activities in the endangered coastal zone, is to invoke spatial buffers around coastal ecosystems. The Coastal Regulation Zone (CRZ) Notifications (MoEF, 2019; 2011; 1991) provides buffer zones in the coastal area is being considered as the pragmatic tool to control, minimize and protect environmental damages to sensitive coastal stretches from unplanned human interference. Management of coastal ecosystems through CRZ requires identification and mapping of the regulation lines and the spatial extent of the ecosystems and morphologies in appropriate scales. Implementation and enforcement of the provisions of CRZ on the ground require extensive coastal mapping and continuous monitoring.

The National Centre for Earth Science Studies (NCESS), Thiruvananthapuram is an agency authorized by Government of India to prepare/update CZMP for the coastal stretches of our Country (OM F. No. J-17011/8/92-IA-III dated 08-08-2019). So, the Government of Kerala entrusted National Centre for Earth Science Studies (NCESS), Thiruvananthapuram for the preparation of Coastal Zone Management Plan (CZMP) for the State of Kerala following the guidelines in CRZ Notification 2019, vide G.O. (Rt) No. 80/2019/ENVT dated 28.08.2019. High Tide Line (HTL), Low Tide Line (LTL), Ecologically Sensitive Areas (ESAs) and Critically Vulnerable Coastal Areas (CVCAs) demarcated by the National Centre for Sustainable Coastal Management (NCSCM), Chennai, and the 'Hazard line' as demarcated by the Survey of India (SoI) have been made use for the preparation of CZMP.

1.1 CZMP Planning Process

The landmark Coastal Regulation Zone (CRZ) Notification, which was first issued on 19th February 1991, has been the most important legislative instrument in the country for coastal governance by considering the livelihood of fisherman and local people residing along the coast. The Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India has issued a revised CRZ Notification on 6th January 2011under Section 3(1) and Section 3(2)(v) of the Environment (Protection) Act, 1986 and Rule5(3)(d) of Environment (Protection) Rules, 1986 in supersession of CRZ 1991 except as respect to things done or omitted to be done before such supersession. Subsequently, in June 2014, the MoEFCC constituted a committee under the chairpersonship of Dr. Shailesh Nayak, the erstwhile Secretary of the Ministry of Earth Sciences, to address the concerns raised by the state governments, eliminating ambiguities and simplifying certain provisions in CRZ Notification 2011. The committee held consultations with the state governments over the following six months and submitted its report to MoEFCC in January 2015. Ultimately, on 18thJanuary 2019, in supersession of the CRZ Notification of 2011, the Government of India brought out the CRZ Notification 2019.

The CRZ is a critical regulation for conservation and livelihood protection on the coast. All developmental activities in the CRZ are regulated through the CRZ Notification. Accordingly, the CRZ has been declared as 'the coastal stretches of the country and the water area up to its territorial water limit'. The Coastal Regulation Zone Notification (MoEF&CC, 2019;2011; 1991) which provides buffer zones in the coastal area is being used as the best tool to control, minimize and protect environmental damages to sensitive coastal stretches from unplanned human interference. Thus, the CRZ Notification promote development in a sustainable manner based on scientific principles considering the dangers of natural hazards in the coastal areas and sea level rise due to global warming.

1.2 Development of a coastal database and information system

In the recent times, the availability of digital spatial data for the world coasts has vastly increased as a result of advancements in data capture and input techniques. The large increase in global data availability has had a significant impact on coastal science. The way in which coastal observations are stored and integrated largely determines the degree to which spatial processes can be understood. Therefore, well-organized and designed data systems are needed to underpin our understanding of the processes taking place over large parts of coasts. The expected accelerated rise in global mean sea levels may cause several physical changes to the world's coasts and hence can endanger coastal populations and infrastructure, as well as threaten many coastal ecosystems. The sensitivity of the coastal zone to sea-level rise, in conjunction with its importance in terms of social, economic and ecological value, highlights the need for consistent national- to global-scale assessments of potential impacts along the coasts. However, the scope of these studies has been limited by the available data in terms of resolution, coverage, parameter availability, and dated sources: this is a generic problem for broad-scale coastal analysis. In addition to these limitations, data quality and integration constitute further problems; even in those cases where data and tools are available to coastal scientists for the analysis and modeling of coastal processes, these usually exist in fragmented forms. This fact compromises the consistency, reliability and versatility of evaluations based on such sources. It has long been recognized that appropriate and reliable information within organized, planned and coherent coastal databases is an essential prerequisite for coastal zone management.

In order to address the preceding issues and provide a consistent source of data for the Indian coast, the data collated digitally onto a GIS platform for the preparation of the CZMP come handy. This database contains physical, ecological and vulnerability parameters and covers the Indian coasts uniformly, probably for the first time on a digital platform permitting retrieval, portability and sharing in a seamless manner. For this reason, the database has been specifically designed to address the data requirements of the project and the needs of researchers in the area of vulnerability assessment of coastal zones. It is also expected to be used for wider assessment of regional and global coastal issues.

1.3 Generation of CZMP maps

Management of coastal ecosystems through CRZ requires identification and mapping of the regulation lines and the spatial extent of the ecosystems and morphologies in appropriate scales. Implementation and enforcement of the provisions of CRZ on the ground require extensive coastal mapping and continuous monitoring. As per the CRZ Notification 2019 issued vide Notification No.G.S.R.37(E), dated the 18th January, 2019, all coastal States and Union territory administrations shall revise or update their respective coastal zone management plan (CZMP) framed under CRZ Notification, 2011 number S.O. 19(E), dated 6th January, 2011, as per provisions of this notification and submit to the Ministry of Environment, Forest and Climate Change for approval at the earliest and all the project activities attracting the provisions of this notification shall be required to be appraised as per the updated CZMP under this notification and until and unless the CZMPs is so revised or updated, provisions of this notification shall not apply and the CZMP as per provisions of CRZ Notification, 2011 shall continue to be followed for appraisal and CRZ clearance to such projects. The Notification also directs the State to prepare or update the CZMP by engaging reputed and experienced scientific institution(s) or the agencies and in consultation with the concerned stakeholders. Consequently, the Government of Kerala entrusted National Centre for Earth Science Studies (NCESS), Ministry of Earth Sciences, Thiruvananthapuram for the preparation of Coastal Zone Management Plan for the State of Kerala following the guidelines in CRZ Notification, 2019.

Accordingly, preparation of the draft CZMP in 1:25,000 scale map identifying and classifying the CRZ areas within the respective territories in accordance with the guidelines given in Annexure-IV to the CRZ Notification 2019 has been taken up by NCESS, which involve public consultation. The subsequent guidelines issued by the MoEF&CC based on Office Memorandum 12-1/2019-1A III dated 26-06-2020 is to facilitate the State Government in updation of the CZMPs. As per the new guidelines, The CZMP database (shapefiles etc.) prepared as per the CRZ Notification, 2011 which have been scrutinized by the Technical Scrutiny Committee, finalized by the National Centre for Sustainable Coastal Management (NCSCM) and approved by the MoEFCC, shall be used as the base for revision or updation of the CZMP, as per the provisions contained in the CRZ Notification, 2019. The guidelines brought out clarity in the case of the Data to be provided

by the States/UTs to the authorized agencies, CRZ buffers, Processing of Census data, CRZ Classifications, Public consultation of draft CZMP updated or revised based on CRZ Notification 2019, format for CZMP report, approval process of CZMP etc.

2. THE STATE OF KERALA

Kerala, the Gods own Country lies in the southwest corner of Peninsular India and positioned between 8°17'30"N and 12°47'40"N latitudes and 74°27'47"E and 77°37'12"E longitudes. It is bound by the Western Ghats Mountain ranges to the east and the Arabian Sea to the west. The Ghats run parallel to the west coast at a distance ranging from 40-80 km. Kerala is spread over a total area of 38,863 sq.km, having significant stretches of water bodies. Altitudes ranges from below sea level (the Kuttanad area) to 2,695 m and the terrain falls into three well marked divisions: (a) the high ranges of the Western Ghats in the east with undulating hilly tracts, marked by long spurs, extensive ravines and dense forest, (b) the midland occupies with plantations and cultivated plains intersected by numerous rivers and streams, and (c) the coastal belt with dense settlements, coconut plantations and rice fields (Soman, 2002). The total population of Kerala is 33,387,677 (as per 2011 census) with a density of 859 per sq km. The density of coastal urban population is 4,228 per sq. km., as compared to the average urban density of 2,097 in the state. The coastal rural population density is 1700, far above the state average rural population density of 603 (Geevan, 1996). The coastline length of Kerala is about 590 km. Kerala, despite its small land area with long coastline studded with world's best string of beaches. It is bestowed with a vast network of backwaters, lagoons, natural lakes, rivers and canals.

The wetlands of the state are categorized into two primary groups namely inland and coastal wetlands. The total area calculated as wetlands was 127930.07 ha, of which the inland wetlands cover approximately 34199.57 ha and the coastal wetlands estimated 93730.50 ha (MoEF, 1990). According to recent estimates by different agencies on wetland categories such as water spread area, aquatic vegetation and turbidity, it is around 1762 wetlands in the state. Moreover, 2592 wetlands smaller than 2.25 ha had been also identified. As a result, the total wetland area estimated was 160590 ha (Anon, 2010). CED, 2003 had suggested the major wetland classification system for Kerala based on different parameters like location, physical extend, depth, salinity, biodiversity etc.,

(Kokkal, 2008).

Kerala is rich with 44 rivers (41 west flowing and 3 east flowing) cut across Kerala with their numerous tributaries. The rivers either debouch into the Arabian Sea through inlets directly or drained to the sea through estuaries/lagoons (backwater). There are 48 inlets along the Kerala coast out of which 20 are permanent, whereas the remaining 28 are seasonal (remain open only during the monsoon period of June – September). The seasonal inlets mostly remain closed during the fair season due to the development of spit along the inlets due to deposition from longshore sediment transport. Seasonal inlets are normally cut open during monsoon for discharging storm- water accumulated from rainfall reducing the coastal inland from flooding risk. Reduction in the supply of riverine sediments might have affected the stability of the south-west coast in recent years.

The backwaters as a part of wetlands which running parallel to the coastline is a characteristic feature of the Kerala coast. It can be described as a body of brackish, marine or hypersaline water impounded by a sandy barrier and having an inlet connecting it with the open sea. Backwaters form an attractive and economically valuable and ecologically significant feature of Kerala. During monsoon, the backwaters overflow into the sea, discharging sizeable quantities of sediments, whereas in summer sea water flows into the backwater over considerable distances. The Kerala Public Works Department (Water Resources of Kerala, 1974) has identified 27 backwaters and 7 lagoons in Kerala. Kerala State has fourteen districts of which 9 districts has seacoast on its west.

There are 14 District, 152 Block Panchayats, 941 Grama Panchayats, 87 Municipalities and 6 Municipal Corporations. Apart from this, Kerala has one Cantonment (Kannur). The fourteen districts in the state are distribute over 75 Taluks consisting of a total of 1535 Villages (1664 is including the Group Villages). It is interesting to note that 9 districts (Kasaragod, Kannur, Kozhikode, Malappuram, Thrissur, Ernakulam, Alappuzha, Kollam and Thiruvananthapuram) out of the 14 have Lakshadweep Sea as their western boundaries and therefore come under the purview of CRZ covering considerable parts of coastline. Apart from the 9 districts, some parts of Kottayam district are also under the purview of CRZ since its western boundary is along the banks of tidal influenced Vembanad Lake.

2.1 Kollam District

The Kollam (erstwhile Quilon) is a southern district of Kerala, located 70 km north of the state's capital Thiruvananthapuram. It is one of the oldest districts in Kerala formed on 1st July, 1949. The district is flanked by the Arabian sea on the west, Tamil Nadu on the east, Alappuzha and Pathanamthitta districts on the north and Thiruvananthapuram district on the south. The headquarters of the district administration is centered at Kollam city, the district capital. Like the rest of Kerala, Kollam is climactically temperate with a generally sunny weather peaking in heat during April-May. The monsoon falls from June to September. The heart land of Kollam is naturally veined by the Ashtamudi lake, a massive, multi-branched brackish water body, which is also a popular boating attraction for tourists. Also, Kollam canal cutting through the city give Kollam a place of prominence in the waterway systems of the country. A number of islands of varying sizes beautifully spot the vast expanse of the Ashtamudi lake. The city is graced by beaches where people go to spend quiet evenings. Kollam also has a considerably large forest cover on its eastern side making home for several eco-tourism projects like Shenduruny, Thenmala, Palaruvi etc. With a varied colonial past under the Portuguese, Dutch and British, Kollam has locations of historical importance like the Thangasseri light house, the St. Thomas Fort and cemetery built by the Portuguese, Thevally Palace, Cheenakkottaram etc. Besides, it is also the site of several old buildings constructed by the Travancore Kings (its rulers during the pre-Independence times) in a variety of architectural styles, where many government offices still function. Kollam has been the centre of cashew industry in Kerala from the time of the Portuguese in 16th century. Having hundreds of working cashew factories in the district, Kollam continues to be the largest processed cashew exporter in India. Neendakara Sakthikulangara and Thangasseri, the three fishing harbours and ports in Kollam, support a thriving marine industry providing a variety of employment and livelihood to people in large numbers. Kollam district lies between North latitudes 8º 45' and 9º 07' and East longitudes 76º 29' and 77º 17'. The length of the coastline of Kollam district is 37 km. It has a geographical spread of 2491 sq km which is about 6.48% of the total area of the State. The location map of Kollam District is given in Figure 2.

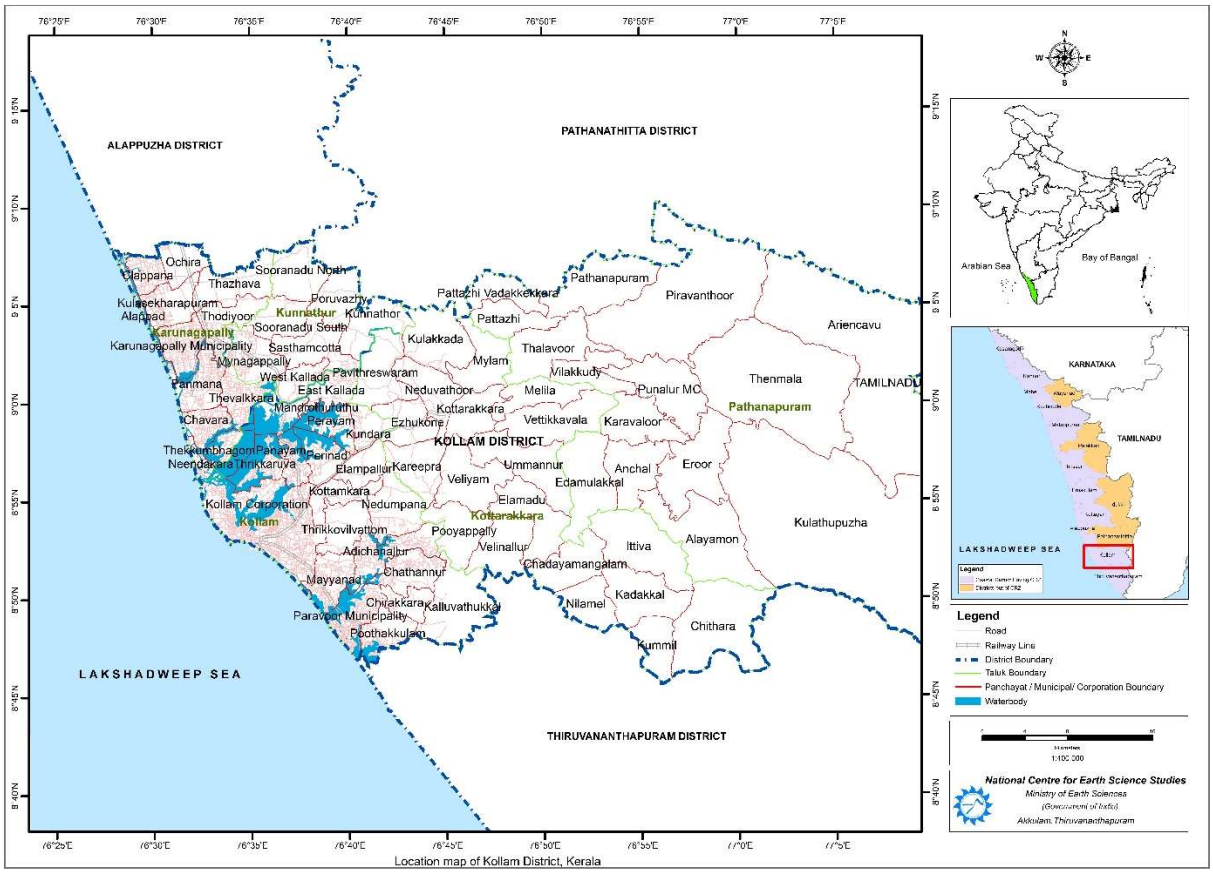


Figure 1: Location map of Kollam District

2.1(a) Administration

There are two systems of administrative set up in the State – Revenue and local self-government. Under the revenue system the district is divided into Revenue Division, Taluks and Villages. However, for local administration, the district is divided into Urban local bodies (Municipal Corporation and Municipal Councils) and rural local bodies comes under the hierarchy of District Panchayat consisting of Block Panchayats defined with geographically contiguous cluster of a few Grama Panchayats. For the implementation of development activities, Panchayats are grouped under Community Development Blocks. Therefore, all these units viz., Taluks, Villages, urban and rural local bodies have their own relevance and importance.

Kollam district is composed of two revenue divisions viz. Kollam and Punalur with three taluks each under them. Kollam is administratively divided into 6 taluks. They are Kollam, Karunagappally, Kunnathur, Kottarakkara, Punalur and Pathanapuram, which are subdivided into

104 villages. The district is further subdivided into 11 development block panchayat and 69 Grama Panchayaths. Paravoor, Punalur, Kottarakkara and Karunagapally are the four Municipal Councils and Kollam is one of 6 Municipal Corporations in Kerala.

2.1(b) Physiography

As a continuum of the State, the district too can be divided into three distinct physiographical units such as the coastal plains, the midlands and the eastern highland regions. The coastal plains form the low land areas adjacent to the Lakshadweep Sea.

The Kollam district comprises of three natural divisions viz., the low land bordering the seacoast, mid land consisting of the undulating country of low hills and valleys east of the low land and the high land covering mainly forests. The coastal plains with an elevation ranging between 0-6 m above MSL occur as narrow belt of alluvial deposits parallel to the coast. To the east of coastal belt is the midland region with altitude ranging from 6-80 m above MSL. The midland area is characterized by rugged topography formed by small hillocks separated by deep cut valleys. The midland regions show a general slope towards the western coast. To its east is the high land region. Major parts of the catchment of river Kallada and Ithikara falls within this unit. This unit occupies the maximum area of the district. The Western Ghat fringes are bounded by 300 to 600 m contours. The highest elevation is noticed at Karimalai (1758 m AMSL). The elevation gradually increases towards the highlands the average heights of Western Ghats in Kollam is 618 meters. The height of the Ghats is generally decreasing from North to South. The Achankovil gap commonly known as Aryankavu pass, give an easy access by rail and road to the adjoining district of Thirunelveli in Tamil Nadu. Morphologically, Kollam district is divided into six divisions namely Costal Zone, Ernakulam- Thiruvananthapuram Rolling Plain, Mid land, Foot Hill zone, Valley zone and Eastern Highland. The Midland constitutes more than 50% of the total geographic area of the district followed by coastal zone.

Slope with 1% to 3% gradient is seen in the coastal areas of Kollam with less than 10-meter elevation from MSL slope with 3 to 10% gradient is seen in the areas with the height of 20 m from MSL, with the undulating topography is seen in the south-western side of Kollam. In the middle of this undulating plain there is some patch of area where the slope is 1% to 3% and these are the paddy

fields of this area. The slope with gradient of 5 to 3 percentage is confined in the midland portions and in between this elevated portion there is patch of land with very gentle slope, in which these areas are also the paddy fields of the area. The soil in Kollam is varyingly loamy, laterite and forest at the coastal regions, mainland and the forest areas respectively.

2.1(c) Rivers and drainage characteristics

The district is drained by three west flowing rivers namely Achenkovil, Kallada and Ithikara, which originating from the eastern hilly region. These rivers together with their tributaries exhibit dendritic pattern of drainage. Achankovil, Ayirur, Ithikkara, Kallada, Pallikkathodu and Vamanapuram are the major water sheds of Kollam. The Ithikara River basin has its maximum elevation north of Madathara (271 m) on the eastern side and slopes down to sea level west of Mayyanad. The Ithikara River originates from the Madatharaikunnu hills, southwest of Kulathupuzha and drains into the Paravoor backwaters near Meenad. Ithikara River is a fourth order stream with a gradient of 8.2 m/km. The total length of the river is 56 km, and the drainage area is 779km^2. The Kallada River basin has its highest elevation at Karimalaikodkal (1763 m) on the eastern side and reaches almost sea level west of Karunagapally. The river originating from the Western Ghats and drains into Ashtamudi backwaters near Kollam. The total length of the river is 121km and drainage area spreads over 1996 km^2. Kallada River is a fifth order stream with a gradient of 12.6 m/km. The Achenkovil River originates from the Western Ghats and covers a basin area of 1484 km^2 and the main channel length is 128 km. The river covers the portions of Kunnathur, Mavelikkara, Chengannoor, Karthikappally, Karunagappally and Pathanamthitta Taluks. The important towns in the basin are Pandalam, Mavelikkara and Harippad. The river joins Pamba River at Veeyapuram and finally debouches into the Vembanad Lake. The Achankovil River is set in a well-known shear zone demarcating the boundary between Kerala Khondalite Belt and Charnockites of Southern Granulites terrain. The district is blessed with the largest freshwater lake of the state namely Sasthamkotta Lake and is one of the resources which cater to the drinking water needs of Kollam district. The lake occupies 440 hectares, and the catchment area of the lake is 1269 sq km.

2.1(d) Coastal Wetlands

Ashtamudi estuarine system is the second largest wetland ecosystem (6424 ha) in Kerala. It

is a palm-shaped extensive water body with eight prominent arms, adjoining the Kollam town. The arms converge into a single outlet at Neendakara near Kollam, to enter the Lakshadweep Sea. This estuary is the deepest among all the estuaries of Kerala with a maximum depth of 6.4 m at the confluence zone. The major river discharging into the Ashtamudi is the Kallada River, formed by the confluence of three rivers, viz., the Kulathupuzha, Chendurni and Kalthuruthy. Ashtamudi Lake has been designated as a Ramsar Site in November 2002. The estuary supports some endangered species according to the Red Data Book of Indian including plants such as Syzygiumtravencoricum. The wetland supports around 43 marshy and mangrove species, 57 species of birds, 97 species of fishes and some unique copepod species. More than 20,000 waterfowl visit the lake annually. Wetland supports some 97 species of fish and an important source of food, a nursery and spawning ground. The Paravoor *Kayal* covers an area of 662 ha. It is the deepest coastal estuary of Kollam district. The Ithikkara River drains into this Kayal. The Paravoor *Thodu* connects this lake to the south and Kollam *Thodu* to the north as a continuation of the Trivadrum-Shornur Inland Canal. Edava and Nadayara Kayal lie further south of Kollam district. They lie partly in Chirayinkeezhu taluk of Thiruvananthapuram district and partly in Kollam Taluk. They are connected with the sea by bars, which are opened during the rainy season. The wetlands of Kollam district face threats to its existence primarily due to encroachment and landuse conversion. The major anthropogenic factors which attributed to the wetland changes of Kollam are clay mining, sand mining, urbanization and the hydrological modifications in the form of dams, bunds and other structures that have substantially affected the ecosystem dynamics of the wetlands.

2.2. Demography and Socio-Economic Activities

Kerala has 33.38 million population as per the Census 2011. It is the 13th most populous State in India with an overall population density of 860 per square kilometer. The State of Kerala accounts for 2.8% of India's population but it contributes nearly 4% of the Indian economy. Kerala is occupied with three times more dense settlement than the rest of the country. The coastal regions are more populated than the mountains and eastern hills of the State with 2.5 times the overall population density. Kerala has a Human Development Index of 0.79, which is "very high" and the highest in India. Kerala also has the highest literacy rates among all Indian states at 98.9% and a life expectancy of 74 years which is among the highest in the country. Kerala has experienced a rapidly dropping rural poverty rate, which fell from 59% in the mid-1970s to 12% by 2010, while the overall poverty

rate fell 47% between the 1970s and 2000s, compared to a drop of just 29% in total poverty in the country. As per 2011 census, Kerala is the most literate state in India having literacy rate of 93.91%.

While Kerala has what appears to be rapid growth by the standards of most areas, its 4.9% decadal population growth rate in 2011 was the lowest in India and less than one-third of the India average of 17.64%. Between 1951 and 1991, Kerala's population more than doubled from 15.6 million to 29.1 million, reaching 33.3 million by 2011. Kerala is currently heading for zero growth in its population, as the state has a meager fertility rate and a stabilizing death rate. In 2021, census figures predict Kerala might record negligible population growth, which will be a first in India. The population is advanced with literacy and educational attainment. The various sectors such as agriculture cash crop production, animal husbandry, aquaculture, fisheries, micro enterprises and large-scale industries, tourism etc. plays important role in the economy of Kerala. This state is unique in many respects among the states of India, one of which is its settlement pattern, characterized by a rural-urban continuum. Applying the "continuous method" to study spatial change in the occupational structure across rural, small towns and large urban units (comprising of cities/big/medium towns and agglomerations), it is interesting to note that economic diversification in general and manufacturing in particular, has been fairly rapid in rural areas.

The population of Kollam district is 26,35,357 as per 2011 census and is about 7.89% of the total population of the State. Of the total population, 12,46,968 are males and 13,88,407 are females. The population density is 1061 persons per sq km. The density is higher in the coastal areas as well as urban centers and the density is low in highland areas. Its population growth rate over the decade 2001-2011 was 1.72 percent. The total literacy rate of Kollam district as per 2011 census is 94.09%. The male literacy being 96.09% and the female literacy rate has improved over to 92.31% in Kollam district. The district occupies the 8thposition in literacy rate in the state. The female work participation rate in the district is 19.28%, which is 9th position as far as the state is concerned.

2.3. Coastal Geomorphology and Ecosystem

The shoreline of Kerala is generally straight, trending NNW-SSE, with minor variations. The various coastal geomorphological units are beaches, beach cliffs, stacks, islands, shore platforms, spits, bars, beach ridges, estuaries, lagoons and tidal flats. The beaches are mostly sandy and

dynamic in nature. Throughout the coast exists narrow stretch of beach except in cliff areas. In areas like Kovalam, Vizhinjam, Varkala, Ezhimala, Bekal etc. the headland is directly abetting the sea where the wave break occurs along the foot of lateritic cliff. The height of the cliff may be of 20 m or more. In some coast having cliffs, there are numerous stacks protruding into the sea in nearshore as well as in offshore regions. These stacks are the vestiges left behind after an island or head land portion which has been eroded out or still receding. Around Mahe and Thalassery, these stacks are found aligned nearly parallel to the coast. In lateritic coast offshore islands are observed in certain locations. The Green Island located in the offshore of Thalassery coast is a similar type of island and have continuity with the mainland with a string of stacks. The constant wave attack on the neck portion resulted discontinuity of the stacks and becomes an island. The coastal wetlands, backwaters and estuaries along the coast of Kerala are rich, biologically and ecologically diverse as well as economically significant ecosystems which plays important role in livelihood of people. The major backwaters in Kerala are Vembanad, Ashtamudi, Kayamkulam, Akkulam, Kadinamkulam, Anchuthengu, Edava, Nadayara, Paravur, Vattakayal, Chettuva, and Valiyaparamba.

Physiographically, the Kollam district can be divided into three distinct units from west to east viz. the coastal plains, the midlands and the eastern highland regions. The coastal plains with an elevation ranging between 0-6 m AMSL occur as narrow belt of alluvial deposits parallel to the coast. It has a maximum width of 90kms in the north and gradually narrows down to less than 0.5kms towards south. It is a near level to very gently sloping terrain depicting depositional landforms like strandlines (palaeo-beach ridges), flood plain and tidal flats. The coastal plain has a number of back waters known as Kayals in Kerala – the prominent being the Ashtamudi Kayal, Paravur Kayal, Panmana Kayal and the Sasthamkotta Kayal. Among these the last one is a freshwater lagoon, while the others are brackish. To the east of coastal belt is the midland region having a rolling topography with elevations ranging from 20m to around 300m. The midland area is characterized by rugged topography formed by gently to moderately sloping spurs, moderately to steeply sloping ridges, flat and domal hills with intervening narrow valleys and broad valley floors. The midland regions show a general slope towards the western coast. To its east is the high land region. The hills have steep slopes and narrow as well as small summits. Highest peaks along the eastern boundary are 1200 to 1500m high. Major parts of the catchment of river Kallada and Ithikara fall within this unit. This unit occupies the maximum area of the district. The Western Ghat fringes is bounded by 300 to 600

m contours. The highest elevation is noticed at Karimalai (1758 m AMSL).

2.4. Marine Fishery Resources

Fisheries sector is recognized as one of the important sectors contributing significantly to the nation's economy. It is not only recognized as a powerful income and employment generator as it stimulates growth of a number of subsidiary industries, but also is a source of cheap and nutritious food earning foreign exchange too. It provides livelihood to approximately 14.49 million people in our country. Kerala is one of the prominent maritime States in India and is blessed with most productive portion of Arabian Sea with a continental shelf area of 39,139 Sq km. Many commercially important finfishes and crustaceans form the high value fish species. The projected value of total fish production from Kerala comes to 706.882 MT by 2019-20. Over exploitation is one of the major threats in marine fishery resources. If the rich underexploited demersal and pelagic resources are utilized effectively, Kerala can brag the top position in total fish production and contribute fruitfully towards the economic development of the State. According to the available estimates of potential fishery resources of the West Coast, particularly in the south-west coasts, Kerala possesses the richest fishing grounds in the region. Marine fish landings for 2014-15 in Kerala was estimated at 524468 MT and that for 2013-14 was 522308 MT. Contribution of various fish resources include, pelagic fin fishes 361956 69 MT, demersal fin fishes 49416 9 MT, crustaceans 65955 12 MT, molluscs 34057 6 MT and miscellaneous 13084 MT.

Kerala holds the second position in terms of fisherfolk population, among the nine maritime states in our country. A great deal of Kerala's economy depends on fishing for subsistence, livelihood and employment. Fish consumption in Kerala is four times the national average and the production share of Kerala is the second largest in the country with 16.6% of India's total marine exports. The total populace of fisherfolk residing in the state of Kerala is estimated to be 11.11 lakh, which includes 8.55 lakh in the marine sector and 2.55 lakh in the inland sector (GOK, 2015). Out of this, the number of active fishermen is 2.28 lakh (1.90 lakh in marine sector and 0.42 in the inland sector). Currently, there are 222 fishing villages in the marine sector and 113 in the inland sector, where fishing and its allied sectors provide livelihood to a vast majority of population (GOK, 2015). Primarily the fishers depend on fishing as the prime source of income. However, 12% of the fisherfolk generates additional income from allied fishing activities like marketing/repairing nets,

fish vending/processing and other fishery related activities. The socio-economic condition of the fisherfolk in the state is sad, when compared to the general section of the population. Most of them are in the grip of subsistence economy and indebtedness due to socio-economic constraints, education and depletion of fishery resources. The density of population in the coastal area is 2168 persons per km^2.

Under the fisheries department, a fisheries station is located at Neendakara in Kollam district to conduct rescue operations. Highest numbers of fishing villages are located along the district coast numbering 53 including the inland fishing villages. Highest fish production is reported from Kollam coast for the year 2018-19 as per the Fisheries Handbook 2020, amounting to 319209 tons, which includes 311896 tons of marine and 7313 tons of inland fish production. As per the available information from the Fisheries Department, Kollam District has a total marine fishing community population of 92,500 including male, female and children. The socio-economic conditions of the fisherfolk in the district are not different what has been explained above.

2.5. Biodiversity of Kollam district

Asramam mangroves forest is one of the most famous mangrove sites in Kollam district which lies along the banks of the extreme southern end of Ashtamudi Lake (Kureepuzha arm) opposite to Kollam KSRTC Bus Depot. The area is undergoing severe environmental destruction and associated land reclamation. Earlier, this is an undisturbed land having rich biodiversity of mangrove species and also having rare/endemic/endangered plant species like *Syzygiumtravancoricum, Rotang calamus, Dalbergia candanatensis* and *Droseraburmann*i etc. The spectrum of animals inhabits the area includes the rare Otter, monitor lizards and many birds including migratory birds etc. The Asramam mangroves and associated wetland comprises15 species of true mangroves, 22 species of mangrove associates, 122 plants species, 34 edible fish species and about 62 species of birds etc. The 50–60-year-old mangroves species like *Sonneratiacaseolaris (Chakkarakandal), Rhizophora mucronate (Prandankandal), Bruguieragymnorrhiza (Kara kandal), Caesalpinia crista (Kazhandi)* are grown in the northern part of Adventure Park. Mangrove vegetation in Kollam occur along the banks of estuarine water bodies and adjacent to the backwater channels, in the form of narrow continuous belt or patches. Kollam districts contribute maximum percentage of private forest (73.3%) and only 26.7% under state ownership. Compared to other

districts, Kollam has the second highest mangrove diversity (11 out of 15 true species).

2.6. Pollution and Waste Management issues

Kerala Solid Waste Management Project carried the waste quantification and characterization to represent the bulk waste generators of the State namely Household, Commercial and Institutional. The waste generation rate per capita in municipalities varies from 364 grams/capita to 456 grams/capita. Low waste generation is noticed in urban local bodies of highland areas. Highly urbanized Municipalities generate above 450 grams/capita and the City Corporation generates around 545 grams/capita. Domestic waste contributes 55-65percent of total waste, while commercial establishment and markets are the second-highest generators of waste. The average waste generation rate in Municipalities is 419 gm/capita/day whereas, the Municipal Corporation areas is 545 gm/capita/day. Based on the 3 broad categories of geographical regions (lowland, midland & highland), the waste generation rates are higher in the coastal belts, which is around 545 gm/capita/day in Municipal Corporation areas whereas, the waste generation rate in the midland belt is about 454 gm/capita/day and it is about 383 gm/capita/day in highland areas.

Mainly, the waste management includes the management of biodegradable waste, management of recyclable wastes, management of non-biodegradable and non - recyclable wastes and the management of biomedical wastes. As per the Solid Waste Management Rules, 2016, Centralized Windrow composting systems exists at Brahmapuram, Kochi and at Njaliyan parambu, Kozhikode. However, household level decentralized solid waste management facilities do exist at Kochi and Kozhikode Corportaion. More than 70% door to door collection of dry waste is achieved for households in 84 urban local bodies and for establishments in 70 urban local bodies as in May 2022. Haritha Karma Sena is working in 92 urban local bodies and 923 Grama panchayaths for collection of dry waste. For wet wastes disposal decentralized treatment methods such as aero bins, pipe compost, compost pits, kitchen bins, biogas plants etc. are followed. Dry wastes are collected, segregated and disposed through recyclers. In Kerala there are 147 plastic recycling units, 21 Steel mills, and 7 kraft paper units. Non-recyclable plastic waste is shredded in the Resource Recovery Facility and is used for the tarring of Public Works Department and Local Self Government Department roads. During the period 2016-2021, Clean Kerala Company Limited (CKCL) has produced 2399.13 T of shredded plastics and given to various agencies.

3. PURPOSE AND SCOPE OF CZMPS

The Coastal Zone Management Plans proposes a spatial planning framework for development by providing setbacks around sensitive eco-zones restricting development and other activities close to it. Setbacks require specific reference lines and boundaries for its meaningful implementation. The High Tide Line (HTL) forms the cardinal reference line for determining the setbacks for CRZ. The 50, 100, 200 and 500m CRZ lines landward from the HTL are the landward setback lines. In the case of inland Backwater islands and islands along the mainland coast, 20m from the HTL is uniformly demarcated. The Low Tide Line (LTL) and the Territorial water boundary (12 NM) form the setback lines towards the sea. The 50m line or width of the creek from the HTL has been demarcated along the tidal influenced water bodies that are connected to the sea and the distance up to which tidal effects are experienced, determined based on the salinity concentration of 5ppt. The CZMP has to be prepared in two scales (1:25,000 and 1:3960 or the nearest scale) in accordance with the guidelines given in Annexure-IV of CRZ notification 2019. The CZMP in 1:25000 scale with Survey of India Toposheets as base maps is required for formulating policy decisions. These are to be submitted to MoEFCC, Govt of India for approval after stakeholder/public consultations. The local level CZMP are to be prepared in 1:4000 with cadastral base maps and based on the approved CZMP. These local level CZM maps are for the use of local bodies and other agencies to facilitate the implementation of Coastal Zone Management Plans. The CZMP also has to incorporate the Hazard Line as demarcated by Survey of India (SoI) with a view to reduce the vulnerability of the coast. Critically Vulnerable Coastal Areas (CVCAs) demarcated by NCSCM is also incorporated into the CZMP prepared. Shoreline of high, medium and low erosion stretches for such erosion prone areas will be added after receiving the data from NCSCM.

4. COASTAL ZONE MANAGEMENT PLANS

The para 6 of the CRZ Notification 2019, numerates the following instructions for carrying out the CZMP of a State:

(i) All coastal States and Union territory administrations shall revise or update their respective coastal zone management plan (CZMP) framed under CRZ Notification, 2011 number S.O.

19(E), dated 6th January, 2011, as per provisions of this notification and submit to the Ministry of Environment, Forest and Climate Change for approval at the earliest and all the project activities attracting the provisions of this notification shall be required to be appraised as per the updated CZMP under this notification and until and unless the CZMPs is so revised or updated, provisions of this notification shall not apply and the CZMP as per provisions of CRZ Notification, 2011 shall continue to be followed for appraisal and CRZ clearance to such projects.

(ii) The CZMP may be prepared or updated by the coastal State Government or Union territory by engaging reputed and experienced scientific institution(s) or the agencies including the National Centre for Sustainable Coastal Management (hereinafter referred to as the NCSCM) of Ministry of Environment, Forest and Climate Change and in consultation with the concerned stakeholders.

(iii) The coastal States and Union territories shall prepare draft CZMP in 1:25,000 scale map identifying and classifying the CRZ areas within the respective territories in accordance with the guidelines given in **Annexure-IV** to this notification, which involve public consultation. All developmental activities listed in this notification shall be regulated by the State Government, Union territory administration, local authorities or the concerned Coastal Zone Management Authority within the framework of such approved CZMP, as the case maybe, in accordance with provisions of this notification.

(iv) The draft CZMP shall be submitted by the State Government or Union territory to the concerned Coastal Zone Management Authority for appraisal, including appropriate consultations and recommendations in accordance with the procedure(s) laid down in the Environment (Protection) Act, 1986 (29 of 1986).

(v) The Ministry of Environment, Forest and Climate Change shall thereafter consider and approve the respective CZMP of concerned State Governments or Union territory administrations.

(vi) The CZMP shall not normally be revised before a period of five years after which, the concerned State Government or the Union territory may consider undertaking a revision.

4.1. Demarcation of High Tide Line (HTL) and Low Tide Line (LTL)

The highest level horizontal positional and spatial accuracy in mapping and presenting the

HTL becomes necessary for field uses by CRZ implementing agencies. The agencies are looking for a planimetric accuracy approaching zero error. The different approaches now practiced in the country to demarcate the HTL are Tide level projection, using morphological signatures observed in the field as well as from the high-resolution satellite imageries. NCESS follows the approach as per the guidelines mentioned in the Annexure IV of CRZ Notification 2019. As per the Amendment to the CRZ Notification 2019: gazette notification no. S.O. 1422(e) dated 1st may, 2020 & no. S.O. 4886(e) dated 26th November 2021, In case there exists a bund or a sluice gate constructed in the past, prior to the date of notification issued vide S.O. 114(E) dated 19th February 1991, the HTL shall be restricted up to the line long along the bund or the sluice gate and in such a case, area under mangroves arising due to saline water ingress beyond the bund or sluice gate shall be classified as CRZ-IA irrespective of the extent of the area beyond the bund or sluice gate. Such areas under mangroves shall be protected and shall not be diverted for any developmental activities. The coastal morphological signatures are collected by field work as well as from the satellite imageries for the purpose of demarcation of HTL.

Morphological signatures are good indicators of shoreline oscillation and inundation of coastal waters, which could be used for identifying the HTL. The inundation of coastal waters on to the land and seasonal shoreline oscillations are dependent on coastal morphology. Shoreline remains stable and would not retreat significantly along cliffy coasts. The shoreline retreats up to the cliff base along pocket beaches. Artificial morphologies like seawalls confine the oscillation of shoreline along the line of the structure itself. Sandy beaches are prone to seasonal and long-term shoreline oscillation. Long term stability of the beach and the position of the stable part of the beach would be evident from morphological signatures such as berm and berm crest. This could be done by field methods and using combination of spatial data sources including satellite data. The HTL must be fixed with respect to certain reference points on the land. These reference points at sufficiently close intervals (preferably at least 1km along shore) have to be marked with respect to latitude-longitude and known points in the base map. Geomorphologic features like berm crest, cliff, headland, line of permanent vegetation, etc. are indicators of the reach of sea water into the land. Stable coastal protective structures like seawall also limit the intrusion of seawater. Hence High Tide Line (line of maximum reach of seawater into the land during spring tide) can be fixed in the field, with respect to these features and tied to the reference points, as detailed below:

a) ***Landward (monsoonal) berm crest for beaches***

In all the well-formed wide beaches, one or more berms (which are nearly horizontal part of the beach developed through the deposition of sand by wave action) are usually observed. The seaward end of the berm at which a sudden downward slope is observed is termed a berm crest. When there is only one berm, it normally gets eroded during the monsoon with a berm crest on the landward side. But when there are two berms the landward berm is the monsoonal berm, which normally do not get eroded. Or else we can say that the erosion reaches only to the second berm crest. Since the tidal waters do not reach the coast beyond this landward berm crest, it is taken as the HTL. The distance to this point from the reference point is measured using the beach profile to fix the position of the HTL.

b) ***Seawall/revetments/embankments***

In highly erosion-prone areas, no second berm is observed landward. Such locations will be protected mostly by seawalls. During monsoon season majority of these places are devoid of beaches. The waves impinge upon the seawall during the monsoon season, especially during the high tide. Thus, they are the artificial barriers stopping the waves/tides at the coast. Since the seaward part of the seawall in most cases is defaced due to erosion, the landward toe is taken as the HTL boundary in such locations. There are some locations with two or three lines of seawall, particularly in the accreting areas. The seaward seawall is considered here for the purpose. On the other extreme, in the case of continuously eroding sites there are lines of sea wall which are now in the sea. In such cases the landward seawall is taken. In order to facilitate the demarcation of HTL at seawall locations, the latter has to be clearly marked in the beach profile during coastal surveys.

c) ***Permanent Vegetation Line***

Permanent vegetation develops on the stable part of the beach. There are several locations along Kerala coast, which has only one berm and the beaches undergo severe erosion during the monsoon, and yet not protected by seawalls. In such cases, permanent vegetation, particularly well grown coconut trees, which are the main vegetation species prevalent all along the coast, is used as an indicator. The part of the beach landward of monsoon berm crest, which is mostly stable, and the

line of permanent vegetation normally follows the line of monsoon berm crest which is the HTL.

d) ***Coastal sand dune / paleo-aeolian dune***

Sand dunes are mounts, hills or ridges of sand that lies behind the part of the beach affected by tides. They are formed over many years when windblown sand is trapped by beach vegetation or other stationary objects. Sand dunes are habitat for coastal plants and animals. The size and morphology of coastal dunes is dependent on the complex interaction between controlling winds, sediment supply, and the geomorphology of the nearshore and beach environment. Mostly, dunes can be divided into those that form from the direct supply of sediment from the beach face (primary dunes), and those that form from the subsequent modification of primary dunes (secondary dunes). Sand dunes provides and storage and supply for adjacent beaches. They also protect inland areas from storm surges, hurricanes, floodwater, and wind and wave action that can damage property. Sand dunes support an array of organisms by providing nesting habitat for coastal bird species including migratory birds. The main secondary dunes include blowouts, parabolic dunes, and transgressive dune fields.

In Kerala, coastal inland areas have remnants of coast-parallel sand ridges manifesting the Holocene transgressive still stands of sea. North and Central Kerala coasts had such dispositions of strandlines of alternating ridges with swales. However, due to the demand of dense population in the coastal region and development activities, we could rarely see such raised dunes/ridges currently in Kerala except along the Pallikkara-Kanhangad coastal belt in the Kasaragod District. Another interesting feature witnessed is the foredunes bordering the beaches along most part of Kerala coast. They are seen in the backshore of the beaches as shadow dunes continuously being formed due to the sand blown out and trapped around any obstruction such as shrubs or grasses in the backshore.

e) ***Mangroves***

Mangroves are unique plant communities comprising of evergreen trees and shrubs belonging to several unrelated families observed in tropical to subtropical intertidal regions, where constant tidal water exchange takes place. Mangrove ecosystem ecologically functions as a complex ecotone or interface zone between the terrestrial and marine ecosystems, exemplifying diverse

habitats, including microhabitats, characteristic of terrestrial, intertidal and aquatic environs. As an invaluable ecological system and for reasons of its rich biodiversity, economic and social standing for sustenance and survival of community people, sustainability of sea food, and shore-line stability, conservation of mangroves is of paramount importance. They exhibit remarkable adaptation for salt tolerance with a spread of around 1 lakh sq.km world over distributed in about 30 countries. Mangroves in India account for about 5 percent of the world's mangrove vegetation and are spread over an area of about 4,800 sq.km along the coastal States/UTs of the country. The best development of mangroves in India is along the east coast with nearly 57% (~2750 sq.km) of the mangrove ecosystem of the country. Along the west coast of the country occur 23% (~1100sq.km) of the Indian mangroves and the remaining 20% is around the Andaman and Nicobar Islands (India). The east coast, unlike the west coast, is endowed with the largest mangrove wetlands developed on larger river deltas created by the major east flowing rivers of the country.

Kerala once in the 1950's was blessed with a large spread of about 700 sq.km mangroves but has been declined considerably to around 20 sq.km. All along the Kerala coast there are a good number of small mangroves stands, though mostly in isolated patches, fringing the estuaries and backwaters (kayals); and around islets or along river margins in the coastline stretches. Kerala with its very limited extent of mangroves is in no way free from the current trends of degradation of mangrove systems in the country. Mangrove systems in Kerala exhibited a higher grade of heterogeneity in their environmental settings and ecosystem features. Mangrove systems are one of the most threatened habitats in Kerala, as anywhere else in the country, or in the world. There is confusion about the actual/exact extent of mangrove distribution in Kerala in the absence of a precise estimate of it.

There are 15 true mangrove species and 49 mangrove associates observed in the coastal brackish water areas of Kerala. The 15 true mangrove species belonged to 9 genera spread over 7 families. The family, Rhizophoraceae is the most represented one with 6 species belonging to 3 genera. Mangrove associates are generally observed in the fringe areas where the wetland nature is devoid of any salinity.

Species like *Acanthus ilicifolicus*, *Excoecariaagallocha*, *Aegicerascorniculatum*, *Rhizophora mucronata*, *Sonneratiaapetalae*and *Acrostichumaureum*are were found in all the

districts of Kerala, whereas *Rhizophora apiculata*is widely distributed in Kannur and Kollam districts but not found in Malappuram. *Avicennia officinalis* is one of the common species noticed in all the districts, however, this is not the case with *A. marina* which was not seen in Trivandrum and is one of the threatened mangrove species in Kerala. Out of four species belonging to the genus Bruguiera, B. cylindrica has relatively wide distribution, however, it is not recorded from in Kottayam district. *B. parviflora* has wide distribution in the northern parts of Kerala which is not present in Trivandrum, Kollam, Alappuzha and Kottayam. *Kandeliakandal*is also a rare species which is distributed in all districts except Trivandrum, so also *Sonneratiacaseolaris* which is found in five districts namely Trivandrum, Kollam, Alappuzha, Kannur and Kasargode, whereas *S. alba* is becoming endangered due to its small populations in the districts of Ernakulam, Kozhikode, Kannur and Kasargode. *Lumnitzeraracemosa*is one of the rarest mangrove species in Kerala found in four districts namely, Trivandrum, Kollam, Alappuzha and Kannur.

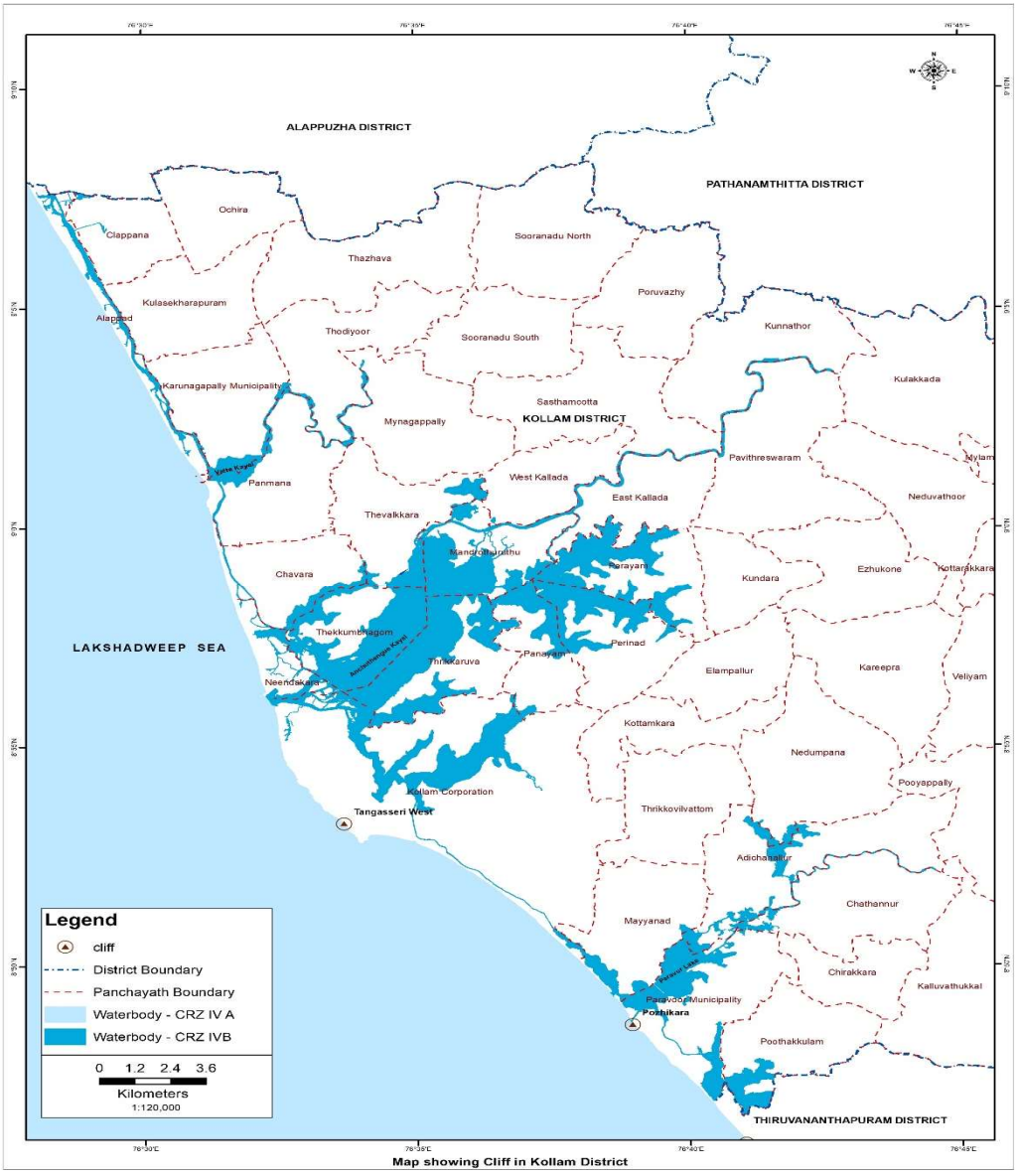
f) *Rocks, Headlands, Cliffs*

The 590km long Kerala coast is dotted in between by rocky promontories, headlands and steeply sloping cliffs. Except the coastal districts of Ernakulam and Alappuzha, all the other 7 districts have distribution of such rocks/headlands/cliffs to varied extent. At the rock outcrops, headlands and cliffs the water is quite deep that there is virtually no spatial displacement in the waterline. Hence, the High-Water Line available in the topographical maps (transferred to the base map) can be taken as such. However, at the eroding laterite cliffs (e.g., Varkala, Paravoor, Thalassery in Kerala), the latest position of the toe is taken from the cross section measured at the respective sites. This is to be verified against the satellite imagery and transferred to the base map.

The cliffs and rocky promontories present along the Kollam coast are diverse in nature. They are composed of either crystalline rocks or Tertiary sediments. The following map (Figure 2) shows the locations of such rocky/cliff headlands along the coast near Pozhikkara and Thankasseri.

Chillackal stretch of the coast near to the Pozhikkara is characterized by laterite cliffs that are under continuous threat from waves similar to that near Varkala beach. As a temporary protection measure, the natural rocks have been dumping from the top of the cliff. This dumping of stones does not withstand the aggravating wave conditions. The cliff sections Kollam district have exposures of

the Warkallai beds of fluviatile origin and underlined by marine Quilon bed belonging to the Tertiary. The contact between these two sets of beds is well exposed in some cliff sections. This section extends for about 8.25 km from Pozhikara to Tangasseri. Two well exposed cliff formations have been studied at Pozhikara and Padappakara whose respective heights are ~15 and ~16 m. The one at Pozhikara varies from 5 to 15 m in thickness and is comprised of five litho units lateritic duricrust at the top followed by lateritic clay, china clay (kaolin), carbonaceous clay and peat/lignite. Sedimentological data suggest that china clay is formed by weathering of khondalite and associated



Map showing Cliff in Kollam District

Figure 2: Map showing the locations of coastal cliffs in Kollam District

peraluminous gneisses. Kaolinite deposits were preserved due to erosion of sedimentary strata with disseminated quartz grains and intercalations of sand pockets. Carbonaceous clay and peat have been formed below the duricrust in a shallow water region, where marls with fossils of molluscus, echinoderms, foraminifers, ostracods and corals are found. Peat laminations of <1.0 m thickness was noticed at cliff bases, where wave-cut notches are formed. The first profile of this section has been measured at Chilakkal (2 km south of Pozhikara). Extended parts of this cliff showing vertical with irregular and step-like faces are protected with seawalls. However, profiles at Pozhikara are almost ephemeral depending mainly on wave conditions. Generally, this type of profile is formed in the beginning of summer monsoon and continues until the next monsoon. The cliff profile is mostly smooth at the top and base, evolving towards sigmoidal type indicating ephemeral inactivity. At the type area of Padappakara, a full section of the Quilon bed of ~16 m height cliff section fringing the Ashtamudi estuary is exposed. The detrital laterite is capped by reddish brown ferruginous gravel and underlain by limestone. The limestone has a set of vertical joints filled by colloidal silica, ferruginous matter and fragments of lignite. The limestone contains gastropods, lamellibranches, corals, pelycypods, foraminifers and ostrocods. Based on foraminiferal assemblages, Miocene age has been suggested for this formation.

g) *Influence of Tidal action*

CRZ shall apply to the land area between HTL to 50 meters or width of the creek, whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea. The tidal influenced water bodies as per the CRZ Notification 2019 means the water bodies influenced by tidal effects from sea in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds that are connected to the sea. The distance up to which CRZ is applicable shall be governed by the distance up to which the tidal effects are experienced which shall be determined based on salinity concentration of five parts per thousand (ppt) measured during the driest period of the year and distance up to which tidal effects are experienced. As per the Office Memorandum dated 26th June, 2019 of the MoEFCC, guidelines were issued facilitating updation of CZMPs, according to which, the CZMP database prepared as per the CRZ Notification 2011 shall be used as the base for revision or updation of the CZMP, as per the provisions contained in the CRZ Notification, 2019. Therefore, the tidal effects as marked in the CZMP prepared as per the CRZ Notification 2011 forms the basis for the updation of the CZMP currently being prepared. The tidal limit of various tide influenced

waterbodies of the Kollam District is given in the table below in terms of location with latitude and longitude.

Table: Salinity/CRZ limit along the inland water bodies in Kollam District

Sl. no	Name of Waterbody	Latitude	Longitude
1	Pallikkal Ar	9° 3' 49.55" N	76° 34' 3.18" E
2	Kallada Ar	9° 3' 31.05" N	76° 42' 41.41" E
3	Ithikkara Ar	8° 52' 8.84" N	76° 44' 30.73" E
4	Thodu connecting to Ashtamudi Kayal	8° 53' 59.03" N	76° 37' 17.64" E

4.2. Demarcation of Ecologically Sensitive Areas

Guidelines for preparation of the CZMP specifies that the CZM maps shall clearly demarcate the land use plan of the area and map out the Ecologically Sensitive Areas (ESAs) or the CRZ-IA areas as per mapping made available by NCSCM to coastal State and Union territories. Coastal ecosystems provide a variety of ecosystem services for humans; however, these systems are susceptible to both terrestrial and marine factors because they are situated in the coastal ecotone. Consequently, coastal marine ecosystems are very sensitive to environmental change and human activities. Constructions for coastal development are still often located in sensitive biological and ecological areas without much consideration of their impact. In this context, the CRZ Notification 2019 provides provisions to achieve coordinated development of the population, economy, and environment in the coastal area. Ecological sensitivity refers to the degree of reflection of ecosystem interference in human activities and changes to the natural environment; that is, the degree to which the ecosystem responds to environmental changes caused by the combination of internal and external factors. Through identifying such sensitive areas, conservation and management strategies could be developed that facilitate the sustainable use of coastal resources.

The different ecologically sensitive areas as listed in the CRZ Notification 2019 have been

assimilated from the previously approved CZMP maps as directed through the guidelines and further the changes occurred till recently has been captured using high resolution satellite data. The same has been field verified for accuracy assessment wherever required.

5. ECOLOGICALLY SENSITIVE AREAS/COASTAL LANDUSE

5.1. Mangroves

In Kollam district, mangroves are mainly present in three places, namely Adventure Park Asramam, Munrothuruth islands and Kumbalam area. Asramam is the one of the most famous mangrove sites in Kollam district and the mangrove species present in the area are *Sonneratiacaeseolaris, Rhizophora mucronata*and *Rhizophora apiculata*. In addition to being a major spawning ground for several edible marine species, the Asramam mangroves in the past was also home to otters and migratory birds and years ago this area contains thick and continuous mangrove patches. Species like *Brugieragymnorhiza* and species of *Rhizophora* are common in regions of Kollam district. But in the present scenario many species have disappeared along this coast. Moreover, the continuity is also lost due to severe disruption and degradation owing to developmental activities of tourism, real estate and pollutant discharges from various sources.

Studies have shown that, among the families, Rhizophoraceae was the most frequent genera having five species, followed by *Avicenniaceae* and *Sonneratiaceae* with two species each. Among the locations, Shaktikulangara recorded the highest number of species (11 species) abided by Ayiramthengu (9 species) and the least was recorded in Cherikadavu (5 Species). Distribution of mangrove at different site indicates that *Avicenna marina, Rhizophora mucronata, Excoecariaagallocha* were noticed in the entire study sites. *Avicennia officinalis* occur in five locations in which these species were found as dominant species across the study sites. Bruguiera cylindrica, Aegicerascorniculatum and Rhizophora apiculata were found in four sites whereas *Bruguieragymnorrhiza and Sonneratiacaseolaris* were noticed in three sites. *Luminitzeraracemosa, Ceriops tagal, Sonneratia alba* were rare species, which was confined only to single location.

A total of 0.883697 km^2 of mangrove spread is still available in the district with Munrothuruthu Grama Panchayat topping the list with 0.220348 km^2 followed by Neendakara Grama Panchayat (0.202596 km^2). Kollam Municipal Corporation area is having a spread of

0.114951 km^2 of mangroves especially by the banks of Ashtamudi around the Ashramam area and surroundings. Grama Panchayats such as Alappad, Clappana and Thrikkaruva have considerable spread of mangroves. The details are provided in the table annexed (Annexure-2).

5.2. Coral Reefs

Coral Reefs locations have not been reported from the Kollam coast.

5.3. Reserve Forests

Reserve Forests have not been reported from the Kollam coast.

5.4. Sand Dunes

Sand dune locations have not been reported from the Kollam coast.

5.5. Salt marsh

Salt marsh locations have not been reported from the Kollam coast.

5.6. Nesting Ground of Birds

Nesting ground of bird's have not been reported from the Kollam coast.

5.7. Archaeologically important and Heritage Sites

An archaeological site is a place (or group of physical sites) in which evidence of past activity is preserved (either prehistoric or historic or contemporary). Archaeological sites are open museum for living history. Heritage is a broad concept that includes the natural as well as the cultural environment. It encompasses landscapes, historic places, sites and built environments, as well as biodiversity, collections, past and continuing cultural practices, knowledge and living experiences. The prime concern of Conservation, Preservation and Maintenance of ancient monuments and archaeological sites along the coastal region remains one of the objectives of the CRZ Notification.

No archeological or heritage site falls within the CRZ area of the Kollam district.

5.8. Seagrass

Seagrass locations have not been reported from the Kollam coast.

5.9. Mud flats

Mud flats locations have not been reported from the Kollam coast.

5.10. Turtle Nesting Grounds

Turtle nesting locations have not been reported from the Kollam coast.

5.11. Inter-Tidal Zone

Tides play very important role in determining the biodiversity of and fertility of coastal and estuarine ecosystems. Intertidal zone is the area between the high tide (HTL) and low tide lines (LTL) as per the CRZ Notification. Intertidal zone exists wherever the tidal effects are experienced. The intertidal zone is an ecosystem where a multitude of organisms living on the shore/banks survive changes between high and low tides. The tidal ranges are low in the southern side of the west coast of India and as we move northward, its amplitude increases. At Kochi, the ranges are of the order of 1m. The tidal range increases northward and reaches to more than 2m at Marmagao. At Mumbai, maximum ranges in tidal elevations are of about 5 m. Kerala coast being microtidal in nature with tidal amplitude around 1m with slight increase from south to north, the extent of intertidal area by the sea and inland water bodies are limited.

In the case of Kollam District, intertidal area within the CRZ-IB category is 3.048955 km^2 (provided in the Table in the Annexure-2). This includes intertidal zones by the coast as well as by the tidal influenced water bodies. Adichanallur Grama Panchayat tops the list with 0.839281 km^2 spread of intertidal area, followed by Kollam Corporation with 0.379176 km^2. Panchayats such as Kunnathur and Poothakulam have no intertidal areas. The details are provided in the table annexed (Annexure-2).

5.12. Salt pan / Aquaculture ponds

Saltpans are not available in Kollam District. Though aquaculture ponds are available in the district, they have not been marked specifically since they occupy partly the intertidal zone (CRZ-IB) as well as the CRZ-IVB areas.

6. METHODOLOGY FOR PREPARATION OF CZMP

As outlined in the Annexure-IV, preparation of the CZMP has been undertaken in 1:25000 scale using the base grids of the Survey of India (SOI) topographic sheets. Wherever 1:25000 scaled toposheets are not available, the 1:50000 SOI toposheets were enlarged accordingly to compose the base maps. The base maps were georeferenced as per the datum and projections specified in the guidelines. The cadastral maps of the villages (1:3960 or nearest scales as per availability) likely to be within the purview of CRZ have been appropriately georeferenced to maintain the horizontal accuracy required. To minimize the RMS error during the georeferencing, maximum number of control points were obtained from the field using GPS (combination of methods using long static DGPS, short static DGPS and RTK obtaining acceptable precision resolving ambiguities in the post-processing techniques) to define the location in terms of latitude and longitude geodetic points in DMS format with second decimal accuracy in seconds (X & Y as cartesian coordinates with submeter accuracy). Wherever, disparity has been noticed in the hardcopy scanned cadastral image, georeferencing has been done by seeding maximum control points adjusting with the physical signatures discernible on the high-resolution satellite image which has been used as a reference image.

6.1. Field mapping and map preparation

The field mapping has been performed with hard copy of the georeferenced cadastral sheets to match the mapping scale with the ground space distance. Hard copy of the satellite images to a matchable scale has also been printed out to refer simultaneously during the field survey which comes handy in matching with the co-locatable ground features. The field surveying becomes confident with the combination of both cadastral and satellite images as well as with tying up the coordinates obtained from the GPS. All the essential features and lines are captured using the GPS by tagging attributes while carrying out the field work so that it becomes easy collate the information

into maps without any confusion or missing. The guidelines issued subsequent to the notification specifically clarifies that HTL, LTL, ESAs and Critically Vulnerable Coastal Areas (CVCAs) demarcated by the NCSCM, Chennai, and the Hazard Line as demarcated by the SOI, shall be used in preparation/updation of the CZMPs as required under the provisions of the CRZ Notification, 2019.

Timeline satellite images were verified for any considerable change in the HTL/LTL/ESAs. Significant changes in the terms of the reduction or increase of mangroves have been noticed at several places in the State, which has been verified in the field intensively. Based on the ground condition, the variations in the extent of mangroves as well as the changes in HTL/LTL has been marked using the GPS tracking *in situ*. Apart from digesting the changes in the CZMP, separate table has been created to mark the changes at each location for scrutinizing the same at the vetting stage.

7. CRZ CLASSIFICATION

The CRZ Notification 2019 has classified the CRZ area in the following manner for the purpose of conserving and protecting the coastal areas and marine waters.

7.1. CRZ-1

CRZ-1 areas are environmentally most critical and are further classified as under:

7.1.1. CRZ-1 A

CRZ-1 A shall constitute the following ecologically sensitive areas (ESAs) and the geomorphological features which play a role in maintaining the integrity of the coast viz.:

(i) Mangroves (in case mangrove area is more than 1000 square meters, a buffer of 50 meters along the mangroves shall be provided and such area shall also constitute CRZ–IA).
(ii) Corals and coral reefs.
(iii) Sand dunes.
(iv) Biologically active mudflats.

(v) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wildlife (Protection) Act, 1972 (53 of 1972), Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 0f 1986), including Biosphere Reserves.

(vi) Salt marshes.

(vii) Turtle nesting grounds.

(viii) Horseshoe crabs' habitats.

(ix) Sea grass beds.

(x) Nesting grounds of birds.

(xi) Areas or structures of archaeological importance and heritage sites.

7.1.2. CRZ-I B

The intertidal zone i.e., the area between the Low Tide Line and High Tide Line constitutes the CRZ-I B.

7.2. CRZ-II

CRZ-II constitutes the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas, which are substantially built-up with a ratio of built-up plots to that of total plots being more than 50 per cent and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply, sewerage mains, etc.

7.3. CRZ-III

Land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-II, shall constitute CRZ–III and CRZ-III shall be further classified into following categories:

7.3.1. CRZ-III A

Such densely populated CRZ-III areas, where the population density is more than 2161 per

square kilometer as per 2011 census base, shall be designated as CRZ–III A and in CRZ-III A, area up to 50 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)', provided the CZMP as per this notification, framed with due consultative process, have been approved, failing which, a NDZ of 200 meters shall continue to apply.

7.3.2. CRZ-III B

All other CRZ-III areas with population density of less than 2161 per square kilometer, as per 2011census base, shall be designated as CRZ-III B and in CRZ-III B, the area up to 200 meters from the HTL on the landward side shall be earmarked as the 'No Development Zone (NDZ)'.

7.4. CRZ-IV

The CRZ- IV constitutes the water area and shall be further classified as under: -

7.4.1. CRZ- IVA

The water area and the seabed area between the Low Tide Line up to twelve nautical miles on the seaward side shall constitute CRZ-IV A.

7.4.2. CRZ- IVB

CRZ-IV B areas shall include the water area and the bed area between LTL at the bank of the tidal influenced water body to the LTL on the opposite side of the bank, extending from the mouth of the water body at the sea up to the influence of tide, i.e., salinity of five parts per thousand (ppt) during the driest season of the year.

7.5. Regulation limits/lines

The CRZ limits has been revised or updated as per the provisions contained in the CRZ Notification 2019. The 50 meters No Development Zone (NDZ) in the case of CRZ-III areas/ a 50 meters buffer line (CRZ limit) in the case of CRZ-II areas or the width of the creeks that are influenced by tidal from sea in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds. have been drawn. The landward extent of NDZ/Buffer by the creek is up to the location where the salinity

limit of 5 part per thousand is encountered.

By the seacoast, a 500-meter line from HTL is drawn as CRZ limit irrespective of whether the area is under CRZ-III or CRZ-II. As per the CRZ Notification 2019, a new sub-category of CRZ-IIIA by the coast is introduced, where the NDZ is limited to 50 meters and the same has been updated. Similarly, as in the previous CZMP, the 200-meter line of NDZ by the seacoast has been drawn for the CRZ-IIIB areas.

The NDZ of the islands in the coastal backwaters as well as islands along the mainland coast has been limited to 20 meters, the same has been updated in the CZMP being prepared according to the CRZ Notification 2019, but it will be implemented only after the approval of IIMP of the particular Island.

Subject to the information to be provided by the State Government on the details of village-wise survey numbers pertaining to government land for deciding/enabling ease in demarcation of buffers around mangrove areas, a uniform buffer of 50 meters have been demarcated in case of mangrove area being more than 1000 square meters. The ownership details of Mangroves more than 1000sq.m spread area provided by Govt. of Kerala is provided in the **Annexure 4**.

7.6. CVCA and IIMP

Critically Vulnerable Coastal Areas (CVCA)

Sundarban region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 such as Gulf of Khambat and Gulf of Kutchh in Gujarat, Malvan, Achra-Ratnagiri in Maharashtra, Karwar and Coondapur in Karnataka, Vembanad in Kerala, Gulf of Mannar in Tamil Nadu, Bhaitarkanika in Odisha, Coringa, East Godavari and Krishna in Andhra Pradesh shall be treated as Critical Vulnerable Coastal Areas (CVCA) and managed with the involvement of coastal communities including fisher folk who depend on coastal resources for their sustainable livelihood.

No CVCA is marked in the Kollam District and in Kerala, except certain parts around Vembanad Lake, no other areas have been marked as CVCA by the NCSCM.

Integrated Island Management Plan (IIMP)

The islands demarcated in Kollam District as mainland coast islands and inland islands in the coastal backwaters need to have Integrated Island Management Plans (IIMPs), as applicable to smaller islands in Lakshadweep and Andaman & Nicobar, as per Island Protection Zone Notification, 2011 number S.O. 20(E), dated the 6th January, 2011 to be formulated by the Kerala State. This would be carried out with the help of NCSCM, once all such islands marked in this CZMP are approved by the Ministry of Environment, Forest and Climate Change. There are fifty four number of backwater islands are present in Kollam district. The islands are buffered with 50 m or width of the creek whichever is less and 20m CRZ line landward of HTL is also depicted in the map which will be considered only after IIMP is implemented. The dimensions of backwater islands show wide variation in the district, ranging in area from 0.000339 km^2 (Kollam Municipal Corporation) to 4.858093 km^2 (Thekkumbhagam). Altogether the area of islands accounts for 14.266666 km^2 (Detailed table is annexed in Annexure 2).

8. HAZARD LINE

A 'Hazard line' has been demarcated by the Survey of India (SOI) taking into account the extent of the flooding on the land area due to water level fluctuations, sea level rise and shoreline changes (erosion or accretion) occurring over a period of time. The hazard line mapped by SOI has been shared by NCSCM as part of the previous CZMP prepared. The hazard line is to be used as a tool for disaster management plan for the coastal environment, including planning of adaptive and mitigation measures. With a view to reduce the vulnerability of the coastal communities and ensuring sustainable livelihood, while drawing the CZMP, the land use planning for the area between the Hazard line and HTL need to be take into account as such impacts of climate change and shoreline changes.

9. CRZ CATEGORIES OF KOLLAM DISTRICT

The CRZ of the Kollam district consists of CRZ-IA, CRZ-IB, CRZ-II, CRZ-IIIA, CRZ-IIIB, CRZ-IVA, CRZ-IVB and the islands with their NDZ areas. Altogether 28 local bodies are covered under the CRZ area in which 25 are Grama Panchayaths, 2 are Municipalities and one Municipal

Corporation. Altogether 39 villages are under the purview of CRZ in Kollam District. The details are provided in the table annexed (Annexure-2).

The new village and panchayat boundaries provided by KCZMA, obtained from Survey and Land Records does not match with the survey plots and district boundaries in the approved CZMP, 2011. Hence old boundaries (approved CZMP, 2011) are used for this exercise, as per the instruction from DoECC, Govt. of Kerala. Even though, based on the new village boundary, the area of East Kallada and Thekkumbhagom villages has been increased by 6.308384 km^2 and 6.707981 km^2 respectively, While the area of Meenad and Panmana villages are decreased by 17.45175 km^2 and 8.732506 km^2 respectively. In the case of Kollam village, it is seen to be divided into two divisions, namely Kollam East and Kollam West.

CRZ categories and ESAs (Panchayat/Village-wise) in Kollam District

A detailed table is annexed (Annexure-2) along with this report separately on the Panchayath/Village-wise statistics of HTL, ESAs, intertidal area, mangrove buffer, area covered under each CRZ category.

10. CONCLUSION

Statistics of the CRZ status of Kollam District is summarized below:	
Total length of HTL along the Seacoast	54.2 Km
Total length of HTL along the inland water bodies	543.12 Km
Total Area under the Archeological/Historical sites	NIL
Total area under mangrove extent	0.883697 Km^2
Total area under mangrove buffer	1.189981 Km^2
Total area under intertidal zone (CRZ-IB)	3.048955 Km^2
Total area under CRZ-II along the Seacoast	9.895206 Km^2
Total area under CRZ-II along the inland water bodies	3.822694 Km^2
Total area in No Development Zone in CRZ-III along Seacoast	1.279707 Km^2
Total area in No Development Zone in CRZ-III along water bodes	15.930917 Km^2
Total area in CRZ-IIIA along the coast between 50-500 meters	5.730019 Km^2

Total area in CRZ-IIIB along the coast between 200-500 meters	0.158093 Km^2
Total area under the CRZ-IVB category	71.81881 Km^2