DRAFT REPORT ON

COASTAL ZONE MANAGEMENT PLAN (CZMP) FOR THIRUVANANTHAPURAM 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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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 Thiruvananthapuram District

Thiruvananthapuram, the southern most district of Kerala came into existence on 1st

November 1956. The district gets its name from the word "Thiru-anantha-puram" meaning the "Abode of Lord Anantha". District has a seacoast which is about 78kms long and also has the presence of continuous stretch of lakes and backwaters. It is bounded in the south and the east by Tamil Nadu, in the north, by Kollam District of Kerala and in the west by the Lakshadweep Sea Geographical extent of Thiruvananthapuram is between 76^0 41' and 77^0 17' East Longitudes 8^0 17' and 8^0 51' North Latitudes. Total area of Thiruvananthapuram District is 2187.81 sq. km. It accounts for 5.63 percentage of the total area of the State (Census India 2011). The location map of Thiruvananthapuram District is given in Figure 1.

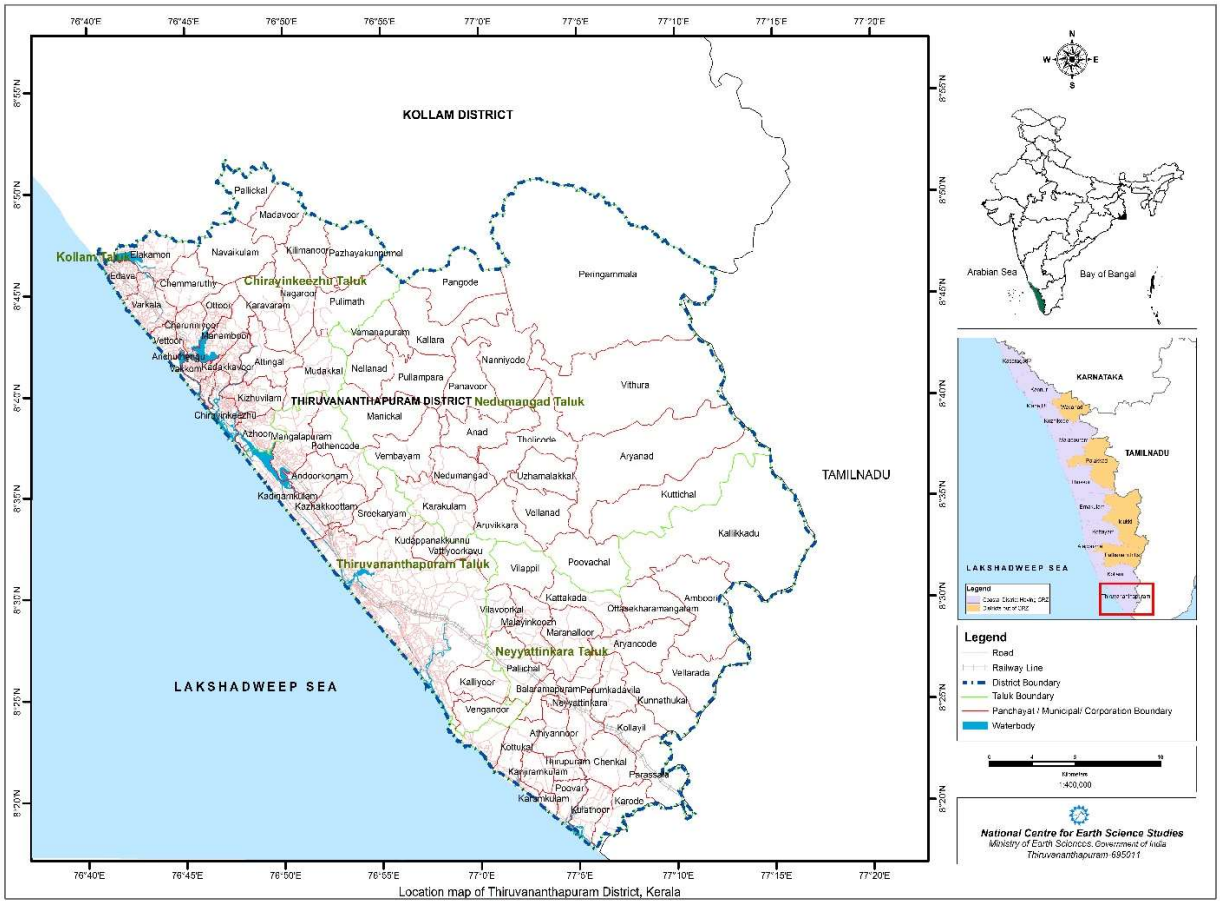

Figure 1: Location map of Thiruvananthapuram District

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. Thiruvananthapuram district is divided into six taluks (Thiruvananthapuram, Neyyantinkara, Nedumangad, Chirayinkeezhu, Kattakkada and Varkala) distributed over 124 villages. The district has two revenue division, 11 Block Panchayaths (Parassala, Perumkadavila, Athiyannoor, Nemom, Pothencode, Vellanad, Nedumangad, Vamanapuram, Kilimanoor, Chirayinkeezhu and Varkala) and 73 Grama Panchayaths and four Municipalities (Attingal, Nedumangad, Neyyattinkara and Varkala) and one Corporation (Thiruvananthapuram)

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. Out of the total area of the district, lowland covers around 5%, midland around 70% and the remaining high land area (~25%). The Chirayinkeezhu, Varkala and Thiruvananthapuram taluks are in the midland and lowland regions, while the Nedumangad and Kattakkada taluk lie in the midland and highland regions. The Neyyattinkara taluk stretches over all the three regions. The highland regions on the east and the north-east comprise the Western Ghats and this area is ideal for major cash crops like rubber, tea, cardamom and other spices. The Ghats maintain an average elevation around 800 meters. The part Agasthyarkoodam, which is the second highest peak in the Western Ghats (1869 meters above sea level) lies in the district.

Thiruvananthapuram coast is a high energy coast characterized by high waves, steep beach face and medium sized beach sand. Coastal plains, barrier beach/spits, pocket beaches and cliff/promontories are the major morphological features along the coast. Five tidal inlets are present along the study region and most of them are seasonal. Coastal protection structures such as groynes and seawalls are present in the southern sector and northern parts of the coast. Harbour breakwaters

are also present both at Muthalapozhi and Vizhinjam. One of the largest coastal structures coming up in the nearshore waters of the Thiruvananthapuram coast is the construction of Vizhinjam International Seaport for which construction of 3.2 km long breakwater is going-on and also reclamation of about 66 ha of coastal strip is also underway. The coastal stretch has varying morphological features as we move from south to north. Generally, the coastal landform of the Kerala is composed of sandy beaches, cliffs, rocky headlands, spits, estuaries, lagoons, barrier beaches, etc., depending on the geology of the location. The average distance of the coast from the Western Ghats is around 100 km. The coastal plains are low-lying areas with elevation < 8 m above the MSL. The coastal areas of Kerala comprise of beaches, alluvium, barrier flats and shell deposited during late Quaternary period. Unlike the east coast of India, this part of the west coast is devoid of deltas.

2.1(c) Rivers and drainage characteristics

The major rivers that draining the district are Neyyar, Karamana, Vamanapuram, Mamom and Ayirur, which form three major drainage basins including the Neyyar, Karamana and Vamanapuram basins. The Neyyar, the southern-most river of the Kerala State has its origin from the Agasthya hills, the second-highest peak (about 1860 m above msl) in the Western Ghats. The important tributaries are the Kallar and the Karavali Aar. The important streams are the Vandichira Thodu, Kulathur Valiyathodu, Maruthur Thodu, Athiyanur Thodu, Thalayil Thodu, Kottukal Channel and Venganur Thodu. The length of the river is 56km. The total drainage area of the basin is 497sq.km and joins Lakshadweep Sea near Poovar. During its course it passes through the villages of Ottsekharamangalam, Kulathummel, Maranalloor, Perunkadavila, Neyyattinkara, Chenkal and Kulathur. The Karamana River has its origin in the Chemmunji Mottai at 1717 m above msl and Agastyamalai of the Nedumangad Hills. The river is formed by the confluence of the Kavi Aar, Atti Aar, Vaiyapadi Aar and Todai Aar. The Killi Aar which joins the Karamana River near Nadakara is its main tributary. The length of the river is 68km with a catchment area of 702 sq.km lying entirely within the State and joins the Lakshadweep Sea near Pachallur. The Vamanapuram, Mamom and Ayirur River forms the Vamanapuram drainage basin and originates from the Chemunji Motai at about +1860m above M.S.L. The river has a length of 88km with a drainage area of 687sq.km.which lies entirely within the State and flows in a north-westerly direction and then to south-west before emptying into the sea. The rivers draining into the Lakshadweep Sea along this coast form estuarine

interface around their inlets.

2.1(d) Coastal Wetlands

There are 10 major backwaters in the district. The major lakes are Veli-Akkulam, Kadinamkulam, Anchuthengu, Kappil, Akathumuri and the Edava-Nadayara. Veli-Akkulam is a small inland brackish water lake in the district and has no permanent connection with the sea. It is fed by Kannammoola stream, Kulathur stream, Amaizhanchan stream and Sreekaryam stream. The Kadinamkulam Backwater is the largest among the backwaters of Thiruvananthapuram district. It lies almost parallel to the adjoining Arabian Sea for some distance and maintains a temporary connection with the sea to the northwest. The inlet to the sea gets closed completely during pre- and post-monsoon periods. The Vamanapuram river empties into the backwater through the Anchuthengu lake in the vicinity of the inlet. In fact, the Akathumuri-Anchuthengu- Kadinamkulam backwater system is an interconnected shallow brackish water system in the Thiruvananthapuram District which is having a common temporary inlet near Perumathura. The Paravur canal (2.14 km long) connects Paravur backwater with the Kappil Kayal. It is separated from the Arabian Sea by a sand bar, which occasionally breaks forming the Kappil inlet. This backwater broadens towards the interior developing four arms. The Varkala canal connects this system with the southern part of Anchuthengu backwater. The Edava- Nadayara backwater is situated in the northern part of Thiruvananthapuram District. The Ayiroor River, which is the second smallest river of Kerala originating near Navaikulam (total length of 17 kilometers) is the major feeder of the Edava- Nadayara Lake. The Edava- Nadayara backwater is connected to Paravur Lake through Maniyamkulam Canal.

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.

Thiruvananthapuram District was formed on July 1st, 1949. It is the administrative capital of the State of Kerala and is the second populated District in the State with an area of 2189 sq.km. As per the 2011 Census data, the district has a total population of 3,301,427 of which male and female were 1,581,678 and 1,719,749 respectively. Thiruvananthapuram District population constituted 9.88 percent of total Kerala population though the district constitutes only 5.66% of the total area of Kerala. In terms of density of population, the district occupies first position in the State (1508 persons/sq.km). The district occupies the 8th position in sex-ratio (1087) whereas in literacy, the district has the 10th position among the districts with 93.02 per cent literates. In sex ratio the district records above the State average of 1084 females per 1000 males in 2011 census. In the district 27.91% of workers are main workers and 9.4 per cent are Marginal Workers in 2011 census. Work participation rate of the district is 37.3 percent and is in 5th position among the district in

2011census. Thiruvananthapuram District has been ranked 4th in female work participation rate (21.4 per cent) according to 2011 census data.

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.

Thiruvananthapuram coastal region is bounded by Kollam coast in the North, Attingal-Neyyattinkara undulating upland in the East, Tamil Nadu in the South and the Lakshadweep Sea in the West. This coastal plain gradually slopes towards the west. Attingal-Neyyattinkara undulating upland region lies parallel to the coastal region and makes its boundaries with Kottarakkara undulating upland in the North, Ponmudi-Agasthyar forested hill in the East, Tamilnadu in the South and Thiruvananthapuram coast in the West. This region has more ups and downs mostly over its central portion. Ponmudi-Agasthyar forested hills lies in the eastern section of the district and is bounded by Kulathupuzha forested hills in the North.

Thiruvananthpuram coast is punctuated by 5 permanent/temporary inlets at Neyyar (Pozhiyur), Karichal (Adimalathura), Karamana (Panathura–Poonthura), Veli, Muthalapozhi and Edava–Kappil. Coastal plains of Thiruvananthapuram are generally narrow. The sandy coast south of Pulinkudi headland extends from Adimalathura to Pozhiyur and further south. This sector of sandy coast is very narrow, and the width is limited by lateritic cliffs and hills. The coastal plain extending from Poonthura in the south to Pudukuruchi in the north is comparatively wider. Construction of coastal protection structures like seawalls and groynes and breakwaters for fishery harbour has substantially modified the coastal features. Seawalls have been constructed for more than 20 km along the coast. Fishing gaps have been provided in between the seawalls for a length of 50 to 100 meters to facilitate traditional fishing. Groynes at Panathura, Poonthura and Chilakkur together occupy more than 4 km length of coast. Groynes at Chilakkur still remain intact though their construction was undertaken way back in 1890s. At the same time some of the groynes at Panathura–Poonthura sector, though constructed recently (2008–2010), are not in good condition. Unlike Chilakkur groynes, the Panathura–Poonthura groynes are supported by seawalls. Groynes further south of Chilakkur along Anchuthengu sector are buried under beach sand and get exposed during monsoon due to erosion. The revetments at Sankhumugham have been devastated during the recent erosion.

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. 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 Vizhinjam in Thiruvananthapuram to conduct rescue operations. Highest numbers of fish landing centres are located along the district coast numbering 48. As per the available information from the Fisheries Department, Thiruvananthapuram District has a total marine fishing community population of 1,67,754 including male, female and children. The socio-economic conditions of the fisherfolk in the district are not different from what has been explained above.

2.5. Biodiversity of Thiruvananthapuram district

Endowed with several natural beaches and backwater, the coast of Thiruvananthapuram

attracts many national and international tourists and nature lovers. Besides, certain anthropogenic activities like construction of the buildings by encroaching the coast, religious activities at few places like Kovalam, Varkala etc., increases the plastic pollution and disturbs the natural vegetation along the coast. Therefore, such activities should be controlled to support the vegetation and conservation of natural vegetation along the coast. Mangroves in Thiruvananthapuram district are growing in the mud flats, estuarine ridges and edges of island systems according to the specific geographical formations of the area. Though earlier reports have shown considerable extent of mangroves (28 ha) in the district, the distribution of mangroves is far less (less than one hectare) and is the least among other coastal districts. Most of the mangroves in Thiruvananthapuram district are in an irreversible process of degradation. Mangroves in Veli-Akkulam lake is completely fragmented and destroyed and need immediate conservation. Earlier studies have suggested comparatively good mangrove vegetation in Kollam, Alappuzha and Kannur districts and a very sparse distribution of mangroves in Thiruvananthapuram district in terms of diversity and richness. The mangroves in Veli backwaters were found to be confined to the Vikram Sarabhai Space Centre (VSSC) campus. *Sonneratia caseolaris*, *Avicennia officinalis* and *Acrostichum aureum* are the only three species found in Thiruvananthapuram district, of which *Acrostichum aureum* was the most dominant species.

One of the important floras noted along the coast is the seaweeds. The luxuriant growth of the seaweeds was seen at the rocky coasts like Chowara, Mulloor, Vizhinjam, Kovalam, Samundra beach, Varkala and Edava, whereas in the sandy coast such Poovar, Eve's beach, Hawah beach, Sangumukham etc. most of the seaweeds can be seen ashore. Thiruvananthapuram district has a geographical area of 2,189 sq km, of which 18.39% is under forest cover. However, 56% of the actual forest area of 403 sq km is considered to be under various stages of degradation. The district has two protected areas viz., Peppara and Neyyar which together accounts for 181 sq km of forests. The natural vegetation in the district could be broadly classified as West Coast Tropical Evergreen, West Coast semi-evergreen, South Indian Moist Deciduous and grasslands.

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 Corporations. 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 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).

Kerala once in the 1950's was blessed with a large spread of about 700 sq.km mangroves (Ramachandran et al., 1985) 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 the species 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 Thiruvananthapuram 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 starting from the north Varkala, Kovalam, Vizhinjam and Poovar.

Varkala is a well-known tourist destination with numerous waterspouts and spas on these cliffs. Extending from Vettoor to Tiruvampadi for about 7.50 km length, comprising cliffs of Chilakur-Janardhanam-Papanasam-Shreat and Varkala. Generally known as Varkala cliffs, they are made up of alternating beds of sand and carbonaceous material exposed along this part belonging to the Warkalli formation of Mio-pliocene age. Thin seams of lignite of the Warkalli formation suggest good vegetation at the time of deposition of the clayey sediments. Vertical ridges or speleothems are visible suggesting local precipitation of carbonates. As it has a unique geological feature, a national geological monument has been declared by the Geological Survey of India for their protection, maintenance, promotion and enhancement of geotourism. In 2015, Ministry of Mines, Government of India and Geological Survey of India (GSI) have declared the Varkala Cliff as a Geo-heritage site. The unit found at Janardhanam is one of the highest (46 m) cliff units, but the height of cliff gradually

decreases to a minimum of 10 m both towards the south (Chilakur) and the north (Papanasam). The profiles at Chilakur and Janardhanam are more complex and strongly affected by wave undercutting, groundwater seepage and sub-aerial weathering. These profiles are typically steep, non-vegetated and vertical (~13 m height) at the top with debris at the base of the cliff. However, the Papanasam profile is similar to that of Chilakur, but mainly affected by gully erosion due to groundwater seepage and human interference.

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

The Poovar cliffs consists of bauxite layer at the base, followed by cross bedded and

variegated sandstones, clays, grits (arenaceous rocks with angular to sub-angular particles) and laterite cap at the top which add up to a height of 30 m. Sandstones and clays show lenticular

distribution with lateral interlinking of clay. An interesting aspect of this sequence is that the sediments overlie bauxite which is developed over khondalitic basement. The sandy units found at Karichal are formed as a part of channel fill sequence. This cliff does not contain any remains of plant fossils like the Warkalli and is evidence for neo-tectonic activity.

The cliffs between Vizhinjam Port and Kovalam consist of impermeable massive charnockites with enclave of mafic granulites with a total thickness of about 8m. Shore normal profile variations of this cliff are very less due to impermeable hard rock which shows slope overwall profile type. The wave cut notches are clearly seen on the lower cliff face near Kovalam. They might have been formed when the sea level was at a higher level during the mid Holocene period.

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 Thiruvananthapuram 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 Thiruvananthapuram District

Sl.no	Name of Waterbody	Latitude	Longitude
1	Vamanapuram River	8°42'31.41"N	76°48'38.96"E
2	Karamana Ar	8°28'44.65"N	76°58'17.36"E
3	Neyyar River	8°21'15.22"N	77° 5'14.38"E
4	Killi Ar	8°27'59.32"N	76°57'35.81"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

As per the report of the Kerala Forest Department published in 2006, spread of mangroves in Thiruvananthapuram district was 23 ha. Small patches of mangroves present on the banks of estuarine water bodies are highly degraded and at the verge of complete devastation. Akkulam- Veli lake is one of the important locations from where mangroves were reported earlier, however during the present mapping campaign no mangroves have been observed around the lake except for sparse associates near the VSSC area. Meagre presence of mangroves has been observed by the banks of Anchuthengu and Kadinamkulam Kayal. Mangrove diversity studies conducted recently have pointed out least diversity and abundance in Thiruvananthapuram district. Mainly three species have been noticed from the district, viz., *Avicennia offiicinalis, Sonneratia caseolaris* and *Acrostichum aureum*, the local body where some abundance of mangrove has been noticed is the Kadinamkulam Panchayat (0.004055 km^2) followed by Azhoor Panchayat (0.000741 km^2). Vakkom, Anchuthengu, Poovar, Chirayinkeezhu and Manamboor Panchayats have nominal presence of mangroves. Noticeably, urban local bodies such as Thiruvananthapuram Corporation, Varkala Municipality and Attingal Municipality are devoid of any mangroves. The table comprising of CRZ details of local bodies attached with this report provides the distribution of mangroves in each of them in terms of sq. km. Altogether, the mangrove spread in the district account of 0.011213 km^2. The details are provided in the table annexed (Annexure-2).

5.2. Coral Reefs

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

5.3. Reserve Forests

Reserve Forests have not been reported from the Thiruvananthapuram coast.

5.4. Sand Dunes

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

5.5. Salt marsh

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

5.6. Nesting Ground of Birds

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

In the Thiruvananthapuram District, there are three locations where archaeological sites have been identified; both of them are within the coastal tracts of Thiruvananthapuram Corporation limits. The total area of the three monuments together constitutes around 0.07 ha.

The rock cut temple in Vizhinjam is located within the 500 CRZ limit by the coast of the Vizhijam Fishing Harbour. Considered to be the smallest rock-cut shrine in southern India, the Vizhinjam Rock-cut cave is dated to back to 8th century. Kanthalloor Shala, the ancient university in the city might have had a campus at Vizhinjam too. Accoding to archaeologists, it is an incomplete temple, carved into a small granite boulder. The shrine has a central cell with an independent sculpture of Dakshinamurthy and on either side of the cell are unfinished sculptures of Siva and Parvathi. It is believed to be one of the earliest rock -cut cave temples in Kerala. This rock cut cave is now a protected monument under the control of the Archaeological Survey of India since 1965.

Ayyipillai Asan and his brother Aynipillai Asan, the maestros of Malayalam literature made many contributions to the development of Malayalam literature. Ayyipilla Asan is the author of

'Ramakatha Pattu', a classical work in old Malayalam. The 'Mavarathapattu' another work in old Malayalam is credited to his brother Aynipillai Asan. This small shrine having no particular idol in the Sreekovil have been turned as the memorial of these two renowned poets of ancient Kerala and it was declared as protected monument in 1987. The shrine is located within 100 meters from the coast of the southernmost pocket (crescent) beach of Kovalam or otherwise known as the Light House Beach.

As per the Department of Archeology, Kerala, Vizhinjam Bhagavathy Temple, a rectangular Nirandhara Dravida shrine made of granite located near the sea dates back to 9th century. It is square in plan and consists of a small shrine with a cell having a dome-shaped superstructure. In Vizhinjam temple the base, the pilasters, the pillars in the corners, the porch, the entablature and the roll cornice are made of stone. The walls and the superstructure are of brick masonry. The grabhagriha (Sanctum sanctorum) without circumambulatory is rectangular in shape, with a small portico in front. The chief deity Bhagavathy (Saptamatrikkal) faces the North. Prime importance is to Goddess 'Vaishanavi' one among the Saptamathrikkal. The Subshrines are Siva facing the west, Veerabhadra and Ganapathy. The Vizhinjam temple is akin to the contemporary Chola shrines in Kaliyapatti, Tiruppur and some others at Pudukkottai. The shrine itself conforms to the square linga shrines of South India. Its adhishthana is of manchaka type, unusual for the temples of early mediaeval times. The stray images of Saptamatrikkal collected from Vizhinjam dates back to the same period as that of Chamundy from Kodungalloor. On one side of its Sopana there located an image, originally belongs in the Saptamatrikkal panel. The image appears to be Kaumari seated in the ardha - paryankasana. This two-armed idol wears Upavita, necklaces, bangles, bracelets and anklets. One of the hands of that idol is placed in Kati and the other is kept in the Varada posture. The idol of a male deity in the same posture having a Jatabhara found there is assumed to be that of Dakshinamurthy. Vizhinjam temple complex is acclaimed generally as a Bhagavathy temple. Besides this Bhagavathi temple there remains a square-shaped Siva shrine in the temple complex. Both of them made out partly of stone and brick. The Siva temple is of Ekatala Vimana (Single storeyed) with a brick built griva (neck of the dome) and a small rounded sikhara (cupola). The Adhishthana (plinth part) is of the Manchaka type. Its overall shape and architectural tradition resemble that of the 8th and 9th century C.E. The Bhagavathi temple had undergone a complete renovation while the Siva temple when compared, retains much of its original nature. The brick superstructure and the walls of the Bhagavati shrine are

now built of ashlar masonry.

5.8. Seagrass

Seagrass locations have not been reported from the Thiruvananthapuram coast.

5.9. Mud flats

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

5.10. Turtle Nesting Grounds

Turtle nesting locations have not been reported from the Thiruvananthapuram 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 Thiruvananthapuram District, intertidal area within the CRZ-IB category is 5.330981 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. Thiruvananthapuram Corporations tops the list with 1.668079 km^2 spread of intertidal area, followed by Kadinamkulam Panchayat with 1.03507 km^2. Attingal Municipality and Panchayats such as Elakamon, Ottoor, Kizhuvilam, Venganoor, Chenkal and Karode 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 Thiruvananthapuram 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 Thiruvananthapuram 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 Thiruvananthapuram 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 thirty-five number of backwater islands are present in Thiruvananthapuram 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 area from 0.001338 km^2 (Azhoor) to 0.806022 km^2 (Chirayinkeezhu and Azhoor). All together the area of islands accounts for 4.127723 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 THIRUVANANTHAPURAM DISTRICT

The CRZ of the Thiruvananthapuram District consists of CRZ-IA, CRZ-IB, CRZ-II, CRZ-IIIA, CRZ-IVA, CRZ-IVB and the islands with their NDZ areas. Altogether 26 local bodies are covered under the CRZ area in which 23 are Grama Panchayaths out of which 9 are 'other Legally Designated urban areas and 3 are with atomic mineral deposits, 2 are Municipalities and one

Municipal Corporation. Altogether 39 villages are under the purview of CRZ in Thiruvananthapuram 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. Based on the new village boundary, the Azhoor and Kadinamkulam villages has been increased by 12.820946 km^2 and 20.9209 km^2 respectively, while the area of Menamkulam and Nemom villages are decreased by 8.35597 km^2 and 11.679071 km^2 respectively.

CRZ categories and ESAs (Panchayat/Village-wise) in Thiruvananthapuram 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 Thiruvananthapuram District is summarized below:	
Total length of HTL along the Seacoast	73.92 Km
Total length of HTL along the inland water bodies	332.96 Km
Total Area under the Archeological/Historical sites	0.00076 Km^2
Total area under mangrove extent	0.011213 Km^2
Total area under mangrove buffer	NIL
Total area under intertidal zone (CRZ-IB)	5.330981 Km^2
Total area under CRZ-II along the Seacoast	18.395438 Km^2
Total area under CRZ-II along the inland water bodies	3.883627 Km^2
Total area in No Development Zone in CRZ-III along Seacoast	1.610527 Km^2
Total area in No Development Zone in CRZ-III along water bodes	5.498989 Km^2
Total area in CRZ-IIIA along the coast between 50-500 meters	12.622189 Km^2
Total area in CRZ-IIIB along the coast between 200-500 meters	NIL
Total area under the CRZ-IVB category	13.548781 Km^2