DRAFT REPORT ON

COASTAL ZONE MANAGEMENT PLAN (CZMP) FOR KANNUR 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.

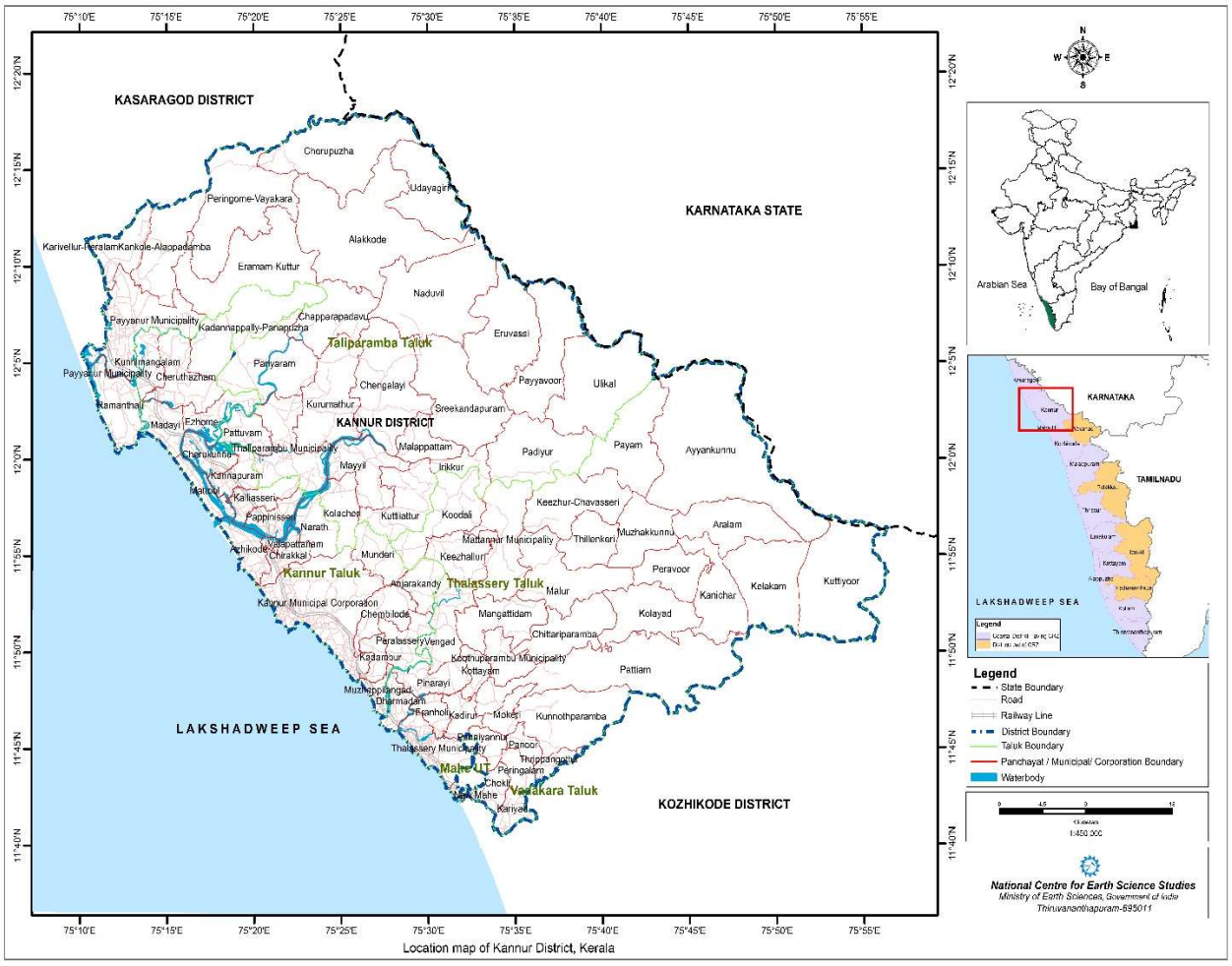
The backwaters as a part of wetlands which running parallel to the coastline is a characteristic feature of the Kerala coast. It can be described as a body of brackish, marine or hypersaline water impounded by a sandy barrier and having an inlet connecting it with the open sea. Backwaters form an attractive 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 Kannur District

Kannur district derived its name from the location of its headquarters at Kannur town.

Kannur is one of the well-known districts in Malabar area of the state, came into existence on 1st January 1957. Kannur district is known as the land of looms and lores, because of the loom industries functioning in the district and festivals held in temples. The district is a major centre of Theyyam, a ritual divine dance worship of northern Kerala. Small shrines known as kavus associated with the Theyyam dot the district. The district has a seacoast of about 82kms long and also has the presence of stretch of lakes and backwaters. Kannur district lies between latitudes 11° 40' to 12° 48' North and longitudes 74° 52' to 76° 56' East. The district is bound by the Western Ghats in the East (Koorg district of Karnataka State), Kozhikode and Wayanad districts in the South, Lakshadweep Sea in the West and Kasaragod district in the North. Total area of Kannur district is 2961 km^2. It accounts for 7.67 percentage of the total area of the State (Census India 2011) and area-wise ranked 6^{th} among the districts. The location map of Kannur district is given in Figure 2.



Location map of Kannur District, Kerala

Figure 1: Location map of Kannur 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. Kannur district is one of the districts in the Malabar area of the State, which is divided into five taluks (Kannur, Thaliparamba, Iritty, Thalassery and Payyannur) distributed over 132 revenue villages. The district has two revenue sub-divisions (Thalassery and Thaliparamba), 11 Block Panchayaths (Payyannur, Kalliasseri, Thaliparamba, Irikkur, Kannur, Edakkad, Thalassery, Kuthuparamba, Panoor, Iritty and Peravoor) and 71 Grama Panchayaths and nine Municipal Councils (Thalassery, Taliparamba, Payyannur, Kuthuparamba, Mattannur, Anthoor, Panoor, Iritty, and Sreekandapuram). The area encompassing the Kannur city and surroundings are in the Kannur Municipal Corporation.

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 Kannur district falls under the four Sub-Micro Regions viz. (i) Kannur Coast, (ii) Peringome - Mattannur Undulating Upland, (iii) Taliparamba Koothuparamba Plain and (iv) Kannoth Forested Hills.

The Kannur coastal region lies as a narrow coastal strip on the western side of the district and cutting longitudinally all the taluks of the district. The central tract is generally flat except the rocky cliff near Ezhimala (260 m) and in certain isolated pockets in the Northern Coast and around Thalassery Coast. Lateritic cliffs of Pre-Cambrian Age are found here.

Peringome - Mattannur undulating upland region is bound by Kasaragod Table - Land in the

North, Karnataka State in the East, Kannoth Forested Hills in the South and Taliparamba - Koothuparamba Plain and Cannanore Coast in the West. This region has undulating terrain with number of isolated hills. The differentiation of heights and its recurring character explain for the planation surfaces of different ages. This phenomenon has been confirmed by the cross profiles drawn. The maximum height (933m MSL) is recorded at Payyavoor Desom of Eruvassy village of Taliparamba taluk. The 100 m contour which reveals that the minimum height occurs mostly over the western portion.

Taliparamba - Koothuparamba Plain region is bound on the North and East by Peringom-Mattannur undulating upland, on the South by Kozhikode district and on the West by Kannur Coastal Plain. This rolling plain gently slopes towards West. The maximum height (159 m) lies in its southern tip at the Kolavelloor Desom in Kolavelloor Village of Thalassery Taluk and its minimum height (63 m) lies at Pattuvam Desom in Pattuvam Village of Taliparamba Taluk. This area has large number of lateritic mesa especially around Taliparamba area, subdued lateritic hills occur here and there, apart from the isolated hills like Ezhimala. The development of flood plains as well as river terraces is planked by moderate slopes. The undulating topography is quite evident over Thalassery area which is drained by the Anjarakandy, Thalassery and Mahe Rivers.

Kannoth forested hill region is bound on the North by the Peringome - Mattannur undulating upland, on the East by Karnataka State, on the South by Wayanad and Kozhikode districts and on the West by the Taliparamba - Koothuparamba Plain. Its steep slope area borders the Wayanad Plateau and there is a sudden drop in gradient within a short distance. The maximum height of this region is I 047 m, which is located at Cheruvanchery of Thalassery Taluk. This region forms the catchment area of the Valapattanam River, Aralampuzha, Bavalipuzha and Anjarakandy Rivers. The river originating from the ridge lines along the border of the Wayanad Plateau plunge down to the Mid-land forming deep gorges. Occasional landslides are the feature of the region during monsoons.

The mountainous regions are the continuation of the Midland region, gradually ascending to the main ridge of the Western Ghats. The highest peak of this district is Veidalmala of Taliparamba Taluk with a height of 1371.60 metres (4500 feet). Mount Eli or Ezhimala is a conspicuous isolated hill with a height of 260.60 metres (855 feet) projecting into the Lakshadweep Sea. It is an important landmark for mariners from old times.

2.1(c) Rivers and drainage characteristics

Kannur district is mainly drained by the Valapattanam and Anjarakandy rivers. The other rivers are Kuppam, Mahe, Thalassery, Perumba and Ramapuram . Dendritic is the common drainage pattern for all rivers. Valapattanam is the largest River in the Kannur district having a length of 110 km. It originates from the Brahmagiri of Western Ghats in Coorg district, Karnataka at an altitude of 900-1350m above mean sea level. After flowing through Karnataka for about 19 km, it passes through the lritty, Irrikur, Kalliasseri and Valapatanam villages of Kannur district. The river drains into the Arabian sea along with Kuppam River near Azheekal. Major tributaries of the river are Sreekandapuram River, Valiyapuzha, Barapole, Venipuzha and the Aralampuzha. Total drainage area of the river basin is 1867 sq.km of which 564 sq.km lie in Karnataka state. Valapattanam River near its confluence with Lakshadweep Sea is having the famous Azheekal fishing harbour which is also the main source for the irrigation project (Pazhassi Dam) in the district. The Anjarakandy River originates from Kannoth Forests in Thalassery Taluk at an altitude of +600m above M.S.L and passes through Kannavam, Kadamkunnu and Vemmanal before it joins the Lakshadweep Sea. The river mainly flowing through the Anjarakandy in Kannur district. The major tributaries of the river include Kappu Thodu and Idumba Thode which joins the main channel near Kunderipoyil. The basin has an area of 412sq.km lying entirely in this State. The length of the river is 48m.

Perumba river flows through the Payyanur in Kannur district. The river in its course flows through the villages of Peringoni, Kuttur, Mathamangalam and Kunnumangalam. This river rises from the densely forested hill slopes of the Western Ghats near Pekunnu in Vayakkara Village at an altitude of +325m above MSL. A tributary of Perumba which is called Vannathi River flows through the Mathamangalam area. Perumba River is known as Panappuzha in the Mathamangalam area. Another tributary is the Kallamkulam Totti that originates from Kallamkunnu and flows through Totti and finally merges with the Murikkum Thazham. The other important streams are the Challachal, Mukkuttenkarachal and Nitaringapuzha. The total length of the river is 51km and drainage area of 300sq.km. Kuppam River originates from the Padinalkadu Ghat forests in Coorg district of Karnataka state at an elevation of 1630m and it flows almost parallel to the Valapattanam River. This river is also called as Mattool river flows through the Kannur and Taliparamba taluks. Before it debouches into the Lakshadweep Sea, it joins the Valapattanam River at Mattool near

Azheekal. Total drainage area of the river is 539 sq.km of which 70 sq.km is in Karnataka state. The main tributaries of the river are Pakkatupuzha, Alakuttathode, Kuttilolpuzha, Mukkuttathodu and Chiriyathode streams. The total length of the river is 82 km, and the navigable length is only 24 km. The Azhikkal minor port is at the mouth of the river. Tellicherry River is also known as Ponniumpuzha or Eranjolipuzha. It originates in the Kannoth Forest at an elevation of +550m above M.S.L. on the western slope of the Western Ghats. The only tributary joins the main river about 14 km away from its mouth near Koduvally, about 3 km. north of Thalasseri town. The river flows through the villages of Cheruvancheri, Mudiyanga, Patyam, Mokeri and Padakkal. This is one of the smallest rivers in Kerala having a length of 28 km with a drainage area of 132 sq.km. The Mahe River which is also known as Mayyazhipuzha, originates from the forest on the western slopes of the Wayanad Hills at an elevation of +910m above M.S.L. The river passes through Mananthavady Taluk of Wayanad District, Vadakara Taluk of Kozhikode District and Thalassery Taluk before it joins the Lakshadweep Sea at Mahe about 6 km south of Thalassery. The river has a length of about 54 km, and it drains an area of 394 sq.km. During the rule of the British, Mahe River was popularly called as the English Channel. The river was named so as this river separated British ruled Thalassery and French ruled Mahe.

2.1(d) Coastal Wetlands

The Kavvayi Wetland, a coastal backwater body spread out in 10.6 sq.km area, located in Kasargode and Kannur districts of Kerala. Geographically it is located between the coordinates 75˚ 06' 48" E to 75˚15' 40" E longitudes and 11˚59' 52" N to 12˚14' 36" N latitudes. Some significant values of this wetland include flood control, diverse mangrove vegetation, rich biodiversity, fishery, coir retting, mussels culturing, pollution control, inland navigation, sacred groves and back water tourism. Kariangode, Kavvayi, Perumba, Ramapuram, and Nileswaram are five major rivers draining into the Kavvayi Lake, in which only the Kariangode River originates from the Western Ghats of Kerala and all the other rivers originate from the lateritic hills of midlands. The Kavvayi Lake mixes with Arabian Sea near Mavilakadappuram of Valiyaparamba panchayath. More than 15 islands, namely Valiyaparamba, Kurippadu, Kochuthuruthu, Kavvayi, Madakkal, Edayilakad, Thekkekad, Vadakkekad, Oriyam, Ori, Kokkal, Chembantemadu, Purathadu, Thuruthy, Achamthuruthy etc., are present in the Kavvayi wetland system. The Kavvayi wetland system

including the five rivers which draining in its account for a drainage area of 1264.62 sq.km. Out of the five rivers, Kariangode basin is the largest and Ramapuram is the lowest. The water spread area of Kavvayi wetland at mean sea level is 9.1 sq.km, with a maximum depth of 8.9m. The Kavvayi wetland system has been facing threat from land reclamation. The environmental problems identified in the catchment area of the wetland includes sand mining, unscientific development of tourism, aquatic weeds which multiply very quickly and cover the water bodies, destruction of mangroves and unscientific construction of bunds that poses a threat to the biodiversity of the wetland which is home to some rare species of hydrophytic plants, birds and fishes, urbanization or anthropogenic pressure and community pressure for fuel, food and fodder.

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 Kannur district was known in its anglicized name 'Cannanore' till 1991 Census, since its formation on the 1st January, 1957. Kannur district ranks the 6th in area (2961 sq.km.) among the districts in the State. With 25, 23,003 persons, Kannur district ranks the 8th in population among the districts. In total density (852) the district ranks the 9th position. The district has recorded the 12th rank in total work participation rate (32.66percent) in the State and also shares the 11th rank in male (51.58 per cent) and 12th rank in female (16.01 per cent) total work participation rate. With 92,558 persons, Thalassery Municipality is the most populous Town in the district. In literacy rate, Kannur district ranks the 5th position (95.1 per cent). Handloom, Beedi and Coir are the important traditional industries in the district. The Central State Farm located at Aralam, is a unit of the State Farmers' Corporation of India Limited, New Delhi under the Ministry of Agriculture, Government of India. It is one of the main centre of production of hybrid coconut seeds in the country. Asia's largest plantation of Cinnamon, the famous Brown's plantation is situated at Anjarakandy in the district with an area of nearly 500 acres, which was started by the English East India Company in 1767. India's as well as Asia's largest Naval Academy Ezhimala Naval Academy is in Kannur.

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.

Kannur coast lies as a narrow coastal strip on the western side of the district. This micro region stretches through 4 municipalities, 7 blocks and 29 panchayats over a length of 82 km out of 590 km coastline of Kerala from Thalassery to Ramanthali. Within this length the coastal area keeps a diversity of landforms from sandy beaches to rocky cliffs. There are rocky outcrops seen in Thalassery at the southern part, hard driving beach at Muzhippilangad, Cliff at Payyambalam, a spit at Kavvayi, rocky outcrops at Ettikulam. Besides the natural eustatic change, the area is disturbed with southwest monsoon, narrow coasts, presence of mid lands up to the coast and river outlets, which may be the reasons for the natural change of landforms.

The district can be divided into three distinct geomorphologic units viz., i) the coastal plains and lowlands in the western part, (ii) the central undulatory terrain comprising the midland region and (iii) eastern highland region. The Coastal plain forms a narrow belt of palaeo-coastal/alluvial depositional landforms running parallel to the coast with a maximum width of about 15 km. It comprises of narrow beaches interrupted by cliffs, promontories and rocky beaches. Estuaries, lagoons, tidal flats, floodplain and palaeo-beach ridges are the other landforms of the area. The region has a maximum height of 7m in the east. The midland region, a relatively wide zone representing denudational landforms exhibiting laterite capped flats, mesa ridges, spurs, laterite interfluves and narrow alleviated valleys. Midland region forms a plateau land at certain places covered by a thick cover of laterite. Elevation of this region displays remnant planation surfaces as well. Two stages of planation surfaces with fairly extensive remnants are characterized by laterite capping. Remnants of relatively older surfaces are identifiable at higher altitudes. The hilly region

in the east is a structural cum denudational landform. In those regions, the elevation crosses 500m with steeply sloping hills. Landforms of intrusive origin are also noticed near Peralimala and Ezhimala. The hilly tract in the eastern part consists of highly rugged terrains. The Ezhimala peak, being nearer to the coastal plain with the characteristic N-S alignment, is a distinct physiographic unit in the coastal plain. Minor laterite cliffs generally rising to an elevation of 50 to 60 m above mean sea level are found at Mahe and Thalasserry coast. The midland region presents a plateau land covered by a thick cover of laterite. This is immediately to the east of the coastal strip, rising from 40 to 100 m above MSL. The valleys in the plateau are gorge-like and V shaped cut due to the youthful streams. The hilly tract along the eastern part of the district constitutes the highland region and is highly rugged. Development of bad land topography along the margins of the valley is a common feature observed in the district.

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.

The famous Mappila Bay fishing harbor is located at Kannur. Under the fisheries department, ADAK has got a fish farm at Eranjholi in Thalassery, Mastyfed is having a prawn hatchery at Mappila Bay in Kannur, Andhalloor and Palayad brackish water farms in Dharamdam. The highest numbers of fish landing centres are located along the district coast numbering 48 nos. Statistics from the Kerala Government- fisheries department shows that Kannur district is in the third position as far as fish production is concerned based on 2018-19 data (total fish production 61271 tons including the marine and inland production). Kannur district has 11 marine fishing villages and 5 inland fishing villages. There are 13 fish landing centres in the district and two modern hygienic fish markets located at Kannur and Thalassery. It is estimated that there are 1512 households within 50 meters from HTL in the district with a total of 9120 members living in them. As per the available information from the Fisheries Department, Kannur district has a total marine fishing community population of 38,597 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 Kannur district

Kannur district has maximum aerial extent of mangroves among the coastal districts in

Kerala, i.e., around 45% of Kerala's total mangrove cover. Nearly 90% of these forests – which support at least 10 species of mangroves (including the uncommon Rhizophora apiculata), 87 species of fish, 83 species of birds and 13 species of mammals – are under private ownership and are therefore highly threatened. The mangroves associated with the Ezhimala and Kawayikayal surroundings and the coastal areas of Kuppam (Payangadi) and Valapattanam Rivers are perhaps the prime centers of mangroves. Mangroves of appreciable growth are also found associated with the Dharmadampuzha, Anjarakandipuzha and the Eranjolipuzha near Dharmadam and Thalassery areas of the district. Further north are the mangroves of the Valappattanam River and the Kuppam River with the notable vegetation-stands being distributed at the locales of Madakkara, Thekkumbad, Payangadi, Ezhom etc. The Ezhimala-KavvayiKayal complex of mangroves associated with Ramapurampuzha, Chankurichal and Peruvamba River systems, predominantly centered in and around the areas of Kunhimangalam, in fact constitute the most potential mangrove genetic resource stocks of the state.

The minor rivers namely Anjarakandy and Eranjoli form considerable extent of wetland network system that possesses small, sporadic stands of mangroves in and around Thalassery and also at Melur, Mathikavu, Nettur, Koduvally areas near and around Dharmadam. Mangrove afforestation and augmentation works (i.e.., planting of mangrove seedlings and their protection) initiated by the Forest Department (Kannur Division) at Koduvalli and Dharmadam areas is claimed to have been successful with a survival rate of about 80% of the augmented plants. The mangroves in these areas predominantly include the species of *Avicennia officinalis, A. marina, Sonneratia alba, Rhizophora mucronata, Aegicerascorniculatum,* etc. Considerable concentration of *Meretrix meretrix and Villorita sp*., forming large beds of harvestable nature were observed near Moidupalam area close to sea. Edible oysters like *Crassostrea madrasensis* and *Saccostrea cucullata* are the other species of potential economic importance, which is widely being collected and marketed. The latter one, locally known as 'KappeeriMuru', owing to its so-called medicinal properties is highly valued and exported to the south-east Asian countries. Among other faunal dwellers of the mangrove ecosystem, the semi aquatic bug, *Halobates galatea*, the member species of the only known genus representing the true marine insects was observed and collected from the brackish waters close to the mangrove environs of the Thalassery River. Scientific investigations have, for the first time, reported the occurrence of this insect species from the coastal waters of Kerala. Many shore birds

were observed abounding the environs of the marsh-mangrove wetland system of these areas. Among the birds sighted include wading birds like Little Egret, Median Egret, Large Egret, Grey Heron, Purple Heron, etc. Rare and endangered water birds like *Darter* (Snake bird), *Anhinga rufa* were occasionally sighted from the area. A roost of Flying Fox, *Pteropus giganteus* was also observed on the tree-canopy of *Sonneratia alba* near Mathikavu area. Smooth coated Otter (*Lutrogaleperspicillata*) was sighted occasionally near Melur area.

The Kavvayi backwaters, otherwise called Kavvayi Kayal, an elongated water body extending all along parallel to the shoreline between Ezhimala and Nileswaram stretching about 21 km, formed by the drainages from four rivers namely Karingote, Nileswar, Kavvayi and Peruvarnba, is perhaps the most conspicuous feature of the lacustrine system in the coastal tract of northern Kerala. The backwater system is found dotted with a few major islets namely, Edayilakad, Madackal, Vadakkekad, Chembantemedu, Oari, Thekkekad ,Purathal, Kockal, etc. The protected shores and vast mudflats along the coast, and the sandy/muddy ridges surrounding the islets are found with potential stock of mangrove stands. The stands exhibit varied types of mangroves with differential stand-structure and abundance at various localities, as varied as tall, widespread canopied tree-stands to degraded shrubby thickets, or stunted or arrested vegetation at other places. The mangroves at Kockal show exemplary climax growth of trees *of Avicennia officinalis* having high girth and well branched canopy characteristics, in addition to well grown species like *Avicennia marina, Bruguiera cylindrica, Rhizophora apiculata, Excoecariaagallocha, Sonneratiacaseolaris, Aegicerascorniculatum*, etc. The occurrence of *Lumnitzeraracemosa* from this area has also been reported by Jafer and Radhakrishnan, 2003.

The mangrove vegetation associated with the muddy intertidal areas of Kavvayi kayal, notably the stocks in and around the areas of Kunhimangalam, and on the fringe deltas of islets, is all that is left nowadays reckoning their extensive, lush and dense stock of the unique ecosystem, which had existed there once upon a time. The present system stands out only as a regenerating stock of a much-disfigured mangrove treasure, constituting mostly of only mangroves with medium sized trees. However, in and around the Kunhimangalam areas, the sporadic occurrence of distinct and isolated giant mangrove trees, with hefty trunks having higher girth measures and well spread branches and canopy, portrays-standing as living relicts-the glory of the older or ancient stock of

mangroves of this region once upon a time. Quantitative structure of the true mangroves studied in terms of frequency, density and abundance related to the diversity of species in and around Kunhimangalam area, has revealed the species *Avicennia officinalis* having 80% frequency with higher density of trees, among the true mangroves' community.

The mangrove fringed coasts and the vast mudflats provided good potential for fisheries. The catches from the coastal estuarine cum backwaters exhibit good diversity and abundance of species. Local fisher folk greatly depend on the fisheries for their subsistence living. Anadaragranosa, locally known as 'KuhanIIambacka is regularly collected from the coastal wetland systems, along with species of *Meretrix, Paphia* and *Villorita*. Among the mollusks collected from the Kavvayi backwaters, *Anadaragranosa* and *Paphiamalabarica* are of high economic importance since their lime is said to be of very high quality.

The midland hillocks of northern Kerala have its own characteristic floral composition supporting scrub jungles and cashew plantations on the hill slopes and grasslands and associated aquatic and semi-aquatic plants on the hilltops. Even though these hills are exposed directly to the sunlight and wind, they harbour rich species diversity. Recent plant explorations revealed more additions to the known plant species of the area some of which turned out to be new to science, and endemic to the locality. The vegetation of the hillocks may be classified mainly into grasslands and scrub jungles. The grasslands can again be categorized into wet phase and dry phase grasslands based on the seasons. More than 500 plant species have been recorded from Madayipara.

The grasslands on the laterite hills of north Malabar are classified under low elevation dry grasslands, characterized by remarkable diversity. This type of natural grassland is the characteristic feature of the laterite hills of Kannur district. These grasslands are highly seasonal and interspersed with other herbaceous plants and scrub jungles. More than 50 species of grasses were recorded from Madayipara hills, many more remaining to be fully identified. The common grass species are the *Eragrostisuniloides, Ischaemum indicum, Heteropogoncontortus, Pennisetum polystachyon, Cynodondactylon*and species belonging to the genera *Arundinella, Dimeria, Panicum, Themeda*, etc. Species of *Arundinella* form the commonest grasses during the months of October and November. The pinkish inflorescence of these grasses makes the area appear as if burnt mixed here and there with green shades.

During the flowering season of mangrove plants, a number of butterflies, wasps, Carpenter bees and honeybees were found visiting the mangrove flowers. *Odonates* (dragonflies and dalnselflies) are represented by *Diplocodestrivialis, Crocothemisservilia, Orthetrumsabina, Tholymistillarga, Agriocnemispygmaea, Ischnura aurora, Ceriagrioncerinorubellum* and *Pseudagrionmicrocephalum*. A notable observation was the epidemic outbreak of pest infestation by the notorious teak defoliator Hyblaeapeura on mangrove vegetations of Avicennia at Payangadi, Thalassery coastal areas in Kannur district. The sandy beaches of Azhikkal and Mattul are known for the breeding of Olive Ridley Turtle*, Lepidochelys olivacea*. (Text is mostly adopted from the ZSI publication titled *Mangroves and their faunal associates in Kerala with special reference to Northern Kerala, India* authored by Radhakrishnan et al., 2006)

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. In areas where stabilized frontal beach with considerable width seaward of seawalls are present, the HTL has been marked following the procedures prescribed in the CRZ

Notification 2019 and HTL manual (NCSCM Technical Report Series 23B, 2015: MANUAL ON DEMARCATION OF High Tide Line and Low Tide Line and preparation of CZMP of the Coast of India). Either the permanent vegetation line or the monsoonal berm crest has been considered for HTL demarcation in such cases as done for the coasts without seawall. 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 Kannur 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 are in different stretches from Thalassery to Dharmadam, Kuttikkakam to Payyambalam, Neerkadavu to Meenkunnu, Puthiyangadi to Ezhimala.

Two stretches of 5 and 2.75 km length—extending from Tellicherry to Dharmadam with height varying from 6 to 14 m are present. They are also semi-permeable (laterite, laterite with clay) to impermeable (charnockite) in nature. Another two stretches of cliffs between Kuttikkakam and Payambalam, covering a total length of about 6 km dots the coast. The cliffs along Kuttikkakam-Kadalai coast (2.25 km) are impermeable to semi-permeable type, whereas the one exposed between St. Angelo's Fort and Payambalam (3.75 km) consisting of laterite and clay is of semi-permeable nature. The toes of the cliffs of this section are protected by seawalls of 1.0–1.5 m height and 3.0–4.0 m width. Another stretch consisting of laterite and laterite with clay is a permeable cliff, extending from Neerkkadavu to Meenkunnu for a length of 1.5 km. Cliffed shoreline sections also extend from Puthiyangadi to Ezhimala (4.25 km) and Pallikere to Bekal (3.75 km). Impermeable basement of these sections is overlain by semi-permeable laterites.

The northern Kerala cliffs are lithologically different from that of southern Kerala. The cliffs distributed discontinuously from Puthiyappa to Mahe are composed of Precambrian crystalline and Tertiary sediments. The beach in front of the cliff is narrow and the shore normal profile is mostly vertical and unstable due to deep wave-cut notches at the base. The cliff section at Mahe varies from 4 to 8.5 m height. Base of the cliffs are composed of Precambrian ultrabasic rocks, while the top 1.5 m is semi-permeable primary laterites. At few places discontinuous thick foliated hornblende-biotite gneissic platforms and horizontally bedded weathered hornblende biotite gneissic structural ledges are found. It has been concluded that high water rock ledges are the result of lithological control and higher stands of past sea level. These ledges are ~5 m thick and 7.5 m wide which might have been

formed due to natural weathering and strong wave activity.

The cliffs at Thalassery are composed of ~12 m thick resistant charnockitic gneiss in the bottom overlaid by ~6 m thick laterite. Slumping of lateritic material is common here due to induced sub-aerial weathering. Lithologically, the Dharmadam cliffs are also similar to that of Tellicherry, but the thickness of charnockitic rock is only ~5 m. At few sites the basement rock is highly jointed/faulted and the gaps are filled with kaolinite. The Green Island located in the nearshore at ~100 m towards west of Dharmadam is formed by highly eroded primary laterites. It is 5.5 m above mean sea level, measuring a length of ~225 m oriented perpendicular to the shore and fully covered with oysters and vegetation. This is a discontinuous profile extending for about 550 m across nearshore. A few well-exposed stacks and notches are formed between the Green Island and the shore due to erosion of lateritic cliffs.

The cliff formations found from Kuttikkakam to Kadalai and St. Angelo's Fort to Payambalam are semi-permeable to impermeable in nature. The height of cliffs increases from 2 to 5 m near Kuttikkakam to 5–12 m near Kadalai. The ones near Kuttikkakam are made up of impermeable hornblende-biotite gneiss where wide joints are formed due to direct attack of waves, whereas those at Kadalai comprises laterite and lateritic clay. The shore normal profile at Kadalai is vertical and retreating due to continuous wave activities during monsoon and spring tides. However, St. Angelo's Fort to Payambalam cliff comprises primary hard laterites of about 8 m thickness. It is concave in shape and its ends project towards sea act as wave breakers. A few stacks are formed due to aerial and sub-aerial weathering but there is no beach in front of this. It is expected that these stacks would be destroyed in the next few years.

The cliff profile of this part is sigmoidal in shape with sharp upper part and sigmoidal curve in the lower part. The cliffs are comprised of permeable laterite (~9 m) and lateritic clay (~7 m) with a total thickness of about 16 m and located along the Azhikkode coast. This section is also retreating due to debris fall and rotational slide induced by direct wave and sub-aerial weathering. The cliff profile is found to be changing rapidly due to formation of wave-cut notches followed by debris fall from middle part of the profile (just above the notch) leading to formation of larger wave-cut notches.

Cliffs of impermeable nature extend from Puthiyangadi to Ezhimala in the district.

Composition of these cliffs varies from gabbro to granite through granophyres and is not vulnerable to wave activity. The overall height of the Ezhimala hillock is about 280 m above mean sea level, but near the coast the height of the cliffs is only about 30 m. The cliff profile varies considerably due to sub-aerial action, debris fall and toppling failures.

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

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 Kannur 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 Kannur District

Sl.no	Name of Waterbody	Latitude	Longitude
1	KavvayiPuzha	12°10'2.33" N	75°12'26.22" E
2	Perumba River	12° 6'30.94" N	75°16'44.86" E
3	Vayalapra River	12° 2'47.60" N	75°16'6.59" E
4	Kuppam (Thalipparamba)	12° 6'39.38" N	75°22'50.27" E
5	Kuttikkol River	12° 0'18.78" N	75°22'44.17" E
6	Valapattanam River	12° 0'27.73" N	75°27'33.48" E
7	Anjarakandi River	11°53'31.98" N	75°31'51.75" E

8	Dharmadam River	11°47'48.30" N	75°30'59.89" E
9	Eranjoli River	11°45'32.56" N	75°31'23.90" E
10	Mahe River	11°43'29.02" N	75°36'43.76" 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

Kannur district occupy highest extent of mangroves in the state hence it is named as the

capital of mangroves in Kerala. More than 60 per cent of the total mangrove areas is under private ownership. Mangroves are luxuriant in certain areas due to the minimum human interference. Plant diversity of pure mangroves is also very high in Kannur when compared to other districts (12 out of 15 pure mangrove species). This is the only district which had undertaken extensive mangrove afforestation programmes with the auspices of Kerala Forest Department. The uncultivated Kaipppad fields are being profusely invaded by mangroves. Kunhimangalam, Kalliassery, Olavailam, Edat, Thekkumpadu and Cherukunnu are few places where mangroves are protected and devoid of much human interference. The mangrove vegetation in the above areas is mainly influenced by the halophytic adaptations. During the study, a total of 15 pure mangroves species were recorded from the mangrove areas and are belonging to 9 genera and 6 families. Rhizophoraceae represented 7 species followed by two each from families, Avicenniaceae, Sonnaraceae and Euphorbiaceae respectively. From the study of structural features of the mangroves at Kunhimangalam, Valapatanam and Dharmadam areas of Kannur, it was noticed that *Avicennia officinalis* represented highest IVI (141.86) followed by *Excoecariaagallocha* (112.14). Species such as *Rhizophora mucronate, Rhizophora apiculate, Avicennia officinalis, Avicennia marina,Bruguiera cylindrica, Kandeliacandal, Sonneratia alba,Sonneratia Caseolaris, Excoecariaagallocha,* and *Aegicerascorniculatum* are present in the district profusely. *Lumnitzeraracemosa* is a threatened species presents in the district.

A detailed study has indicated that *Rhizophora mucronata*is profusely distributed in Kannur whereas it was not seen in Kottayam and Thiruvananthapuram districts. *Rhizophora apiculata*is widely distributed in Kannur district but not found its presence in Thiruvananthapuram, Kottayam, Thrissur and Malappuram districts. *Avicenniaofficnalis* is one of the common species which could be able to establish in different mangrove formations in the state. It is noticed in all the districts except Thiruvananthapuram. However this is not the case with *A.marina* which was not seen in Thrissur and is one of the threatened mangrove species present in Kannur. Out of three species belonging to genus Bruguiera, *B. cylindrica* has relatively wide distribution. *B. gymnorrhiza* is a rare species which had shown its presence in few districts but surprisingly are rare in Kannur. Similarly, *B. sexangular* is one of the endangered species, which is also rare in Kannur District. *Kandeliakandal* is also a rare species which is distributed in considerable extent in Kannur. *Sonneratiacaseolaris*is also widely distributed species in Kannur which can be found in almost all the districts in Kerala.

The total extent of mangroves in Kannur district is 9.10894 km^2, which is the highest among any coastal district in Kerala. Among the local bodies, Ezhome Panchayat (1.28298 km^2) followed by Cherukunnu Panchayat (1.272338 km^2) have luxuriant growth of mangroves. Panchayats such as Thripangothur, Keezhallur, Vengad, Anjarakandi, Kurumathur, Chengalai, Chapparapadavu and Kadannappaly-Panapuzha are devoid of mangroves. Among the urban local bodies, Payyannur Municipality (0.685798 km^2) followed by Anthur Municipality (0.217899 km^2) have considerable extent of mangroves left in spite of the urbanization process (Detailed table is annexed in Annexure 2).

5.2. Coral Reefs

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

5.3. Reserve Forests

Reserve Forests have not been reported from the Kannur coast.

5.4. Sand Dunes

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

5.5. Salt marsh

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

5.6. Nesting Ground of Birds

Nesting ground of bird's have not been reported from the Kannur 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 Kannur district, there are three locations where archaeological sites have been identified; two of them are in the coastal vicinity of Kannur Municipal Corporation and the third one in Thalassery Municipality. The total area of the three monuments together constitutes around 5,56 ha.

St. Angelo's Fort is located near Kannur cantonment, one among the 62 cantonments in the country. The fort is facing the shore of Lakshadweep Sea and this fort is also known as Kannur Fort, which has a major role in the history of Kerala. The fort offers an enchanting view of Mappila Bay, a natural fishing harbour and Dharmadam Island, situated 100metre away from the mainland near Muzhappilangadu beach. The fort is built of laterite and has a triangular shape. The secret tunnels, the underground jail, the ammunition dumps are the proof of brilliant planning and design, even though the technologies were limited at that time. The pathway behind the fort leads into the sea is an excellent view from the top. It is believed that there is a secret underground tunnel that connects Thalassery fort to Kannur fort. It was said that this secret tunnel of 21 km long is used by the soldiers to escape from enemy attacks. The fort was built by Portuguese leader Francisco De Almeida on October 1505. It was built with wood initially. Later in 1507 Almeida used the stone to construct the fort at the same site. The fort had been a military base for the Portuguese army. On 15 February 1663, The Dutch caught the fort from Portuguese. They renovated the structure adding some modern features. Arakkal King Ali Raja of the famous and only Muslim dynasty of Kerala bought the fort from the Dutch in 1772. Later, 1970 British captured the control and used as their chief military centre in Malabar till 1947.The famous St. Angelo Fort is open for tourist and is one of the most popular and attractive tourist destinations in Kannur. Now it is protected and maintained under the Archeological survey of India. Tourists from all over the world are dropping by to get a peep into the history of the European invasion of Kannur during the 12th century.

Arakkal Museum monument the Arakkal Dynasty, which is the only Muslim dynasty in Kerala. The Arakkal royal palace is called Arakkalkettu locally. The royal family pursued a matriarchal system of lineage with the oldest person from the family, regardless of gender, turned

into the head of the family and the ruler of the dynasty. While male rulers were known as Ali Rajah, female rulers were called Arakkal Beevis. The durbar hall, a portion of Arakkkal royal palace was renovated and converted into Arakkal museum by the government of Kerala in July 2015 and it is opened for public since then. The Arakkal kettu is not under the control of the Archaeological Survey of India but it is protected and well maintained by Arakkal royal trust. The royal residence with its antique furnishing, coloured glass window and its wooden floor offers the tourists a sneak peek into the history and the glorious past of Arakkal rulers. Exhibits of artifacts, heirlooms (such as weaponry, musical instruments, old telephone, utensils, family seal, pathaayam, elegant paintings, royal copies of the Holy Quran) and writings about the history of the royal family enhancing the visitor's experience. Arakkal museum is located at Ayikkara, which is 2-3 kilometer away from Kannur town.

The Thalassery Fort is an ancient monument in Thalassery also known as Tellicherry which is a town in the Kannur district of Kerala. It is situated on the Thalassery beach on a rocky cliff. Established by the East India Company as a testimony to show the power and ability of the imperial rulers, the Thalaserry fort was built in 1703. It played a prominent role in the military as well as commercial activities of the English during their colonial rule in India. The fort is now supervised by the Archaeological Survey of India and comprises of a large gateway as well as a lighthouse. Near the fort also lies the bungalow of the sub-collector, St. Rosary Church and Brennen cemetery. The fort has a square shape, massive walls and doors which are artistically carved. It has laterite blocks and walls with holes of loops which are aided by strong supporters. History has it that the king of Mysore, Hyder Ali tried to capture Mysore in 1781 but was unable to do so. The fort was constructed by British East India Company in the 18th century with the aim to set a firm foot in the Malabar Coast. The fort was used against the rebellion of Pazhassi Raja by Lord Wellesley. Since the fort was the military centre of British, it was believed to comprise of a secret tunnel to the sea which acted as a route to escape whenever attacked. The imposing structure of Tellicherry Fort is constructed out of laterite with high round holed walls and flanking bastions in a strategic location to withstand attacks and invasions. The most captivating feature of this architectural marvel is the entrance door, which is through the top of the giant wall. It is decorated with mural paintings tracing back to the 18th century present on its rooftop. It is said that Thalassery Fort was constructed by using a mixture

of quicklime, white of egg and sugar candy. The massive fort has secret tunnels leading to the sea and a lighthouse marking the enrapturing site. The tunnel leads to the sea, which could be used to escape an attack, but is now closed. To the western side of this mighty structure stands the lighthouse with a precarious flight of stairs leading to its top. Another unique feature of the fort is the underground chamber, which is believed to be the minting go down for the coins of East India Company. The mighty fort also comprises of a gallery inside it with pictures of caves, monuments and ancient paintings.

5.8. Seagrass

Seagrass locations have not been reported from the Kannur coast.

5.9. Mud flats

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

5.10. Turtle Nesting Grounds

Three adjacent locations along the Azheekkal beach stretch and the southern part of the Payyambalam beach stretches are identified as turtle nesting locations, though the local information confirms that turtles do not appear regularly during nesting period of November and December every year. Total area of turtle nesting is around 0.014778 km^2 out of which the Payyambalam stretch account for only 0.00101km^2 (Detailed table is annexed in Annexure 2).

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 Kannur District, intertidal area within the CRZ-IB category is 21.258592 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. Ezhome Panchayat tops the list with 1.28298 km^2 spread of intertidal area, followed by Cherukunnu Panchayat with 1.272338 km^2. Except Chapparapadavu, Anjarakandi and Thrippangothur panchayats, all other local bodies have varying spread of intertidal areas (Detailed table is annexed in Annexure 2).

5.12. Salt pan / Aquaculture ponds

Though saltpans are available in Kannur district, they are mostly classified under the intertidal areas (CRZ IB) or as CRZ IVB due to their alternating use for aquaculture and agriculture. The same sort of categorization adopted with the approved CZMP of 2011 is being followed in the updation process.

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 Kannur 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 Kannur 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 sixty-six number of coastal and backwater islands are present in Kannur 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 0.000422 km^2 (Ezhome grama panchayat) to 8.448663 km^2 (Dharmadam grama panchayat). All together the area of islands accounts for 15.167525 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 KANNUR DISTRICT

The CRZ of the Kannur District consist of CRZ-IA, CRZ-IB, CRZ-II, CRZ-IIIA, CRZ-IIIB, CRZ-IVA, CRZ-IVB. Altogether 44 local bodies are covered under the CRZ area in which 38 are Grama Panchayath out of which 11 are other Legally Designated urban Areas, 5 Municipal Council areas and 1 Municipal Corporation. Altogether 60 villages are under the purview of CRZ in Kannur District. The details are provided in the table annexed (Annexure-2). Other Legally designated urban areas as per CRZ Notification 2019 includes Azhikode, Cherukunnu, Chirakkal, Chockli, Kallisseri,Kannapuram, Mattool, New Mahe, Pappinisseri, Ramanthali and Valapattanam.

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.

CRZ categories and ESAs (Panchayat/Village-wise) in Kannur 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 Kannur District is summarized below:	
Total length of HTL along the Seacoast	62.89Km
Total length of HTL along the inland water bodies	689.88 Km
Total Area under the Archeological/Historical sites	0.055817 Km^2
Total Area under the Turtle Nesting Sites	0.014778 Km^2
Total area under mangrove extent	9.10894 Km^2
Total area under mangrove buffer	27.057259 Km^2
Total area under intertidal zone (CRZ-IB)	21.258592 Km^2
Total area under CRZ-II along the Seacoast	23.543312 Km^2
Total area under CRZ-II along the inland water bodies	13.087878 Km^2
Total area in No Development Zone in CRZ-III along Seacoast	1.091965 Km^2
Total area in No Development Zone in CRZ-III along water bodes	13.202907 Km^2
Total area in CRZ-IIIA along the coast between 50-500 meters	2.727566 Km^2
Total area in CRZ-IIIB along the coast between 200-500 meters	1.251307 Km^2
Total area under the CRZ-IVB category	36.834061 Km^2