BEFORE THE NATIONAL GREEN TRIBUNAL

WESTERN ZONE BENCH PUNE

ORIGINAL APPLICATION No: 42 of 2023(WZ)

IN THE MATTER OF:

OSWALD FERNANDES & ANR. ORIGINAL APPLICANTS

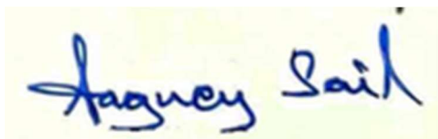
V/s.

GOA COASTAL ZONE MANAGEMENT AUTHORITY & ORS. …RESPONDENTS

INDEX

NEXT DATE: 16.02.2026

ORIGINAL APPLICANTS
THROUGH



AAGNEY SAIL
ADVOCATE FOR THE ORIGINAL APPLICANTS,
A-36, Rama Life City, Uslapur,
Bilaspur, Chhattisgarh – 495003.
Ph. +91.9810076618,
Email: aagneysail@gmail.com

Filed on 15.02.2026
Place: Goa

BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE BENCH, PUNE
ORIGINAL APPLICATION No: 42 of 2023(WZ)

IN THE MATTER OF:

OSWALD FERNANDES & ANR. …ORIGINAL APPLICANTS

V/s.

GOA COASTAL ZONE MANAGEMENT AUTHORITY & ORS.

…RESPONDENTS

REJOINDER OF ORIGINAL APPLICANTS TO REPLY OF RESPONDENT NO. 1.

MOST RESPECTFULLY SHOWETH:

1. That the present rejoinder of the Original Applicants is filed to the Reply Affidavit dated 27.02.2024 of the Goa Coastal Zone Management Authority - GCZMA (Respondent No. 1). At the outset the facts and averments in the said reply of R1 which are inconsistent with the pleadings of the Original Application are denied. It is stated that rejoinder is not being filed for each and every statement and averment made by R1 and nothing may be deemed to be admitted unless the same is specifically admitted herein, but should be treated as though the same has been set out seriatim and denied and disputed specifically.

PRELIMINARY SUBMISSIONS IN REJOINDER TO G.C.Z.M.A. REPLY AFFIDAVIT DATED 27.02.2024:

2. The Appellants submit the following points as preliminary submissions in rejoinder to the GCZMA reply affidavit dated 27.02.2024:

(a) GCMZA has miserably failed to submit any reasoning, justification, deliberations conducted by itself or by the National Center for Sustainable Coastal Management (NCSCM) on why the areas identified as Khazan Lands and Sand Dunes in Cavelossim village by the WRD ground truthing were deleted from the Final approval CZMP Maps. In their reply affidavit only a bald statement is made stating that,

> *"7. I state that additionally this Respondent had also received objections and suggestions received at large and same were considered by this Respondent and forwarded to the NCSCM for its assessment. The NCSCM has prepared the CZMP 2011 after conspicuously considering the suggestions and recommendations in accordance with CRZ Notification 2011."*

(b) GCZMA has not submitted any documents to show that they considered the representation of the Appellant No. 1 dated 14.07.2021 (Refer Exhibit-D at Pg. 59-69). Similarly, no document has been submitted to show the considerations done by GCZMA of representations made by others that resulted in the downgrading of Khazan Lands and sand dunes as mentioned in the Exhibit-E(colly) at Pg. 72 to 74.

(c) GCZMA being the statutory authority for implementation of the CRZ Notification, 2011 is obliged to comply with

its provisions especially para 8(i)(V)(3) which states that,

"8. Norms for regulation of activities permissible under this Notification,-

(i) The development or construction activites in different categories of CRZ shall be regulated by the concerned CZMA in accordance with the following norms, namely:-

…

(V) Areas requiring special consideration.-

…

3. CRZ of Goa

In view of the peculiar circumstances of the State Goa including past history and other developments, the specific activities shall be regulated and various measures shall be undertaken as follows:

…

(iv) the eco sensitive low lying areas which are influenced by tidal action known as khazan lands shall be mapped and 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;

(v) the mangroves along such as khazan land shall be protected and a management plan for the khazan land prepared and no developmental activities shall be permitted in the khazan land;

(vi) Sand dunes, beach stretches along the bays and creeks shall be surveyed and mapped. No activity shall be permitted on such sand dune areas;"

(d) The National Center for Sustainable Coastal Management (NCSCM) i.e. the Respondent No. 3 has despite service chosen not to file any affidavit explaining their decision to delete the concerned areas (Khazan land and Sand dunes) in Cavelossim village.

For fair and just adjudication of the issues raised in this Original Application true and correct copies of the following documents are hereto marked and annexed as **ANNEXURE – A(colly):**

(i) Superimposed WRD ground truthing maps no. 11, 13 & 14 showing khazan lands in Cavelossim Village which have been left out from the CZMP 2011 in blue colour,
(ii) Superimposed CZMP map sheet no. GA4 (1:25,000 scale) showing the boundary of Cavelossim village and
(iii) Superimposed CZMP map sheet GA4 (1:25,000 scale) showing the Khazan lands left out of Cavelossim village.
(iv) CZMP map sheet no. GA42 (1:4,000 scale) of the CRZ Notification, 2019 of Cavelossim Village.

3. REJOINDER TO PARA 1, 2 & 3 OF REPLY: That the contents of these two paragraphs need no response. It is pertinent to mention here that GCZMA in its "Draft Report on Coastal Zone Management Plan of Goa as per CRZ Notification, 2011" prepared by NCSCM in January, 2021 has stated that,

"*6.11 Khazan Land:*

As per the Para 8.V.3 of CRZ notification 2011, "the eco sensitive low-lying areas which are influenced by tidal action known as khazan lands shall be mapped and the mangroves along such as khazan land shall be protected and a

management plan for the khazan land prepared and no developmental activities shall be permitted in the khazan land". The Khazan land data are received from the Department of water Resource, through the Department of Environment, Government of Goa and the same are depicted in the CZMP maps.

The Total area of Khazan land of Goa is 135.55 sq.km and the north Goa having 107.32 sq. km area and south Goa having 28.23 sq. km area. The Taluka wise Khazan land area is shown in Table 7."

A true and correct copy of the relevant extracts of the "Draft Report on Coastal Zone Management Plan of Goa as per CRZ Notification, 2011" prepared by NCSCM in January, 2021 is hereto marked and annexed as **ANNEXURE – B**. In addition to this the "Manual on Demarcation of High Tide Line and Low Tide Line and Preparation of CZMP of the Coast of India" (2015) of MoEF&CC which has been used by GCZMA for the CZMP 2011 preparation is hereto marked and annexed as **ANNEXURE – C**.

4. REJOINDER TO PARAs 4, 5, 6 & 7 OF THE REPLY: That the contents of these paragraphs establish that the Respondent No. 3 i.e. the National Centre for Sustainable Coastal Management (NCSCM) was allotted with the work of preparation of the CZMP along with plans. Hence, it is imperative that an affidavit clarifying the issues / grounds raised in the present Original Application be filed by the said Respondent No. 3 NCSCM as they are the respective expert body which after assessment / consideration of the objections / suggestions made by the public (including the ones made by Original Applicant No. 1 and the Respondent No. 5) have prepared

the CZMP 2011 of Goa. In other words, the objection / suggestion dated 14.07.2021 (Refer Exhibit-D at Pg. 59 to 69 of the Original Application) raised by the Original Applicant No.1 before GCZMA have not been accepted by the NCSCM. Hence, it is essential that the deliberations of NCSCM which include the stated *'conspicuous consideration'* should be brought on record by GCZMA or NCSCM for assisting this Hon'ble Tribunal in adjudication of the present Original Application.

5. REJOIDNER TO PARAs 8 & 9 OF THE REPLY: The contents of these two paragraphs are most important as the GCZMA has admitted that there is a *'doubt'* in the CZMP 2011 and referred to the procedure to be followed as per "Annexure I - Guidelines for preparation of Coastal Zone Management Plans" of the CRZ Notification, 2011 in such cases. Unfortunately, GCZMA has not taken any steps in compliance of the said procedure referring the matter i.e. issues raised in the present Original Application, to NCSCM for verification etc. Hence, this Hon'ble Tribunal may direct GCZMA to comply with the said procedure as provided in para V.(1) of Annexure I – "Guidelines for preparation of Coastal Zone Management Plans" of the CRZ Notification, 2011.

6. REJOINDER TO PARA 10 OF THE REPLY: The contents of this paragraph are vehemently denied as being false and without any basis. It is submitted that the Applicants are not challenging the entire CZMP 2011 of Goa and the present O.A. is limited to the

prayers sought i.e. the deletion of Khazan Land and Sand Dunes in Cavelossim village from the Draft CZMP maps / plan 2011. In essence the present Original Application highlights non-compliance of the CRZ Notification, 2011 by GCZMA in protecting the Khazan lands and the sand dunes of Cavelossim Village and seeks rectification of the same. It is also submitted that the present Original Application is maintainable under Section 14 of the NGT Act, 2010 i.e. under exercise of the original side jurisdiction of this Hon'ble Tribunal which has been held by Hon'ble Supreme Court of India to be a special jurisdiction for enforcement of environmental rights and this Hon'ble Tribunal is set up under the constitutional mandate in Entry 13 of List I of Schedule VII to enforce Article 21 with respect to the environment. (refer Municipal Corporation Of Greater Mumbai v. Ankita Sinha And Others (2022) 13 Supreme Court Cases 401 – para 50). The contention that an Appeal under Section 16 of the NGT Act, 2010 should have been filed in the present case is denied as being wrong understanding of the appellate jurisdiction of this Hon'ble Tribunal. Without prejudice to the fact that there is no challenge to the CZMP of Goa, it is submitted that the CZMP of Goa as per CRZ Notification, 2011 approved by MoEF&CC on 06.09.2022 (Exhibit-A at Pg. 21) is not an order or decision or direction issued under any of sub-sections of Section 16 of the NGT Act, 2010 and especially under sub-section (g) which makes a direction issued under Section 5 of the Environment (Protection) Act, 1986 appealable. A direction issued

under Section 5 of the EPA has to be issued in compliance of the Rule 4 of the Environment (Protection) Rules. 1986 which is not the case here.

7. REJOINDER TO PARA 11 OF THE REPLY: The contents of this paragraph are denied as being wrong interpretation of the CRZ Notification, 2011 especially with respect to preparation of CZMPs and their rectification as provided in its Annexure – I – "Guidelines for preparation of Coastal Zone Management Plans". It is submitted that the main issue raised in the present Original Application is whether there was sufficient scientific data available with NCSCM and/or GCZMA to delete the Khazan land classification and the sand dune classification of said lands. Once this Hon'ble Tribunal adjudicates this issue and if it holds that the said deletion is not based on scientific data then GCZMA is duty bound to rectify the classification of the said lands through the process provided in the CRZ Notification, 2011 which includes giving concerned persons a hearing. If the contention of GCZMA that every person whose land is involved should be made a party respondent and heard by this Tribunal is accepted then it will result in dozens of respondents being made parties and voluminous pleadings being added to the present O.A. which will frustrate the basic issue raised. BY suggesting such a course GCZMA is trying to shirk off its responsibility of being the adjudicatory authority in deciding claims

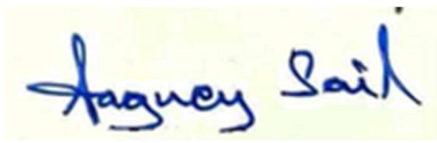
with respect to the CZMPs and classification of ecologically sensitive area under the CRZ Notification, 2011.

8. REJOINDER TO PARA 12 OF THE REPLY: The contents of this paragraph are testimony to the discrepancy or wrong classification of Khazan Land and Sand Dunes in Cavelossim village in preparing the CZMP 2011 by GCZMA as they have made a statement that they are ready to update the CZMP maps by recording the discrepancies which in essence are the prayers sought in the present Original Application, i.e. rectification of the CZMP of Goa to include the Khazan Lands and Sand Dunes in Village Cavelossim as per Exhibit-E colly.

9. REJOINDER TO PARA 13 OF THE REPLY: The contents of this paragraph are denied for want of proper supporting documents. The GCZMA has not submitted any document showing that they have made a request to MoEF&CC for correction of discrepancies in the CZMP 2011. Hence, the Applicants reserve the right to make submissions of this aspect after the necessary documents have been brought on record by the GCZMA. It is pertinent to mention here that MoEF&CC which is Respondent No. 2 in the present O.A. have in their reply affidavit not given any particulars of the how the suggetions/objections received by NCSCM pertaining to Cavelossim village in Salcete Taluka were dealt with by NCSCM (Refer table no. nil given at internal page no. 63 of the MoEF&CC reply dated 07.12.2023.

10. REJOINDER TO PARA 13 OF THE REPLY: The contents of this paragraph are denied in light of the abovementioned rejoinder and the prayers sought in the present O.A. are reiterated which may be granted by this Hon'ble Tribunal.

ORIGINAL APPLICANTS
THROUGH



AAGNEY SAIL
ADVOCATE FOR THE ORIGINAL APPLICANTS,
A-36, Rama Life City, Uslapur,
Bilaspur, Chhattisgarh – 495003.
Ph. +91.9810076618,
Email: aagneysail@gmail.com

Filed on:15.02.2026
Place: Goa

BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONE BENCH, PUNE
ORIGINAL APPLICATION No: 42 of 2023(WZ)

IN THE MATTER OF:

OSWALD FERNANDES & ANR. ...ORIGINAL APPLICANTS

V/s.

GOA COASTAL ZONE MANAGEMENT AUTHORITY & ORS.

...RESPONDENTS

NOTARY SANDEEP B. DESSAI Reg. No. 304/14 SALCETE TALUKA Exp. Dt. 27-02-2029 GOVT. OF GOA, (INDIA)

AFFIDAVIT

I, Mr. Oswald Fernandes, aged about 47 years, S/o Mr. Caetano Fernandes, R/o H. No. 1141, Muxivaddo, Curtorim, Salcete Goa - 403709 do hereby solemnly state and affirm that:

1. That I am the Applicant No. 1 in the above-mentioned Original Application and I am aware of the facts of the present case and authorized to file on behalf of Applicant No. 2. As such am competent to swear this affidavit.
2. That I have read and understood the accompanying Rejoinder to the reply of GCZMA which has been drafted on my instructions and the contents of which are true & correct to my knowledge and legal advice which I believe to be true and have been read and explained to me.
3. That the Annexures A to are true and correct copies of their respective originals.

DEPONENT

VERIFICATION:

Verified that the contents of paras 1 to 3 of my above affidavit are true to my knowledge and its content is read and explained to me in the vernacular, no part of it is false and nothing material has been concealed therefrom.

NOTARY SANDEEP B. DESSAI Reg. No. 304/14 SALCETE TALUKA Exp. Dt. 27-02-2029 GOVT. OF GOA, (INDIA)

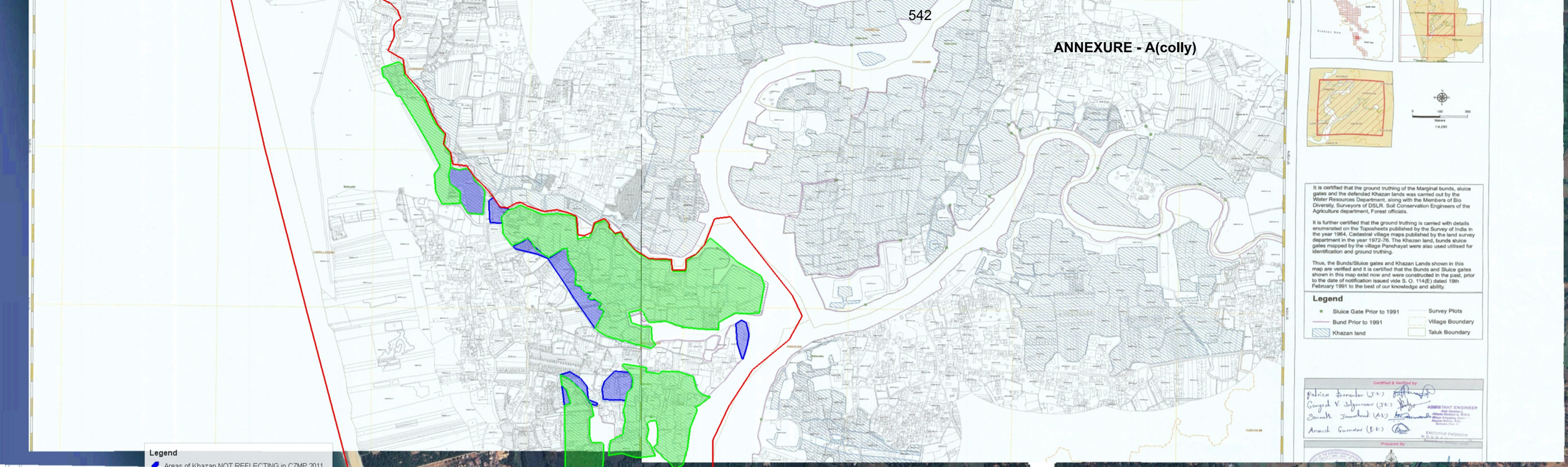
Verified on 11th day of February, 2026 at Margao, Goa.

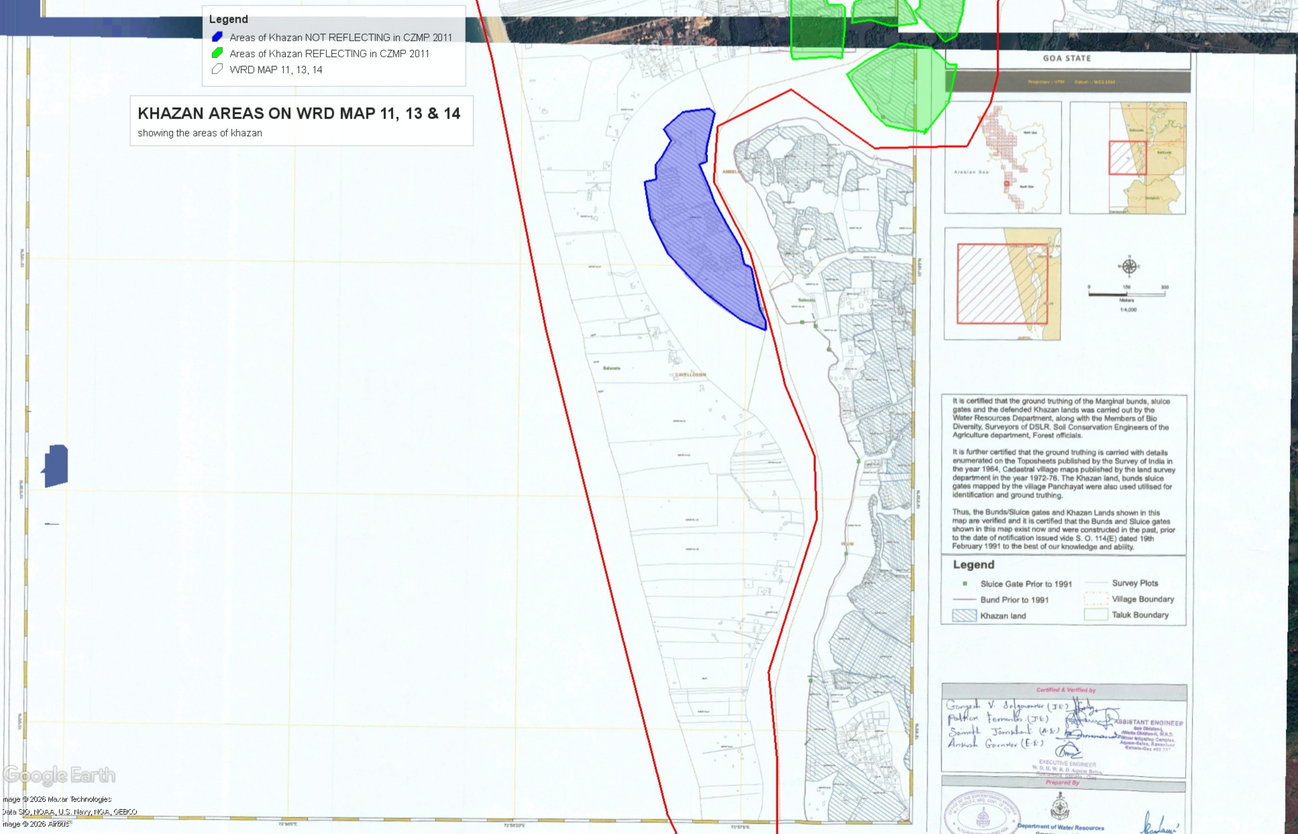
DEPONENT

Solemnly affirmed before me by
Shr/Smt. Oswald Sydney Fernandes
Who is identified before me by
Shri/Smt. (Id.No) GA08199900715H21
On this 11th day of Feb.2026

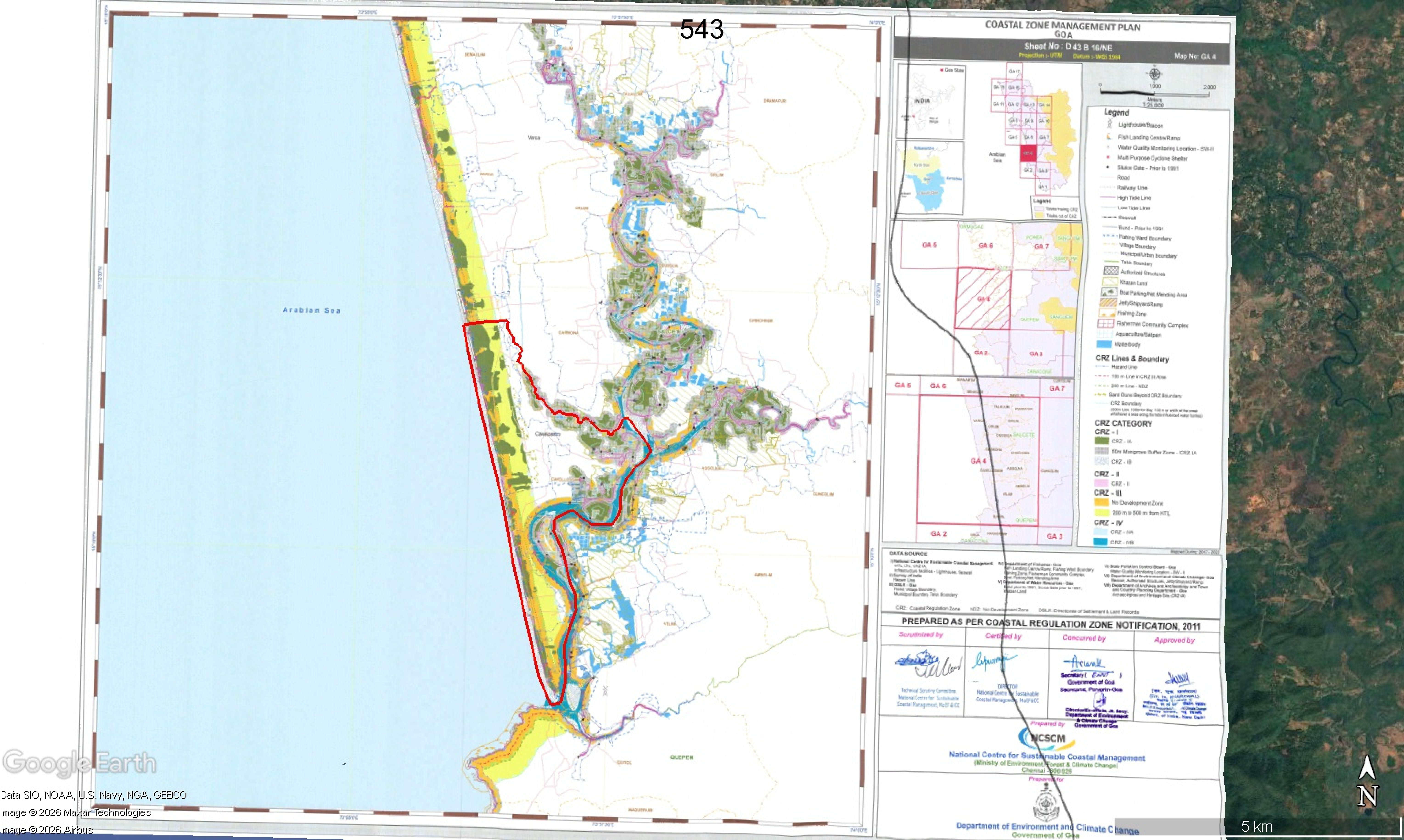
SANDEEP B. DESSAI
NOTARY
SALCETE TALUKA
State of Goa (India)
Reg. No: 1936/2026
Date: 11-02-2026

ANNEXURE - A(colly)

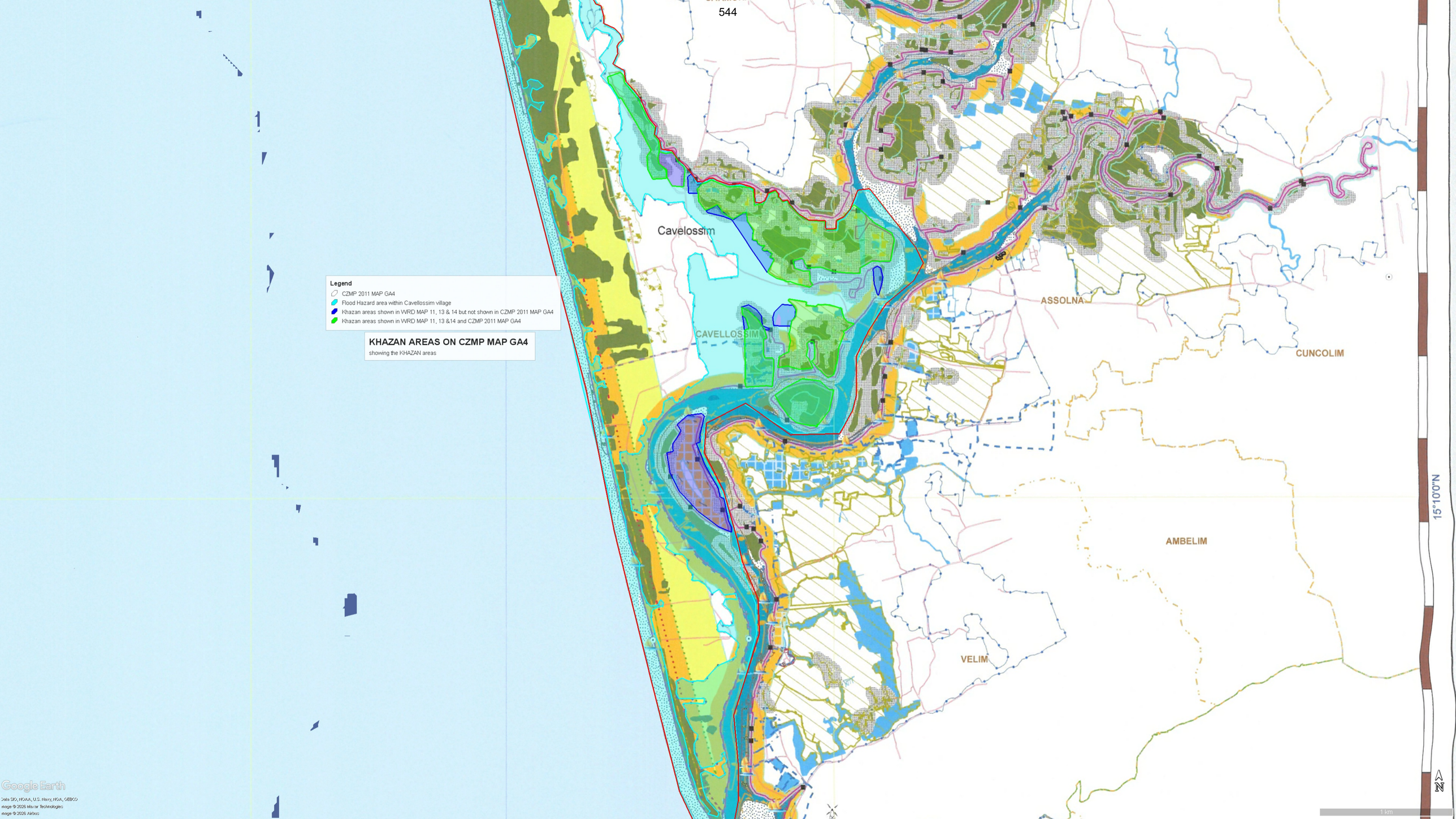




543

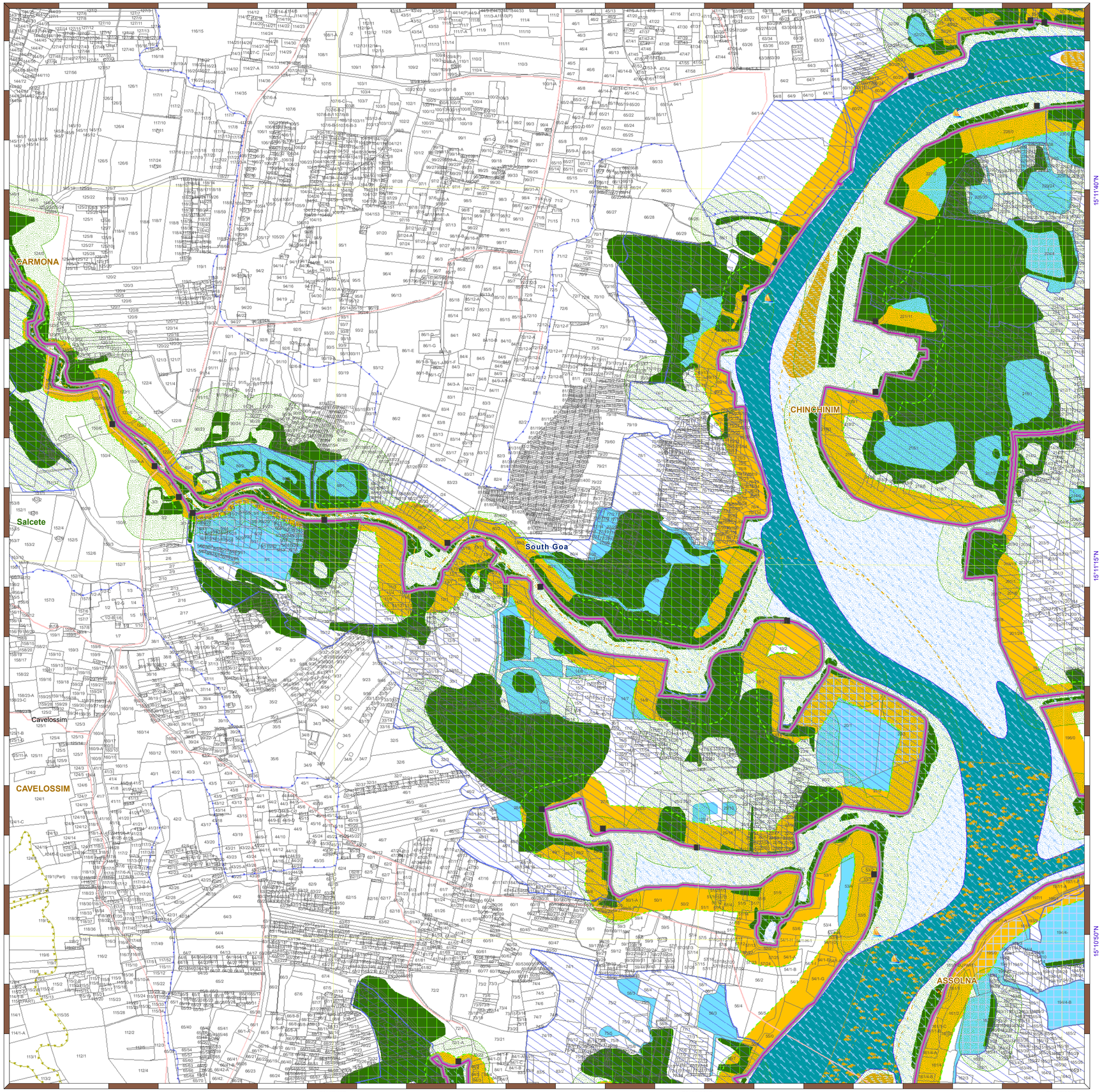


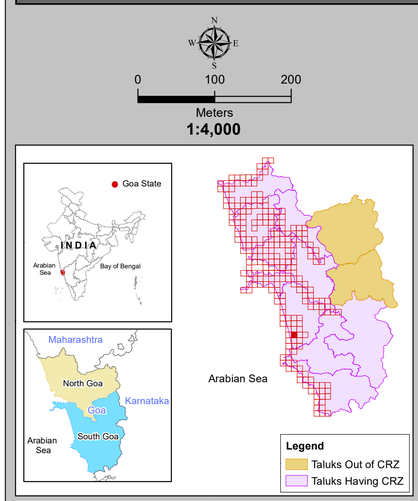
COASTAL ZONE MANAGEMENT PLAN
GOA
Sheet No : D 43 B 16/NE
Map No: GA 4
Arabian Sea
Legend
CRZ Lines & Boundary
CRZ CATEGORY
PREPARED AS PER COASTAL REGULATION ZONE NOTIFICATION, 2011
Scrutinized by
Certified by
Concurred by
Approved by
NCSCM
National Centre for Sustainable Coastal Management
Department of Environment and Climate Change
Government of Goa
Google Earth
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2026 Maxar Technologies
Image © 2026 Airbus
5 km
N

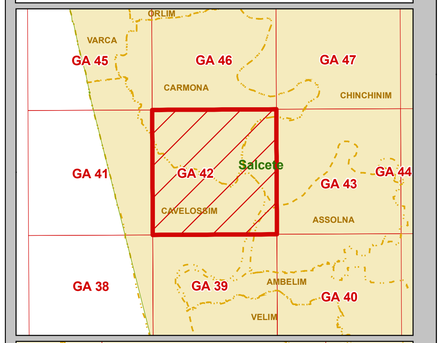

544
Cavelossim
CAVELLOSSIM
ASSOLNA
CUNCOLIM
AMBELIM
VELIM
15°10'0"N
Legend
CZMP 2011 MAP GA4
Flood Hazard area within Cavellossim village
Khazan areas shown in WRD MAP 11, 13 & 14 but not shown in CZMP 2011 MAP GA4
Khazan areas shown in WRD MAP 11, 13 &14 and CZMP 2011 MAP GA4
KHAZAN AREAS ON CZMP MAP GA4
showing the KHAZAN areas
Google Earth
1 km

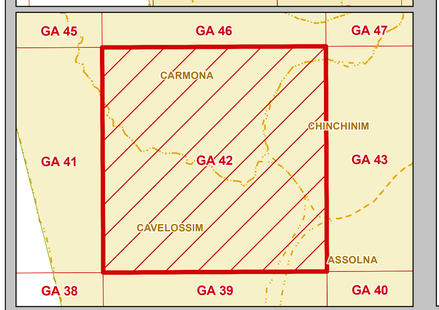
DRAFT COASTAL ZONE MANAGEMENT MAP OF GOA
SOUTH GOA DISTRICT

Projection :- UTM **Datum :- WGS 1984** **Map No: GA 42**









Legend

- Lighthouse/Beacon
- Multi Purpose Cyclone Shelter
- Fish Landing Centre/ Ramp
- Water Quality Monitoring Location - SW-II
- Sluice Gate - Prior to 1991
- Bund - Prior to 1991
- Road
- Railway Line
- Seawall
- High Tide Line
- Low Tide Line
- Port Limit
- Survey Plots
- Authorized Structures
- Panchayat Boundary
- Municipal/Urban Boundary
- Taluk Boundary
- Boat Parking/Net Mending Area
- Jetty/Shipyard/Ramp
- Fishing Ward Boundary
- Fishing Zone
- Fisherman Community Complex
- Khazan Land
- Aquaculture/Saltpan
- Waterbody

CRZ Lines & Boundary

- 20m CRZ Line for Islands
- 50m CRZ Line for Bays
- 200m CRZ Line - CRZ IIIB (NDZ)
- 500m CRZ Line
- CRZ Line for River or Creek
- Hazard Line
- Sand Dune Beyond 500m CRZ Line

CRZ CATEGORY

CRZ - I

- Mangrove - CRZ IA
- 50m Mangrove Buffer Zone - CRZ IA
- Coral and Coral Reef - CRZ IA
- Sand Dune - CRZ IA
- Mudflat - CRZ IA
- Reserve Forest - CRZ IA
- Salt Marsh - CRZ IA
- Turtle Nesting Ground - CRZ IA
- Nesting Ground of Bird - CRZ IA
- Archaeological and Heritage Site - CRZ IA
- Intertidal Zone - CRZ IB

CRZ - II

- CRZ Landward of HTL - CRZ II

CRZ - III

- No Development Zone - CRZ III
- 200m to 500m from HTL - CRZ IIIB

CRZ - IV

- Waterbody - CRZ IVA (Upto 12 Nm)
- Waterbody - CRZ IVB

DATA SOURCE

I) **National Centre for Sustainable Coastal Management**
HTL, LTL, ESAs (CRZ IA), Seawall
II) **Survey of India**
Hazard Line
III) **DSLR - Goa**
Road, Survey Plots (used in BhuNaksha Platform), Panchayat Boundary, Municipal Boundary, Taluk Boundary
IV) **Department of Fisheries - Goa**
Fish Landing Centre/Ramp, Fishing Ward Boundary Fishing Zone, Fisherman Community Complex, Boat Parking/Net Mending Area
V) **Department of Water Resources - Goa**
Bund prior to 1991, Sluice Gate prior to 1991, Khazan Land
VI) **State Pollution Control Board - Goa**
Water Quality Monitoring Location - SW - II
VII) **Department of Environment and Climate Change - Goa**
Lighthouse/Beacon, Authorised Structures, Jetty/Shipyard/Ramp Multi Purpose Cyclone Shelter
VIII) **Goa Coastal Zone Management Authority**
Ownership Status of Mangrove Land
IX) **Department of Archives and Archaeology and Town and Country Planning Department - Goa**
Archaeological and Heritage Site (CRZ IA)
X) **National Centre for Earth Science Studies**
CRZ Categories and Lines

ABBREVIATIONS

CRZ: Coastal Regulation Zone NDZ: No Development Zone IIMP: Integrated Island Management Plan DSLR: Directorate of Settlement & Land Records

NOTE:

1) ISLANDS: 20m CRZ Line from HTL is valid only after approval of IIMP of the particular island. IIMPs of the particular island shall be prepared by concerned States/UTs and got approved by MoEF&CC.

2) 50m Mangrove Buffer Zone is provided only for Mangroves in Government land having area more than 1000m².

PREPARED IN ACCORDANCE WITH THE DRAFT CZMP OF GOA STATE AS PER CRZ NOTIFICATION, 2019

Prepared by	*Approved by*
D R A F T	M A P
OFFICE SEAL	OFFICE SEAL

Prepared by

National Centre for Earth Science Studies
Ministry of Earth Sciences, Government of India,
Thiruvananthapuram - 695 011, Kerala

Prepared for

--TRUE COPY--

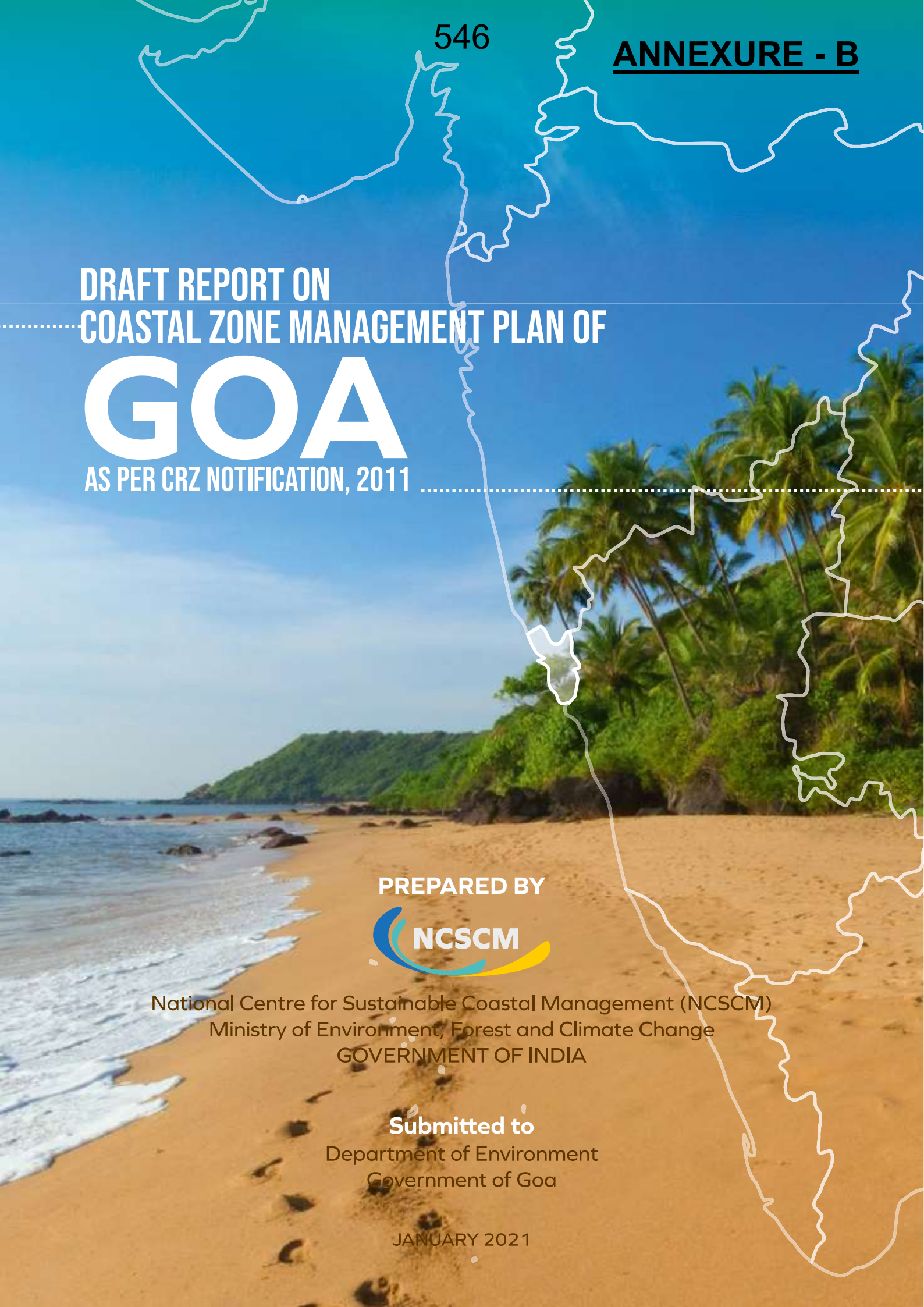
Department of Environment and Climate Change
Government of Goa

Ver - 2 (08.12.2025)

ANNEXURE - B

DRAFT REPORT ON COASTAL ZONE MANAGEMENT PLAN OF GOA

AS PER CRZ NOTIFICATION, 2011



PREPARED BY

NCSCM

National Centre for Sustainable Coastal Management (NCSCM)
Ministry of Environment, Forest and Climate Change
GOVERNMENT OF INDIA

Submitted to

Department of Environment
Government of Goa

JANUARY 2021

DRAFT REPORT ON COASTAL ZONE MANAGEMENT PLAN OF GOA

AS PER CRZ NOTIFICATION, 2011

PREPARED BY

National Centre for Sustainable Coastal Management (NCSCM)
Ministry of Environment, Forest and Climate Change
GOVERNMENT OF INDIA

Submitted to

Department of Environment
Government of Goa

JANUARY 2021

Acknowledgement

The National Centre for Sustainable Coastal Zone Management (NCSCM) wishes to thank Department of Environment for their financial support and technical advice during the preparation of Coastal Zone Management Plan of Goa. NCSCM is thankful to Shri Kunal, IAS Secretary, Environment, Government of Goa, for timely advice, technical discussions and for chairing the joint meetings with the Department of Environment and other departments/ user agencies. The assistance from various Government Departments of Goa is highly acknowledged for their extensive support throughout the work without which this assessment would not have been possible.

NCSCM conveys special thanks to Mr. Sanjeev Shashikant Joglekar, Officer on Special Duty (OSD) to Department of Environment for his dedicated effort in coordinating the project and in providing necessary secondary data and technical support. Mr. Joglekar was very supportive in facilitating interactions with various Government Departments of Goa and NCSCM.

NCSCM is very thankful to Shri Dashrath Redkar, GCS, Director Environment and Ex-officio Joint Secretary to Government for the technical advice and support. The NCSCM is also thankful to Shri Parag Nagarcenkar and Shri Srinet Kotwale, Former Director, Environment, Government of Goa. Dr. Joseph Rauto De Souza, Director, Goa State Remote Sensing Agency is thanked for extending their trust and support to NCSCM to undertake this study.

NCSCM also thankful to Shri Chandrakant Velip, Deputy Director, Fisheries, Shri Nazareth Vaz and Shri Shailesh Naik, Assistant Engineer, Water Resources Department, Shri Shailesh Faldessai, Junior Engineer, Water Resources Department, Shri Patrick Gonsalves, Supervisor, Shri Nitin Mantri, Supervisor, Shri Siddhesh Tuenkar, Head Surveyor, Department Survey and Land Records , Government of Goa.

The committed team of scientists and project staff of NCSCM, whose dedication and hard work led to the timely completion of the study are gratefully acknowledged.

DIRECTOR, NCSCM

CONTENTS

ANNEXURES

LIST OF ABBREVIATIONS

CBRM	Community Based Resource Management
COMAPS	Coastal Ocean Monitoring and Prediction Systems
CRZ	Coastal Regulation Zone
CVCA	Critically Vulnerable Coastal Area
CZMP	Coastal Zone Management Plan
DEM	Digital Elevation Models
DSAS	Digital Shoreline Analysis System
ESA	Ecologically Sensitive Areas
GIS	Geographic Information System
HTL	High Tide Line
HWL	High Water Level
IMP	Integrated Management Plan
GCZMA	Goa Coastal Zone Management Authority
LTL	Low Tide Line
LWL	Low Water Level
MOEF&CC	Ministry of Environment, Forest and Climate Change
NCSCM	National Centre for Sustainable Coastal Management
NCZMA	National Coastal Zone Management Authority
SoI	Survey of India

EXECUTIVE SUMMARY

The Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India, New Delhi issued Notification No. S.O. 19(E) dated 6th January 2011 which is referred to as the Coastal Regulation Zone (CRZ) Notification, 2011 in supersession of CRZ Notification 1991, with a view to ensure ensuring livelihood security to the fisher communities and other local communities living in the coastal areas, to conserve and protect coastal stretches, its unique environment and its marine area and to promote development through sustainable manner, based on scientific principles taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming. The CRZ Notification 2011 declared that the coastal stretches of the country and the water area upto its territorial water limit, excluding the islands of Andaman and Nicobar and Lakshadweep and the marine areas surrounding these islands upto its territorial limit, as Coastal Regulation Zone (hereinafter referred to as the CRZ) and restricted the setting up and expansion of any industry, operations or processes and manufacture or handling or storage or disposal of hazardous substances. The respective State Governments and Union Territories were directed to prepare Coastal Zone Management Plans in 1: 25,000 scale maps by identifying and classifying the CRZ areas within the respective territories in accordance with the guidelines given in Annexure-I of the CRZ Notification 2011 for the approval of Ministry of Environment, Forest & Climate Change (MoEF&CC), Govt. of India.

Annexure-I of CRZ notification also stated that "The local level CZM Maps shall be prepared on a Cadastral scale in accordance with the CZM Maps approved by the Central Government and Local level CZM Maps are for the use of local bodies and other agencies to facilitate implementation of the Coastal Zone Management Plans".

As per the provisions of the CRZ Notification, 2011, Department of Environment, Government of Goa entrusted the responsibility of preparation of the Coastal Zone Management Plans (CZMP) in 1:25,000 as well as 1:4000 scale to National Centre for Sustainable Coastal Management (NCSCM), Chennai, which is an authorized agency approved by the Govt. of India, for the said purpose, vide Ministry of Environment & Forests Govt. of India Order No. J-17011/8/92-IA-III dated 14th March 2014. NCSCM, Chennai has completed the preparation of draft CZMP of Goa as per the guidelines of CRZ Notification 2011 including amendments.

The CZMP of Goa has been prepared on 1: 25,000 as well as 1:4000 scale. The CZMP is prepared as per the guidelines given in the CRZ Notification 2011 indicating CRZ I, CRZ II, CRZ III, CRZ IV, Regulation Lines, and Hazard line etc. A description of the High Tide Line (HTL), Low Tide Line (LTL), demarcation, Ecologically Sensitive Areas (ESA), Hazard line, regulation zone and its categories are given in this report. The draft Coastal Zone Management Plan (CZMP) and report submitted to Environment Department, government of Goa for website publication and public hearing/stakeholder consultant.

1. INTRODUCTION

The Coastal Regulation Zone (CRZ) Notification was first issued by the Government of India on 19.2.1991 under sub-section (1) of section 3 and clause (v) of subsection (2) of section 3 of the Environment (Protection) Act, 1986 with the aim to provide comprehensive measures for the protection and conservation of India's coastal environment. The notification was reissued in 2011 (published in the Gazette of India, Extraordinary, Part-II, Section 3, Sub-section (ii) dated the 6th January, 2011).

By the CRZ notification, 2011, a specified width of the coast is sought to be protected by restricting the setting up and expansion of any industry, operation or process and manufacture or handling or storage or disposal of hazardous substances. The objective of the CRZ 2011 Notification is to ensure livelihood security to the fisher communities and other local communities living in the coastal areas; to conserve and protect coastal stretches, its unique environment and its marine area and to promote development in a sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming. Ecologically sensitive areas and other geomorphological features play a vital role in maintaining the integrity of the coast. These ecologically sensitive areas are extremely vulnerable and need to be managed judiciously by maintaining a balance between ecology and development.
As per the notification, CRZ is the land area from High Tide Line (HTL) up to 500 m on the landward side along the sea front and 100 m or width of the creek for the tidally influenced water bodies. The inter-tidal zone and waterbed area up to 12 nautical miles from the Low Tide Line (LTL) are also included under CRZ Notification 2011.

1.1. CZMP Planning Process

Para 5(vi) of the CRZ Notification of 2011, inter-alia, provides that the Coastal States/Union Territory will prepare, within a period of twenty-four months from the date of issue of this notification, draft CZMPs in 1: 25,000 scale maps identifying and classifying the CRZ areas within the respective territories in accordance with the guidelines given in Annexure-I of the notification, which also involve public consultation. Para 5(ii) of the said Notification of 2011 further provides that the CZMPs may be prepared 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 MoEF&CC and in consultation with the concerned stakeholders.

Annexure-I of CRZ notification also stated that “The local level CZM Maps shall be prepared on a Cadastral scale in accordance with the CZM Maps approved by the Central Government and local level CZM Maps are for the use of local bodies and other agencies to facilitate implementation of the Coastal Zone Management Plans”.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

As per the provisions of the CRZ Notification, 2011, Department of Environment, Government of Goa entrusted the responsibility of preparation of the Coastal Zone Management Plans in 1:25,000 as well as 1:4000 scale to National Centre for Sustainable Coastal Management (NCSCM), Chennai, which is an authorized agency approved by the Govt. of India, for the said purpose, vide Ministry of Environment & Forests Govt. of India order No. J-17011/8/92-IA-III dated 14th March 2014. NCSCM, Chennai has completed the preparation of draft CZMP of Goa as per the guidelines of CRZ Notification 2011 including amendments.

As per the CRZ Notification, 2011, the draft CZMPs (1:25000) as well as 1:4000 scale maps shall be submitted by the State Government/UTs to the concerned Coastal Zone Management Authority (CZMA) for appraisal, including appropriate consultations, and recommendations in accordance with the procedure(s) laid down in the Environment (Protection) Act, 1986. The State Government/UTs shall submit the draft CZMPs to MoEF&CC along with its recommendations on the draft CZMP after incorporating the suggestions and objections received from the stakeholders.

1.2. Development of a coastal database and information system

Coastal Information System refers to Geographic Information System (GIS) applied to the coastal zones for acquiring, storing, organizing, analysing, modelling and managing geospatial data. This data will be utilized for preparing the CZMPs, and will comprise information on the following areas:

a) coastal protection
b) fisheries
c) aquaculture
d) tourism
e) mining
f) ports and harbours
g) coastal resource management
h) infrastructure development and planning, etc

For the preparation of the CZMPs the following essential details were inducted in the information system:

a) NCSCM base layer based on SoI OSM Grid 1:25000
b) HTL/ LTL, CRZ regulation lines, CRZ categories such as CRZ I, II, III and IV.
c) Coastal land use and infrastructure
d) Administrative Boundaries
e) Cadastral information
f) Ecologically Sensitive Areas (ESAs), Geomorphologically Important Areas and Archeologically Important and Heritage Sites

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

Additional infrastructure details are also supplemented by local sources/ agencies. The information on the administrative boundaries such as district, taluk, village, municipality, corporation and such others have been demarcated using information/ data provided by the Government of Goa. The cadastral information such as survey numbers and boundaries, road network, rivers/canal boundary and other infrastructure available was generated. Information on ESAs, geomorphologically important zones and archeologically important and heritage sites has been demarcated by NCSCM. The details of data sources for the preparation of CZMP is given in Annexure – I.

1.3. Generation of CZMP maps

The LTL and HTL were delineated from aerial photograph/satellite images. 500 m CRZ line on the seacoast and the line marking 100 m or width of the water body for the tidally influenced water bodies, 100 m for bay and 100 m for fishing villages were drawn landward of HTL. The boundary lines of CRZ I (ESAs, archaeological and heritage sites), CRZ II (Developed area/ municipal areas), CRZ III (undeveloped /rural areas) and CRZ IV (water body) have been incorporated. In case of CRZ III (sea front), a 200 m No Development Zone (NDZ) line was drawn on the CZMP maps. In case of mangrove areas of greater than 1000 sq.m, a buffer line of 50m has been provided. Other buffer lines were drawn wherever necessary, as specified in the CRZ Notification 2011. With this information, the draft maps in 1:25,000 as well as 1:4000 scale were generated as per CRZ Notification, 2011 and submitted to the Department of Environment, Government of Goa.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

2. THE STATE OF GOA

Goa covers a total area of 3701 sq km bordering the western Indian coastline, ~105 km long and 65 km wide. The state shares its border with Maharashtra, Karnataka and Arabian Sea in the north, south and west respectively. The geographical location of Goa state is between 14°53′54″ N to 15°48′00″ North latitudes and 73°41′21″ E to 74°20′25″ East longitudes.

The state of Goa is divided into two districts: i) North Goa and ii) South Goa and further subdivided into 11 talukas and 360 villages. Of the 105 km long coast, more than 70 km comprise of linear and wide sandy beaches, interrupted by rocky shores and headlands and backed by high dunes; sandy pockets and secluded coves backed by rocky cliffs.

Coast related details of Goa are given in Table 1.

Table 1: Overview of Coastal Goa

1.	Total Area of State	3701 sq km
2.	No. of Coastal Districts	Two a) South Goa b) North Goa
3.	No. of CRZ Covering Taluks	10
4.	No. of Municipality/Local Planning Area	8
5.	No. of villages under CRZ area	178
6.	Length of High Tide Line	1002.29 km

2.1. Demography and Socio-economic Activities

The state is divided into two districts: North Goa and South Goa. Panaji is the headquarters of the north Goa district and Margao of the south district. According to the 2011 Census of India, the total population of Goa is 14,58,545 comprising of 7,39,140 males and 7,19,405 females. The rural population is 5,51,731 (37.83%) and the urban population is 9,06,814 (62.17%). Goa is the smallest state in India by area and the fourth smallest by population. Goa comprises of 2 districts, of which has 12 talukas. The population density is 394 per sq km as against the national figure of 382 per sq km. The sex ratio is 965 females per 1,000 males. The literacy rate is 88.70% with 92.65% for males and 84.66% for females. The literacy rate of the State has shown a significant increase from 82.01 percent in 2001 to 88.70 percent in 2011 showing an increase of 6.69 percent during the decade. At the district level, North Goa (89.57%) had a higher literacy rate than South Goa (87.59%) in 2011. The literacy rate in rural area is 86.60% with 91.70% for males and 81.60% for females. For urban population, the literacy rate is 90.00% with 91.70% for males and 81.60% for females.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

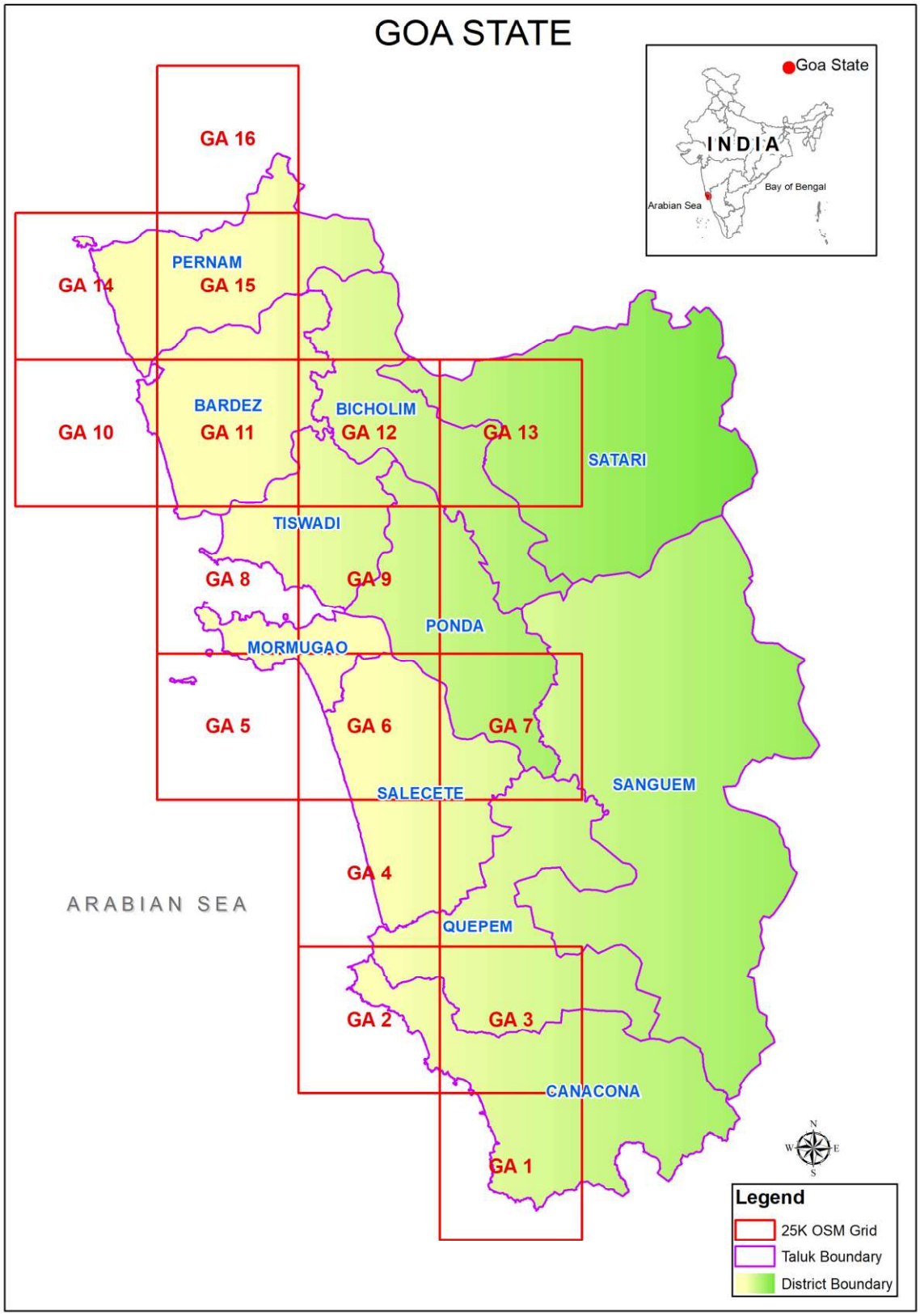


Figure 1: Location map with 25000 OSM grid

As per 2011 census, North Goa district has the higher population of 8,18,008 (56.08%) with an urban population of 60.28% followed by South Goa District of 6,40,537 (43.92%) with an urban population of 64.59%. Comparing the sex ratio of the two coastal districts, South Goa have a higher sex ratio (986 per 000' male population), than North Goa district (963 per 000'male population). North Goa district is having 4,16,677 male and 4,01,331 female population South Goa 3,22,463 male and 3,18,074 female population (Table 2).*(Source: Economic Survey 2015-16)*

Fishing is an important economic activity in the Goa. Marine Fish Production of Goa in 2019 is 86027 tonnes and Inland fish production of Goa in 2019 is 3669 tonnes. The GSDP of Goa stands at Rs. 80,000 per annum. The Agriculture along with Forests in Goa covers nearly 65% of the total area of the State. The major crops of the State are paddy, followed by other cereal such as small millets and pulses. A major portion of the cropland is utilized for Cashew nut cultivation with an area of nearly 55,000 Ha, followed by paddy (About 31,000 Ha), Coconut, areca nut etc. Other garden crops are garden crops like mango, pineapple, jackfruits and bananas. Iron ore, manganese, bauxite, high magnesia limestone and clay are the chief minerals of economic importance found in Goa.
(Source: Directorate of Agriculture, Goa)

Goa, with a coastline of 105 kilometers, most of which are sandy beaches, attracts a large number of tourists both domestic and international. Goa is one of the most favored tourism destinations in India with a consistent ranking amongst the top states in terms of tourist arrivals. This steady and increasing inflow of tourists provides employment, income and business opportunities to the locals. The contribution of tourism to employment generation both direct and indirect is of immense importance to the State. Tourism has also contributed to the growth and development of many sectors in the State such as infrastructure, hotels, transport, housing, banking, travel agencies and tour operators. Presently, tourism contributes to approximately 34% of the State Gross Domestic Product, providing employment to nearly 30% of the total workforce (Economic survey 2011-12).

Table 2: Taluk wise population and density of coastal Goa

State/District/ Taluka	Area (Sq Kms)	Population 2011	Population % 2011	Density of Population 2011	Sex Ratio 2011	Workers	Literacy Rate 2011		
							M	F	T
Goa	3702.00	1458545	100.00	394	973	577248	92.65	84.66	88.70
North Goa	1736.00	818008	56.08	471	963	327658	93.40	85.60	89.57
Pernem	251.69	75747	5.19	301	960	28438	92.90	83.02	88.05
Bardez	263.97	237440	16.28	899	980	94662	93.78	88.14	90.98
Bicholim	238.80	97955	6.72	410	962	37603	93.69	84.62	89.24
Tiswadi	213.57	177219	12.15	830	966	73486	93.41	87.24	90.37
Satari	489.46	63817	4.38	130	959	24352	91.65	78.59	85.24
Ponda	292.78	165830	11.37	566	940	69117	93.56	84.58	89.21
South Goa	1966.00	640537	43.92	326	986	249590	91.67	83.47	87.59
Mormugao	109.13	154561	10.60	1416	905	62162	93.33	84.84	89.30
Salcete	292.94	294464	20.19	1005	1,025	108209	92.63	86.15	89.34
Quepem	318.25	81193	5.57	255	994	32890	87.50	78.35	82.93
Sanguem	836.82	65147	4.47	78	997	27281	89.60	77.24	83.43
Canacona	352.04	45172	3.10	128	1,005	19048	90.02	79.39	84.68

(Source: Economic Survey Report Goa 2015-16)

2.2. Coastal Geomorphology and Ecosystem

Goa is a part of Konkan area has a coastal line of about 105 Kms. and inland waterways upto 250 kms. Coastline of Goa is generally straight and narrow and trends in NNW-SSE direction. Goa has hills, low and highland areas. Geographically Goa has mainly three natural divisions namely the Low lands, the Plateaus and the Mountain region.

A) Low Lands: Low land area is mainly coastal lines. It is about 110 km long. Many beaches are along the coast in this area. Many rivers flow east to east in this area therefore this area land is fertile.
B) Plateau Lands: The plateau region is found between the mountain region in the east and the lowlands in the west. Plateau land height ranges from 30 meters to 100 meters. In this region mainly plenty of laterite stone is found. Some of the part of plateau land is called headland of Goa. Light houses are built on these headlands
C) Mountainous region: Sahyadri mountains are to the east of South Goa. This part is covered with dense forest. *(Source :South Goa District, Govt. of GOA, https://southgoa.nic.in/about-district/)*

Physiographically the region can be broadly classified into: 1) the coastal tract; 2) sub-ghat region and 3) the high ranges of the Western Ghats. The drainage is dominated by two directions: 1) directly to the Sea (from E to W) and 2) the NW or NNW direction in accordance to the geological structure. Goa's main rivers are the Mandovi, the Zuari, the Terekhol, Chapora River and the Sal. The Mormugao harbor on the mouth of the river Zuari is one of the best natural harbors in South Asia. The Zuari and the Mandovi are with their tributaries draining 69% of its geographic area. Goa has more than forty estuarine, eight marine and about ninety riverine islands. The total navigable length of Goa's rivers is 253 km (157 miles). Goa has more than three hundred ancient tanks and over a hundred medicinal springs. The lakes are Mayem and Carambolim. Goa receives rainfall from South West monsoon between the months of June to September. Laterite covers the major portion of Goa and typically occurs as plateau landforms. The different laterite levels observed from 120 m level to sea level was the result of sea level fall. Remnants of the plateau surfaces showing deep lateritic weathering profiles are common in the northern part of Goa. The southern part presents a rugged topography with hills having an altitude upto 600 m.

The Coast is full of creeks and estuaries formed by rivers. Along the coast of Goa, existence of sand dunes can be observed. Promontories and rocky headlands protruding into the coast (as in Vasco, Dona paola or Quepem) also act a natural protective structure. The coast is prograding along beaches and retreating along the cliffs and headlands. Fluvial, marine and aeolian features are common along the coast. The presence of laterite beds along the estuaries at a depth of 27 to 35 m below present sea level indicates a drowned

valley. Based on the disposition of landforms the present coast is neither emergent nor submergent but it is a combination of both. Occurrence of laterites conglomerate beds, beach rock, beach ridges, old tidal flats beyond the present-day high-water line are the evidences of the sea level oscillations during the Quaternary period. Most of Goa's soil cover is made up of laterites which are rich in ferric aluminium oxides and reddish in color. Further inland and along the river banks, the soil is mostly alluvial and loamy. The soil is rich in minerals and humus, thus conducive to plantation. Some of the oldest rocks in the Indian subcontinent are found in Goa between Molem and Anmod on Goa's border with Karnataka. The rocks are classified as Trondhjemite Gneiss (*Wagle, B.G (1982)*

2.3. Marine Fishery Resources

The fish and fisheries sector in Goa play an important role in the socio-economic development of the state in view of its contribution to the food sector, nutritional security, foreign exchange earnings, employment generation and income. The Indian fisheries industry contributes to about 1-1.4% of the total GDP. The fisheries sector in Goa contributes to about 2.5% of the total GDP of the state (third position after West Bengal and A.P.). In India fish eating population is about 56% of the total population (Planning Commission, Govt. of India), Goa contributes to about 1.85% of the total marine fish landings of our country (CMFRI, 2013).Marine and coastal fisheries contribute 97% of the total fish production from Goa. Out of the India's Exclusive Economic Zone (EEZ) of 2.02 million Sq. km, Goa has a share of 87,000 Sq. km (4.3%).

Fish assumes greater significance to the people of Goa and it forms an integral part of Goan life and culture as it forms one of the most important items of the food of more than 90% percent of population. Goa is the state with a coast line of 105 km(1.28% of Indian coast line of 8117 km) with numerous bays and headlands are very rich in fishery resources specially Mackerels and sardines. The continental shelf area of Goa extends to about 10,000 km2 of about 100 fathoms depths. Goa is bestowed with 330 ha of brackishwater resources which hold good potential in the fisheries development, particularly through capture and coastal aquaculture. The total estuarine area in Goa is 13,157 ha with Mandovi and Zuari are the two major estuaries known as life lines of Goa. These are inter-connected by Cumbharjua canal.

The inland fish production of Goa, which is 4678 tonnes in 2013, is majorly supported by the brackishwater and estuarine fish production. The major fisheries resources are Mackerals (Bangdo), Sardines (Tarlo), Cat Fish (Sangot), Shark fish (Mori), Seer Fish (Wiswan), Prawns (Sungtam), Pomprets (Paplet), Cuttle Fish (Manki), Tuna (Bokdo), Ribbon Fish (Balle), Reef Cod (Gobro), Kowala kowal (Velli), Golden Anchovy (Kapsale), Silver Belly (Kampi), Soles (Lepo), Silver Bar (Karli), Crabs (Kurlio), Sciaenoids (Dodiaro), Butter Fish (Soundale), scat, milkfish and anchovies.

There is a significant hike inland fish production in Goa during the last five years. It is also observed that there is abundant natural stocks of seeds of brackish water fishes like Pearlspot, Etroplus suratensis, Asian Seabass, Lates calcarifer and Mullets(Mugil cephalus, Valamugil cunnesius, Liza parsia, L. tade) etc. The state also holds enormous scope in developing coastal aquaculture activities including finfish cage culture, mussel and oyster culture etc. Coastal and brackishwater finfishes, clams, mussels and oysters have a great demand for consumption in the fish markets of Goa. The group mullets with 4-5 species contribute significantly to the coastal and brackishwater fisheries of Goa and the species stripped Grey mullet, Mugil cephalusis the dominant species in this group. This species provides significant contribution in quantity and value of the coastal fisheries of Goa. The Striped grey mullet (Mugil cephalus) locally known as Shevto is declared as a State Fish Goa vide Official Gazette Series I No.40 dated 31/12/2015. The fishermen population of Goa is 30,225. *(Source* https://fisheries.goa.gov.in/wp-content/uploads/2020/10/newmullet.pdf*)*

2.4. Biodiversity of coastal Goa

Goa can be divided into three broad ecozones: The mountainous region of the Sahyadris in the east, the middle level plateaus in the centre and the low-lying river basins, and the coastal plains. Of these the most visible or well-known part is the coastal belt which runs as a strip from north to south. Within these, there is a wide diversity of ecosystems from the Arabian Sea to the ranges of the Western Ghats. A minimum of 14 distinct ecosystems can be identified, as follows:-

1. Aquatic ecosystems: - The natural aquatic ecosystems constitute an important fraction of Goa's habitats and include, the coastal stretch with the associated sandy beaches, rocky beaches and sand dunes, subtidal waters stretching up to the shelf break, rivers and their estuaries, mangroves fringing the estuaries, islands and saline lakes including salt pans.

2. Coastal habitats: - The typical sandy beach fauna like crustaceans (a common example is the ghost crab) and the bivalve molluscs are common in all the beaches of Goa. The rocky beaches are homes to marine algae and sedentary organisms like the sponges and coelenterates. The rocky pools within these beaches provide microhabitats for many organisms like snails and sea-anemones. An important component of the sandy beaches in Goa are the sand dunes in the supralittoral region. These are colonized by a variety of sand binding vegetation, notably Spinifex littoreus and Ipomeapescaprae.

3. In terms of economic use of biodiversity, the continental shelf is the most important. The entire marine fishery harvest of Goa comes from this continental shelf region. While about 200 fishes are known from shelf waters of Goa, only few

support major fisheries. These include sardines, mackerels, tunas, seerfishes and pomfrets. Important shellfishes of the shelf region are prawns, crabs and mussels. The shelf region has also some patchy coral growth. This occurs around some offshore islands. While the recorded number of coral species (Porietes lutea, Favitessp. Turbinaria sp.and Astangia sp.) and their areal cover are quite low, not really enabling them to be designated as ecosystems per se, the coral patches still have a resident fish population typical of rocky bottom

4. Lotic freshwater ecosystems: - There are smaller freshwater streams which have diversity of algae and freshwater fungi. Still lesser known are the springs and fountains.

5. The estuarine ecosystem: - The mangroves on the banks of these estuaries in meso and oligohaline zones are important vegetational features. The estuaries are known for fish and shellfish diversity and as refugia of several bird species.

6. Mangrove ecosystem: - The mangroves occupy about 2000 ha and occur along both the banks of the seven tidal estuaries and the Cumbarjua canal. The mangrove flora consists of 15 species of 10 genera belonging to 7 families. The dominant mangroves are Rhizophora mucronata, Sonneratia alba and Avicennia officinalis. Major mangroves in Goa are recorded from Mandovi-Cumbajua-Zuari complex with R. mucronata, Kandelia candel and S. alba as dominant species. Sea grasses are often associated with mangroves. Mangrove environments harbour 50 bacterial strains, mostly grampositive. Micrococus, Brevibacteriumand Kurthiahave been reported as predominant. Mangrove environments, though fairly high in primary production, have very few phytoplankton species. These include Pleurosigma, Naviculaand Nitzchia, followed by Bacillaria, Coscinioidiscusand Cymbella. Other forms like Biddulphia, Diplonies Mastgloiaand Thalassiothrixoccur only rarely.

7. Riverbank freshwater ecosystem: - Reduces soil erosion and harbours many plant species.

8. The Island ecosystems: - The Island of Anjedive, Grande, Pequeno, Saint George's are well known marine island ecosystems. The estuarine islands are densely populated and include-Chorao, Divar, Corjuem, Juve, Cumbarjuve. The riverine islands are colonized by vegetation and are poorly known being small in size and subjected to erosion.

9. Lentic ecosystems: - The natural lakes are found in the Western Ghats area. The manmade lakes, reservoirs, tanks and ponds are scattered in the coastal and the central portion of Goa and include large dams like Selaulim and Anjunem.

10. Khazan lands-saline agroecosystems of Goa: -The Khazan lands constitute a unique agro-eco-system.

11. The salt-pan ecosystem: - This is a man-made hypersaline ecosystem from which crude salt is extracted during summer. Salt-pans in Goa are inundated by tidal waters and monsoon runoff.

12. Myristica Swamps: - In Valpoi, Sattari Taluka there is a unique fresh water marshy ecosystem. Here the dominant species of Myristicamalabarica grows with inverted 'U' shaped roots.

Source: GOA STATE BIODIVERSITY STRATEGY AND ACTION PLAN (https://kalpavriksh.org/wp-content/uploads/2019/05/Goa-April-2002.pdf)

2.5. Pollution and waste management issues

The coastal zone of Goa is under increasing pressure from rapid urbanization, development of hotels/resort, coastal erosion, saline water intrusion, illegal sand extraction, siltation in estuarine zones, insufficient facilities for ecologically sustainable tourism etc. This has resulted in a rapid deterioration of coastal lands and wetlands, depleting biodiversity and causing imbalances in ecological dynamics. The following provisions have been made in the CRZ Notification to combat pollution:

- Disposal of wastes and effluents into coastal waters is a prohibited activity.
- Existing practice of discharging untreated waste and effluents should be phased out within a period not exceeding two years.
- Dumping of solid waste should be phased out within one year from the commencement of the Notification.
- An Action Plan should be prepared for dealing with pollution in coastal areas and waters and in a time bound manner.

There are various industrial projects operating in the coastal talukas of Goa.

3. PURPOSE & SCOPE OF CZMP

The primary purpose of a CZMP is to describe proposed actions to be implemented by administrative or other public authorities and potentially by the private sector to address priority management issues in the coastal zone over a defined implementation period. These issues include:

1. Ensuring livelihood security to the fisher communities and other local communities, living in the coastal areas
2. Conserving and protecting coastal stretches, its unique environment and its marine area and
3. Promoting sustainable development.

The CZMPs should support the goals and objectives of the CRZ Notification 2011 and assist in implementing an integrated coastal zone management plan. The CZMPs have to be prepared and developed in accordance with Annexure - I of the CRZ Notification 2011. The CRZ notification of 2011 has made it mandatory for the State to prepare Coastal Zone Management Plan (CZMP) as per the guidelines in the notification and get it approved by the Government of India.

Draft Coastal Zone Management Plan (CZMP) for Goa has been prepared accordingly as part of the study and submitted to the Department of Environment, government of Goa Coastal Zone Management Authority (GCZMA) for their review, public consultation and acceptance. The revised draft CZMP after public hearing to be submitted to Goa Coastal Zone Management Authority (GCZMA) for appraisal and recommendation. The GCZMA would subsequently submit the final draft CZMPs (after revisions if any by NCSCM) to the Ministry of Environment Forest and Climate Change for their approval for implementation.

Accordingly, for public consultation and website publication draft CZMP maps of 1:25,000 scale and local level CZM maps of 1:4000 scale was prepared. The 1:4000 scale map falling within the 1:25000 scale map is given in Figure 2.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

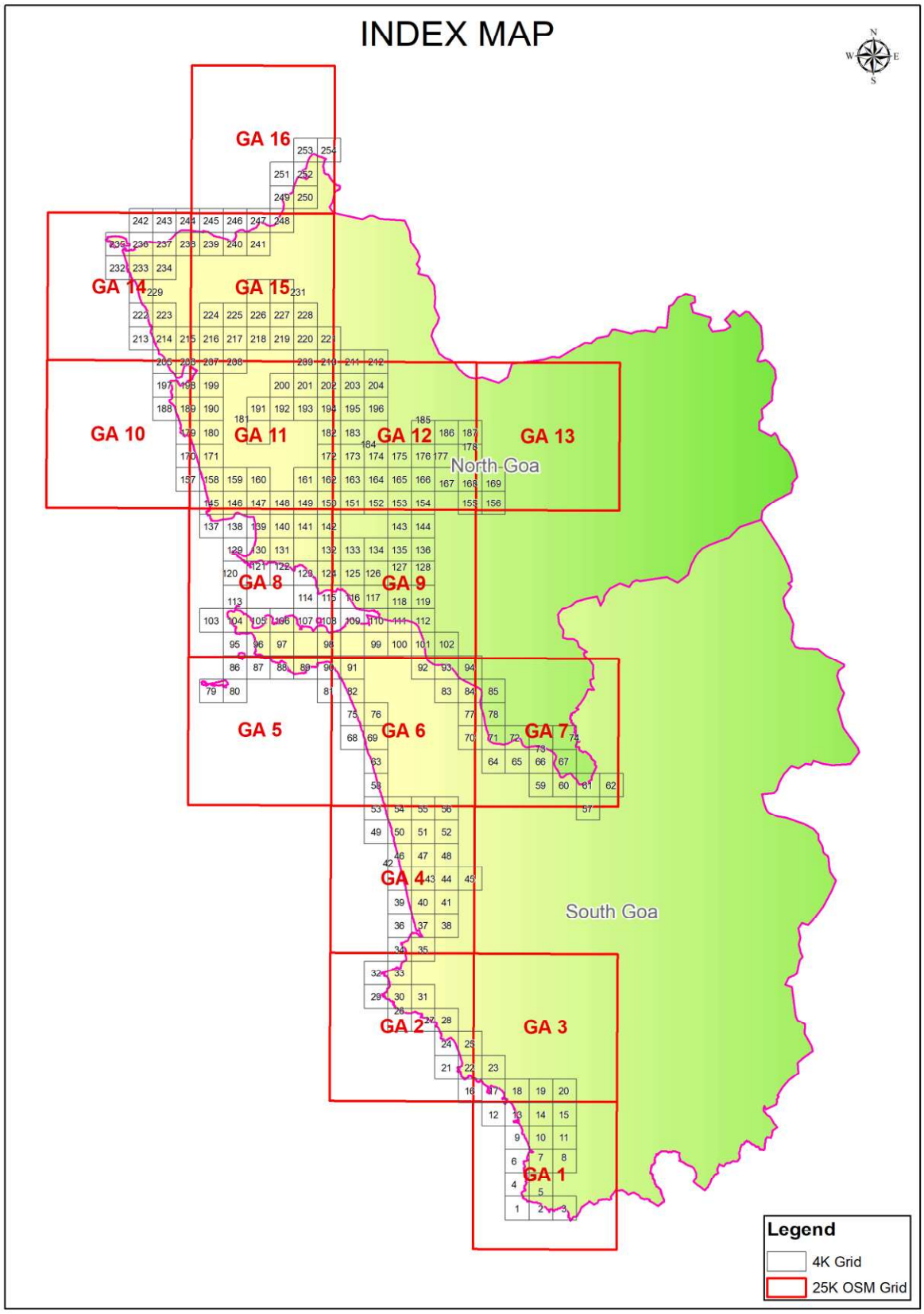


Figure 2: Index map showing 1:4000 scale map falling within the 1:25000 scale map

4. CRZ of Goa

As per the CRZ Notification, 2011 (para 7, (V) A(iii)) the CRZ of Goa is categorized separately in a special status as "areas requiring special consideration for the purpose of protecting the critical coastal environment and difficulties faced by the local communities".

While detailing with the Norms for regulation of activities permissible under this notification, it is mentioned under (para 8 (V) 3) that "in view of the peculiar circumstances of the State Goa including past history and other developments, the specific activities shall be regulated and various measures shall be undertaken as follows:

(i) the Government of Goa shall notify the fishing villages wherein all foreshore facilities required for fishing and fishery allied activities such as traditional fish processing yards, boat building or repair yards, net mending yards, ice plants, ice storage, auction hall, jetties may be permitted by Gram Panchayat in the CRZ area;
(ii) reconstruction, repair works of the structures of local communities including fishermen community shall be permissible in CRZ;
(iii) purely temporary and seasonal structures customarily put up between the months of September to May;
    (iii) (a) such structures shall not be removed and dismantled during the month of June to August. Provided that the facilities available in these structures shall remain non-operational during the month of June to August.
(iv) the eco sensitive low-lying areas which are influenced by tidal action known as khazan lands shall be mapped;
(v) the mangroves along such as khazan land shall be protected and a management plan for the khazan land prepared and no developmental activities shall be permitted in the khazan land;
(vi) Sand dunes, beach stretches along the bays and creeks shall be surveyed and mapped. No activity shall be permitted on such sand dune areas;
(vii) the beaches such as Mandrem, Morjim, Galgiba and Agonda has been designated as turtle nesting sites and protected under the Wildlife Protection Act, 1972 and these areas 16 shall be surveyed and management plan prepared for protection of these turtle nesting sites;
(viii) No developmental activities shall be permitted in the turtle breeding areas referred to in sub-paragraph (vii).

As per the amendment to the CRZ notification 2011 dated 1st May 2020 S.O.1422(E) where it stated that:-

Under paragraph 8.V relating to Areas requiring special consideration, in clause 3, for sub-clause (iv), the following sub-clause shall be substituted, namely: -

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

"(iv) the eco sensitive low lying areas which are influenced by tidal action known as khazan lands shall be mapped and 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".

In the CRZ Notification 2011, certain areas and geomorphological features of importance in maintaining the integrity of the coast, has been addressed with special reference to Goa. These include the Khazan landsand the mangroves along Khazan land, coastal sand dunes and turtle nesting sites.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

5. COASTAL ZONE MANAGEMENT PLAN

The Coastal Zone Management Plans are prepared in 1:25,000 scale with Survey of India toposheets as base maps. The maps are submitted to MoEF&CC, Government of India for approval after stakeholder/public consultations. The local level CZM maps of 1:4000 cadastral scale are also prepared for the use of local bodies and other agencies to facilitate implementation of the CZMPs. The present study and report provide the CZMP maps in 1:25,000 scale as well as 1:4000 scale.

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

The HTL is defined as "the line on the land up to which the highest waterline reaches during the spring tide" which is different from the well-known and widely accepted definition of High Tide Level. The above definition of HTL takes into consideration not only the level of inundation due to maximum tide (spring tide) but also the wave set up (having a seasonal periodicity). The sea level thus formed due to the combined effect of spring tide and wave set up gives the line of maximum reach of water on the land. Unlike the HTL, the Low Tide Line (LTL) has not been defined for CRZ. The HTL required specific definition since the 100, 200 and 500m setback lines are defined with respect to the HTL. The conventional definition of lowest low water level and the resultant low water line during spring tide is taken as the LTL.

As per Para IB.8 of Annexure-I of CRZ notification 2011, the following geomorphological features shall be considered while demarcating in HTL or LTL:

Landward (monsoonal) berm crest in the case of sandy beaches Rocks, Headlands, Cliffs Seawalls or revetments or embankments.

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 has been done by using aerial photographs/satellite data. Manual on "Demarcation of High Tide Line and Low Tide line" prepared by NCSCM is referred during the delineation of HTL and LTL.

The following signatures/ geomorphologic/ man-made structures used to demarcate the HTL are explained below using suitable illustrations.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

5.1.1. Landward (monsoonal) berm crest for beaches

In all the well-formed wide beaches, one or more berms (which are the nearly horizontal part of the beach formed by the deposition of sand by wave action) are usually observed. The seaward end of the berm, which shows a sudden downward slope, is called the 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 does 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.

5.1.2. Seawall/revetments/embankments

In highly erosion-prone areas, there are no landward second berms. Such locations will be protected mostly by seawalls. During monsoon season, a majority of these are devoid of beaches. The waves impinge upon the seawall during the monsoon season, especially during 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.

5.1.3. Permanent Vegetation Line

Permanent vegetation develops on the stable part of the beach. The part of the beach landward of monsoon berm crest is mostly stable. Hence, the line of permanent vegetation/perennial plants normally follows the line of monsoon berm crest, which is considered as the HTL.

5.1.4. Coastal sand dune

Coastal sand dunes are ridges or a series of ridges that form at the rear of the beach. Sometimes sand dunes are covered with vegetation. If the vegetation is present then the seaward limit of vegetation boundary is considered as HTL. For eroding dunes, the toe of the foreshore face of dune is considered as HTL.

5.1.5. Mangroves

These are evergreen, tropical coastal plants/ trees occurring in the intertidal zone, bays, estuaries, deltas, lagoons, creeks or any low energy zones of the coast. Landward boundary of mangrove to the extent where tidal water reaches, is considered as the HTL.

5.1.6. Rocks, Headlands, Cliffs

At rock outcrops, headlands and cliffs, the water is quite deep in 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.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

5.1.7. Other geomorphic/land cover features

Some coasts have a fairly large inter-tidal zone fringed by vegetation or coastal alluvial plain. In such cases, the HTL is demarcated using tonal differentiation between clayey or silty clay region along with salt encrustation upto supra- tidal mudflat and adjoining sandy alluvial plain. Other geomorphic/ land cover features such as marshes, mangroves, fringing corals, saltpans, aquaculture ponds, and seaward side of agricultural/ horticulture land are also used for some of the coastal regions.

5.1.8. Influence of Tidal action

The distance up to which CRZ is applicable upstream of estuaries, creeks, backwaters and lagoons depends on the extent of tidal influence. The distance up to which tidal influence is experienced is dependent on salinity concentration: if it is 5 ppt or more (during the driest month) the water body is considered to be influenced by tidal action (CRZ, 2011). Salinity measurements are carried out during the driest month (usually during March-April) to determine the limit. Tidal barrages/lock and bunds constructed are also taken as the limit of tidal influence.

HTL and LTL were demarcated from aerial photographs. Wherever aerial photograph were not available, high resolution satellite images have been used. Coastal geomorphological signatures as discussed above were used as indicators to demarcate the HTL. The High Water Level (HWL) and Low Water Level (LWL) marked on the Survey of India toposheet on 1:25000/1:50000 scale was extracted/digitized. The coastal geomorphological signatures in the field or satellite imageries or aerial photographs were used for appropriate adjustment in the HWL or LWL for demarcating HTL or LTL in accordance with the CRZ notification. The delineated HTL and LTL has been corrected with field visits and validated taking respective state governments' suggestions / recommendations before finalisation.

As per the amendment S.O.1422(E) dated 1st May 2020 for CRZ Notifications 2011, stated as fallows,

"In paragraph 2, the following provision shall be inserted, namely: -

"Provided that 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."

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

Whereas,
Under paragraph 8.V relating to Areas requiring special consideration, in clause 3, for sub-clause (iv), the following sub-clause shall be substituted, namely: -
"(iv) the eco sensitive low lying areas which are influenced by tidal action known as khazan lands shall be mapped and 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".

As per the above amendment to the CRZ notification 2011, the High Tide Line has been modified and restricted up to the line long along the existing bund or the sluice gate which is constructed in the past, prior to the date of notification issued vide S.O. 114(E) dated 19th February, 1991.

5.2. Demarcation of Ecologically Sensitive Areas

NCSCM was awarded the task of mapping ESAs by MoEF&CC. The task was undertaken in partnership with various expert agencies as provided in Table 3. Mangroves, sand dunes, mudflat and salt marsh ecosystems have been mapped by NCSCM using aerial photographs and satellite images.

Table 3. Research Partners / Data Sources for Mapping ESAs

ESA	Source
Mangrove	NCSCM
Coral Reef	NCSCM
Sand Dunes,]	NCSCM
Mudflat, Salt marsh	NCSCM
MPAs	Wildlife Institute of India, Dehradun
Archaeological Sites	Archaeological Survey of India, Chennai
Turtle Nesting Grounds	Indian Institute of Science, Bengaluru

The demarcated ESAs were updated / corrected after rigorous field visits. Further the data has been validated taking respective state governments' suggestions / recommendations before finalisation.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

6. ECOLOGICALLY SENSITIVE AREAS AND COASTAL LAND USE

Coastal land use is essential for assessing the status of natural resources and the coastal environment. It is also a pre-requisite for zonation of the coast as well as for making a sustainable coastal zone management plan. The coastal land use maps on 1:25000 scale were prepared using satellite images of 2011-2012 as available with NCSCM and according to the "Manual on Demarcation of High Tide Line and Low Tide Line and Preparation of CZMP of the Coast of India". The landward extent of coastal land use area is the landward limit of CRZ boundary or hazard line, whichever is further inland. For classification of coastal land use, the classification system mentioned in the "HTL Manual" was followed. The coastal land use map also depicts the ESAs, HTL and other details. The land use classification scheme in 1:25000 scale is given in Annexure II. Ground truthing was carried out for validation and accuracy assessment of the maps. Necessary corrections in the maps were carried using field data. The accuracy assessment report is given in Annexure – III. Details such as cadastral boundary, administrative boundaries and infrastructure were superimposed on the map and the final draft map was prepared. Taluka wise area statistics of different coastal features are shown in Table 4.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

Table: 4 Area statistics of Ecologically Sensitive Areas (ESAs) and Geomorphological classes

Taluk	Area (sq km)													
	MG	MG Buffer	Coral	SD	MF	SM	RF	NGB	TNG	AH	ITZ	Khazan Land	Saltpan/Aqua	Total Area
Canacona	0.73	1.63	-	0.07	-	-	3.48		0.17	0.18	2.95	1.39	0.01	***10.61***
Quepem	0.05	0.18	-	-	-	0.13				-	0.34	0.28		***0.98***
Sanguem	-	-	-	-	-	-			-	-	0.02			***0.02***
Salcette	4.29	9.74	-	2.24	0.46	0.77				-	5.70	22.77	0.73	***46.70***
Mormugao	2.41	2.31	0.37	0.09	0.38	0.02				0.01	2.97	3.79		***12.33***
Tiswadi	18.40	19.75	-	0.01	0.58	0.62		2.87		0.02	6.05	51.33	1.92	***101.54***
Ponda	3.85	6.04	-	-	0.04	0.14				-	3.94	15.98	0.06	***30.05***
Bardez	5.93	9.97	-	0.15	0.08	0.33				0.09	4.56	19.90	0.16	***41.17***
Pernem	3.20	3.85	-	0.51	0.36	0.08			0.08	0.00	2.81	8.61	0.31	***19.81***
Bicholim	2.26	3.49	-	-		0.00				-	1.51	11.50		***18.76***
	41.12	***56.97***	***0.37***	***3.07***	***1.89***	***2.10***	***3.48***	***2.87***	***0.25***	**0.30**	**30.85**	***135.55***	***3.18***	

MG: Mangrove; MG Buffer: Mangrove Buffer Zone; SD: Sand Dune; MF: Mudfalt; MPA: Marine Protected Area; SM: Salt Marsh; TNG: Turtle Nesting Ground; NGB: Nesting Ground of Birds; AH: Archaeologically important and Heritage Sites; ITZ: Inter-Tidal Zone; RF: Reserve Forest.

The coastline of Goa is a combination of bays and headlands intersected by dynamic estuarine river systems, coupled with minor streams. The tidal river systems of Goa are lined by mangroves that flourish on the saline soil providing a unique habitat for birds and marine animals. Extent of ESAs of coastal Goa is given in Table 5.

Table 5: Extent of ESAs as per CRZ Notification 2011(in sq.km)

State Name:- Goa		Section in CRZ 2011 notification	In Sq.km
Ecosystems	Mangrove	7(i)A(a)	41.12
	Corals	7(i)A(b)	0.37
	Salt Marsh	7(i)A(f)	2.10
Habitats			
	Turtle Nesting Sites	7(i)A(g)	0.25
	Bird nesting Sites	7(i)A(j)	2.87
Geomorphological features	Sand Dune	7(i)A(c)	3.07
	Mudflat	7(i)A(d)	1.89
	Reserve Forest	7(i)A(e)	3.48
	Archaeological & Heritage Sites	7(i)A(k)	0.30

6.1. Mangroves

Mangroves are trees of various species of several families, which grow only where they can come into permanent contact with sea water or brackish water. They occur at the edges of the tropical or subtropical seas, bays, lagoons and estuarine regions (Gerlech, 1973). Mangroves occur in quiet depositional coastal environments. Although mangroves grow in a variety of sediments including coral sands, they attain full development on the fine grained, soft organic mud deposited in sheltered coasts. Mangrove roots help accumulation of silt which gradually builds up to form dry land, thus extending the coastline. Mangroves support in maintaining a rich coastal biodiversity.

Mangroves and associated swamps are observed along the creeks, rivers, estuary and water bodies which are influenced by tidal action. Luxuriant mangrove forests are mainly observed in the Mandovi-Zuari estuarine complex. The total area covered by the mangroves of Goa is 41.12 sq. km. North Goa has maximum mangrove which is 33.93 sq km whereas South Goa has only 7.19 sq km. All the mangroves areas are mapped in the CZMP maps. The draft management plan for mangroves prepared by Department of Environment, Government of Goa is given as Annexure -IV.

6.2. Coral Reefs

Corals are exclusively polypoid, marine organisms which belong to Class: Anthozoa of Phylum: Coelenterata/ Cnidaria, capable of secreting a massive calcareous skeleton.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

Hermotypic or reef building corals, colonize suitable sea floor substrates in tropical and sub-tropical shallow waters with appropriate ecological conditions (summer maximum mean temperature of 28°C and winter minimum mean temperature generally above 18°C, colonizing mainly photic depths, salinity 35±2 psu etc (SAC, 2012). Coral reef is defined as 'a complex organogenic framework of calcium carbonate (primarily of corals), which forms a rocky eminence on the sea floor and customarily grows upwards to the tide limit' (Fairbridge, 1968). Coral reefs are one of the most productive and complex coastal ecosystems with high biological diversity. The high productivity is owing to the combination of its own primary production and support from its surrounding habitat. All corals are protected in India as they are listed as Schedule I species under the Wildlife Protection Act, 1972. This implies that touching, removing, dislocating corals in any fashion is a prohibited activity in the Indian territorial waters.

In Goa, Coral reefs are confined only to Grand Island which is 0.37 sq km. The Live corals in Grand Island account for 50.8% of the benthic substrate. The coral life form diversity in Grand Island was observed to be moderate. The live coral cover includes various life forms viz., encrusting, massive, sub-massive and foliose type, of which foliose corals were the dominant forms.

6.3. Reserve Forests

The Indian Forest Act, 1927 contains provisions pertaining to reserved forest whereby the state government could constitute any forest land or wasteland as a reserved forest or protected forest by a notification in the official gazette. Forest Conservation Act 1980 defines the term "Forest". No state government or other authority can, without the prior approval of the Central Government, make any order to: (1) de-reserve forest, (ii) use any forest land for non-forestry purpose; (iii) lease out forest land to a private agency; (iv) cut naturally grown trees in forest land for the purpose of using it for re-afforestation. Total reserved forest area in the CRZ area of Goa is 3.48 sq km. Reserved forest are observed only in Canacona Taluka, South Goa district.

6.4. Sand Dunes

These are single or multiple ridges or mounds of loose wind-blown material, usually sand on the coast. Coastal sand dune covers a small area and is defined as topographical feature of aeolian origin composed of sand grain deposited downwind from a natural source of sand (Fairbridge, 1968). They are developed in any environment in which loose sand size particles are exposed to wind action and are free to migrate and accumulate as unconsolidated masses. The sand dunes function as a buffer for the beach and reduce the impact of coastal erosion.

The coastal stretch of the Goa state is covered by sandy beaches backed by sand dunes, which are sensitive geomorphic features of vital economical and ecological importance.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

The tourism development along the coast has been the major reason for the flattening of the sand dunes which need to be restored. The purpose of the Coastal Zone Management Plan (CZMP) notification is to control and minimize environmental damage to these coastal ecosystems.
Initially sand dunes were extracted from satellite images. The extracted sand dune were corrected by loverlaying on the ortho aerial photograph with spatial resolution of 10cm and refined the spatial extent of the sand dune. A detailed ground investigation was also carried out for the entire study area using the instruments such as GPS and Disto Meter during October 2016 to verify the spatial extent and the present scenario of sand dunes. Subsequently, the sand dunes has been finalised.

Total sand dune area along the Goa coast is 3.07 sq km out of which maximum sand dune is observed along the South Goa coast which is 2.40 sq km and North Goa having 0.67 sq km.

6.5. Salt marsh

Salt marsh is a flat or gently sloping vegetated wetland in the upper intertidal zone on sheltered parts of the coast (estuaries, inlets, lagoon shores). Often in the form of a depositional terrace, periodically submerged, with halophytic grasses, herbs, and shrubs; dissected by tidal creeks, and may contain enclosed Salt Pans.

Salt marsh is a community of organisms dominated by plants that are tolerant of wet, saline soils, generally found in low-lying coastal habitats which are periodically wet and unusually saline to hyper-saline. The term salt marsh summarizes the saline conditions of the habitat as well as the emergent vegetation which dominates it. Plants which grow in salt marshes are thus tolerant of two conditions: saline and wet. Total salt marsh area of Goa is 2.10 sq km and is observed mainly in Tiswadi taluka.

6.6. Nesting Ground of Birds

Nesting Ground of Birds are the designated area where large number of birds/migratory birds are nesting and that area is highly susceptible to changes by human activities and requires special protection. Nesting ground of birds (i.e., Dr. Salim Ali (Chorao) Santuary) are found in Mandvi river in Tiswadi taluka. The total area is 2.87 sq km.

6.7. Archaeologically important and Heritage Sites

The Ancient Monuments and Archaeological Sites and Remains Act 1956 (AMASR Act, 1956) is an Act of Parliament of the Government of India that provides for the preservation of ancient and historical monuments and archaeological sites and remains of national importance, for the regulation of archaeological excavations and for the protection of sculptures, carvings and other like objects “Areas or structures of archaeological

importance and heritage sites" have been included as CRZ IA under CRZ Notification, 2011.

0.30 sq. km of archeologically important and heritage sites were mapped along Goa coast; of this North Goa contributes 0.11 sq. km and South Goa 0.19 sq. km. Details of Archaeologically important and Heritage sites are given in Table 6.

Table 6: Details of Archaeologically important & Heritage sites within the CRZ limit

Sl. No	Districts	Taluka	Location
1	North Goa	Pernam	Fort of Terekhol
2		Bardez	Chapora Fort
3			Fortification Wall of Auguda Fortress (Lower)
4			Upper Agauda
5			Church of Reis Magos
6			Reis Magos Fort
7		Tiswadi	Church of Our Lady of the Cape
8			Chapel of St. Cajetan and Largo
9			Arch of Viceroy
10	South Goa	Mormugao	The Fort of Marmagoa
11			Shantadurga temple
12			Church at sancole,Nagapattinam
13		Canacona	Cabo da Rama Fort

6.8. Mudflats

Mudflats/ tidal flats are formed by fine-grained silt and clay in a medium to- large tidal environment. They have a fairly large intertidal zone, fringed by euryhaline vegetation and may or may not be interlaced with individual mangroves or creeklets. Mudflats provide important habitat for burrowing and bottom-dwelling invertebrates, such as clams and mussels, as well as other invertebrates such as horseshoe crabs, mud-snails and shellfish species. Mudflats serve as an important feeding ground for many animals, especially for migratory wading birds which to refuel on their long journeys. Mudflats are observed along the bank of rivers namely Terakol, Chapra,Mandvi and Zuary, sal river. Total area of mudflat of Goa is 1.89 sq km.

6.9. Turtle Nesting Grounds

Sea turtles or marine turtles are generally found in waters over continental shelves; females come ashore to sandy beaches where they were born where they dig nests and lay eggs during the nesting season. These beaches are known as turtle nesting grounds/sites. India has five of the seven species of known sea turtles. Mass nesting

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

occurs along sandy beaches on the west and east coast. After hatching, the turtles find their way back to the sea.

All the five species of sea turtles occurring in India, including the Olive Ridley turtles, are legally protected under Schedule I of the Wildlife Protection Act, 1972 and Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES Convention) which prohibits trade in turtle products.
Sea turtles are air-breathing reptiles spending most of their lives at sea and migrate in large numbers to a nesting site at which they lay eggs, typically found on sandy beaches. The sandy beaches along the coast Goa are inherently suitable for the sea turtles to nest on. The nesting sites of Lepydochelys olivacea commonly known as the Olive Ridley turtle are found along the coasts of Morjim and Mandrem in North Goa, Galgibag and Agonda in South Goa. Sea turtles are a key ecological component helping the substrate and nutrient transportation, ensuring to maintain a healthy functioning system. Hence the preservation and management of these nesting sites are of vital importance. Total Turtle nesting area along the Goa coast is 0.25 sq km. Draft management plan for turtle nesting sites prepared by Department of Environment, Government of Goa is given as Annexure-V.

6.10. Salt Pan/ Aquaculture Ponds

Salt pans is defined as “An undrained usually small and shallow rectangular, man-made depression or hollow in which saline water accumulates and evaporates leaving a salt deposit” (Margarate et al, 1974). Salt pans are square or rectangular in shape. Whereas, aquaculture is defined as "The breeding and rearing of fresh-water or marine fish in captivity. Fish farming or ranching". The water bodies used for the above are called aquaculture ponds (Encyclopaedic Directory of Environment, 1988). The Total area of saltpans/aquaculture area in Goa is 3.18 sq km and mainly observed in Pernam, Bardez, Tiswadi, Ponda and Salecete taluka.

6.11. Khazan land

As per the Para 8.V.3 of CRZ notification 2011, “the eco sensitive low-lying areas which are influenced by tidal action known as khazan lands shall be mapped and the mangroves along such as khazan land shall be protected and a management plan for the khazan land prepared and no developmental activities shall be permitted in the khazan land”. The Khazan land data are received from the Department of water Resource, through the Department of Environment, Government of Goa and the same are depicted in the CZMP maps.

The Total area of Khazan land of Goa is 135.55 sq.km and the north Goa having 107.32 sq. km area and south Goa having 28.23 sq. km area. The Taluka wise Khazan land area is shown in Table 7.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

Table 7: Taluka wise area of Khazan lands

Districts	Taluka	Area in Sq. km
North Goa	Pernam	8.61
	Bardez	19.90
	Bicholim	11.50
	Tiswadi	51.33
	Ponda	15.98
South Goa	Mormugao	3.79
	Salecete	22.77
	Quepem	0.28
	Canacona	1.39
Total area		135.55

Draft Khazan land management plan **prepared by Department of Environment, Government of Goa** is given as **Annexure-VI**.

6.12. Fishing Wards/infrastructure

The Department of Fisheries, Government of Goa provided the data on fishing ward boundary, fish breeding area, fisherman community complex, boat parking area/net mending yard, fish landing centre/ramp and it has been depicted in the CZMP on 1:4000 scale. A 100m buffer line was drawn from HTL to landward side in case of fishing wards near the sea coast to facilitate special consideration available for coastal communities. Construction/reconstruction of dwelling units of traditional coastal communities including fisher folk may be permitted between 100 and 200 metres from the HTL along the seafront.

The **draft comprehensive plan is prepared for fisherman community living in CRZ areas** by Department of Environment, Government Goa is given as **Annexure -VII**

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

7. METHODOLOGY FOR PREPARATION OF CZMP

Survey of India (SOI) toposheets on 1:25,000 scale were used as base map. Toposheets of the area of study are geo-referenced and the High Water Line (HWL) and Low Water Line (LWL) in the toposheets have been extracted along with other coastal features like water bodies, inter tidal zones, mudflats, beaches, mangroves, saltpans, prawn aqua farms, etc. The HWL and LWL is updated using aerial photographs and where ever Aerial photographs are not available high resolution satellite images such as Quick Bird, World View and IKNOWS are used. The pdf maps provided by Directorate of Settlement and Land Records Department are of scale 1:500 to 2000 were used as base map.. Survey Plot boundaries, road junction points, which are locatable on the ground are taken as the reference points for georeferenceing/spatially adjusting the cadastral maps and satellite images.

7.1. Field mapping and map preparation

The PT sheet obtained from the Directorate of Settlement and Land Records were checked for scale and accuracy by comparing the distance of 2 known points from the map and from the ground. Information derived from toposheets and satellite imageries/aerial photos of different coastal ecosystems in the given area was used as baseline information for planning the field investigations. PT sheets were rectified using aerial photographs and cross verified with coordinates of known ground control points (GCP) taken from the field with the support of DSLR Goa all along the coast of Goa. The datum used was WGS 84 and the projection was UTM Zone 43N. The HTL, LTL and ESAs were verified in the field. Ground features that can be clearly identified both on ground and on the cadastral maps were used as ground control points (GCP). With precise planimetry of the identified GCPs, the PT sheets were geo-referenced with GPS/DGPS measured geo-coordinates.

Signature for the nearest HTL was identified and distance to the HTL from the control point was measured using a distometer. The GPS/DGPS was moved along the HTL identified through signatures and the readings were recorded. Wherever possible, these were linked to the control points identified earlier and distance to HTL measured with distometer. The data thus collected was transferred to cadastral maps and superimposed in GIS platform.

The use of aerial photographs/satellite imageries in combination with field mapping provided better results in the preparation of CZMP maps. At the same time, various location and spatial errors that could get magnified in large scale maps such as cadastral maps were contained through appropriate approaches. The filed works were carried out during 2016 and during 2018 and 2019.

Few photographs taken during the fieldwork have been given as Annexure-VIII. Steps involved in the preparation of CZMP maps are shown in Figure 3.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

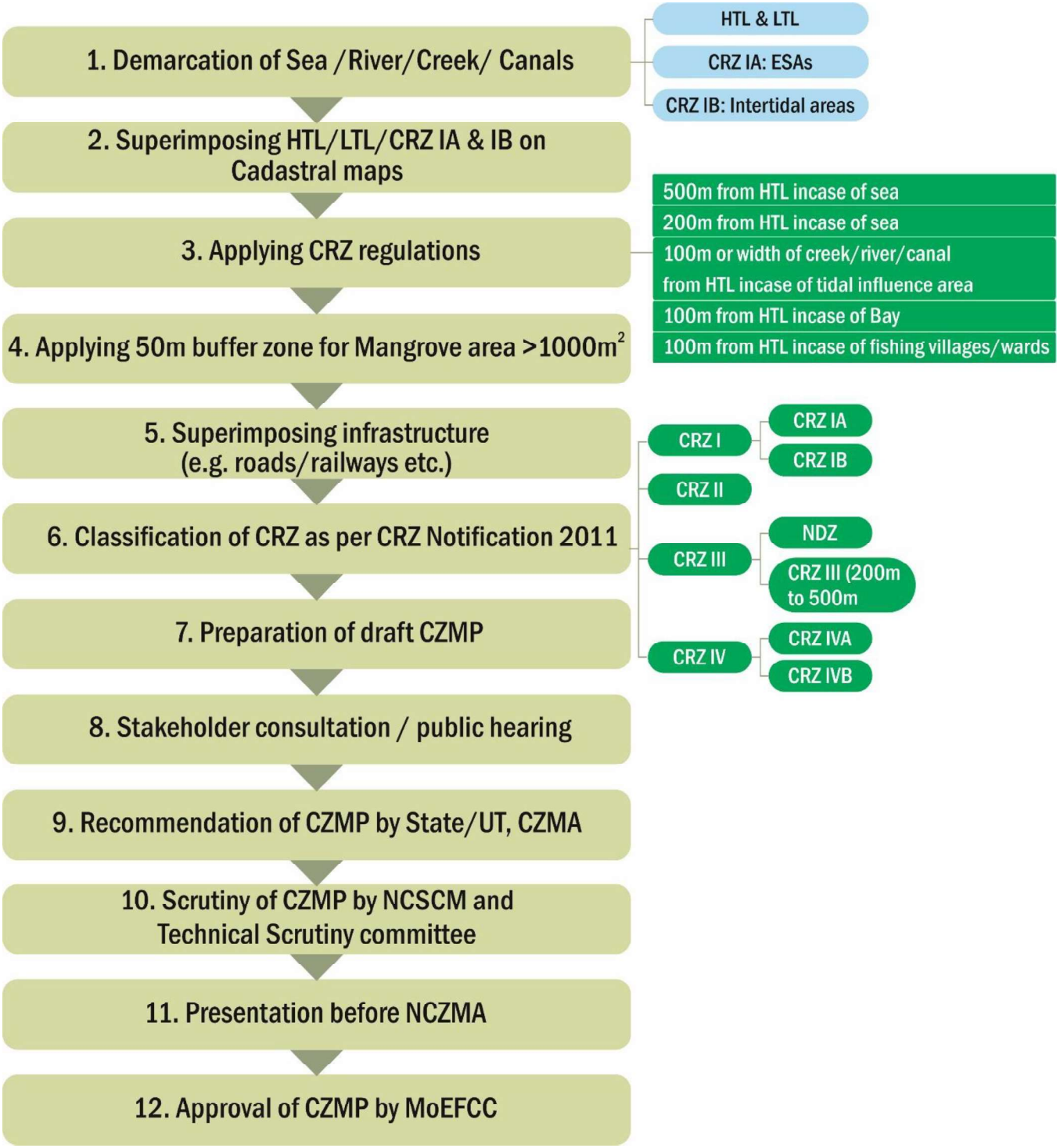


Figure 3: Various steps involved in the preparation of CZMPs

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

In the 33rd Meeting of the National Coastal Zone Management Authority (NCZMA) was held on 24.05.2018 under the chairmanship of Secretary (MoEF&CC) the following major directions are given by Chariman NCZMA under agenda 4

Agenda 4:

"All the draft CZMPs shall be routed through NCSCM for a final round of technical scrutiny. Additional inputs, information and clarification etc., if any, envisaged by the States to be incorporated in their CZMPs, may be provided to NCSCM in the intervening period. After the technical scrutiny, a briefing note may be prepared for the guidance of the NCZMA"
Accordingly, NCSCM has constituted a Technical Scrutiny Committee under the Chairmanship of Dr. Shailesh Nayak, former Secretary, Ministry of Earth Sciences, Govt. of India, to scrutinize the Coastal Zone Management Plans (CZMPs) prepared by agencies authorized by MoEF&CC and provide recommendation for NCZMA.

The First Meeting of the Committee to Scrutinize Coastal Zone Management Plans Prepared by Coastal States/ UTs, held on 2nd and 3rd July 2018 at NCSCM, MoEF&CC, Chennai. The general recommendations of the First Meeting of the Technical Scrutiny Committee were as follows:-

"2) The coastal land use and CZMP maps shall be prepared according to the Manual on Demarcation of High Tide Line and Low Tide Line and Preparation of CZMP of the Coast of India".

(5) Two sets of maps need to be provided: (i) CZMP map depicting different CRZ categories and (ii) Coastal land use maps (i.e. land use map used to define CZMP) categories along with the year in which it was prepared.

(6) Maps of Ecologically Sensitive Areas (ESAs) provided by NCSCM are to be integrated with the coastal land use map".

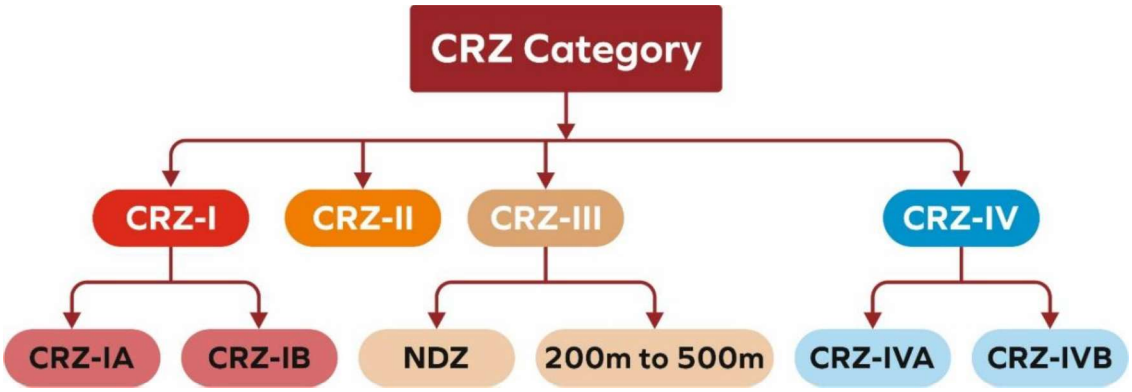
Hence, the CZMPs of 1:2500 scale of Goa has been prepared to clearly identify, demarcate and represent different categories of coastal regulation zone such as CRZ IA, CRZ IB, CRZ II, CRZ NDZ-CRZ III, 200 to 500m –CRZ III, CRZ IVA, CRZ IVB in distinguishing colours. Whereas, in coastal land use map (used to define CZMPs) Ecologically Sensitive Areas (ESAs) such as salt marshes, sand dunes, mudflats, corals and coral reefs, Sanctuaries, National Parks, Turtle Nesting Grounds, Nesting grounds of birds, , areas of structures of archaeological importance and heritage sites as required under Annexure-I to CRZ Notification, 2011 are to be integrated.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

8. CRZ CLASSIFICATION

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ areas were classified as follows, namely CRZ I which includes ecologically sensitive areas and the geomorphological features which play a role in maintaining the integrity of the coast (CRZ IA) as well as the inter-tidal zone (CRZ IB); CRZ II - the developed land areas up to or close to the shoreline; CRZ III are land areas that are relatively undisturbed (viz. rural areas, etc.) and those which do not fall under CRZ-I, CRZ-II and CRZ IV (the water and bed) area as per the CRZ Notification 2011. The schematic diagram showing various CRZ categories is given below (Figure 4).

Figure 4: Classification of CRZ area



The schematic diagram showing various CRZ categories is given below **(Figure 5).**

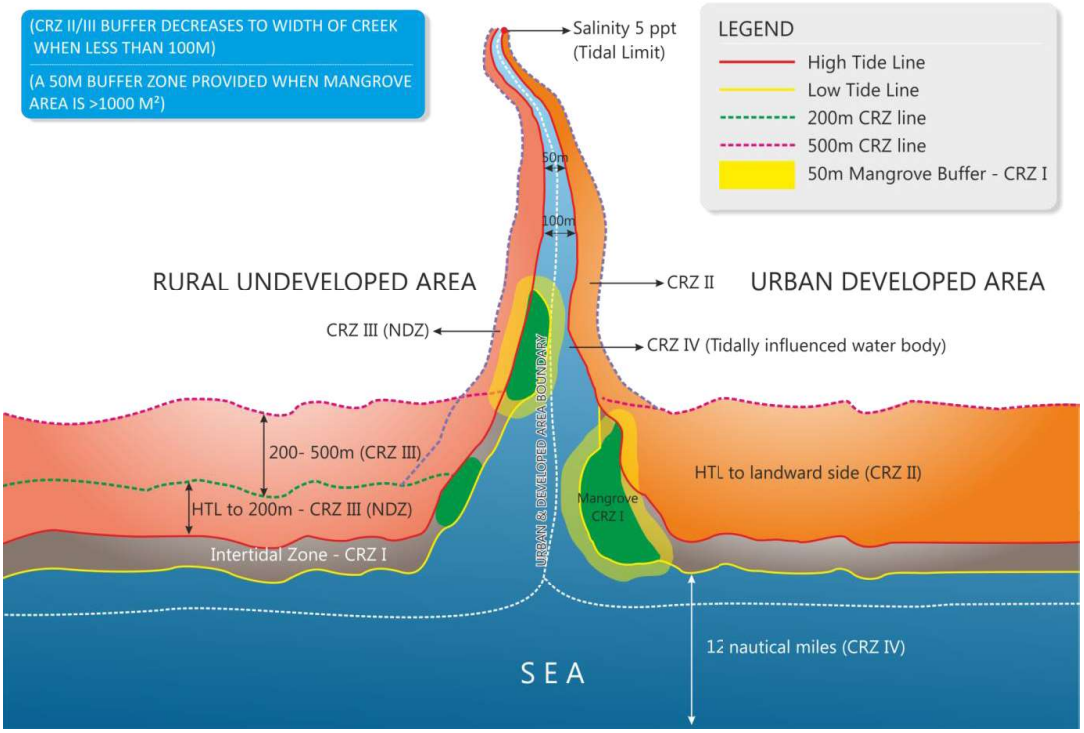


Figure 5: Schematic diagram showing demarcation of different CRZ categories

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

8.1. CRZ I

As per the CRZ Notification 2011, CRZ I consists of CRZ IA and IB. CRA IA areas are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast, include the following:

a) Mangroves, in case the mangrove area is more than 1000 sq.m, a buffer of 50m along the mangroves shall be provided;
b) Corals and coral reefs and associated biodiversity;
c) Sand Dunes;
d) Mudflats which are biologically active;
e) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves;
f) Salt Marshes;
g) Turtle nesting grounds;
h) Horse shoe crabs habitats;
i) Sea grass beds;
j) Nesting grounds of birds;
k) Areas or structures of archaeological importance and heritage sites

The area between Low Tide Line and High Tide Line is the Inter Tidal Zone and categorized as CRZ IB.

8.2. CRZ II

CRZ II areas are developed areas up to or close to the shoreline. “Developed area” is referred to that area within the existing municipal limits or in other existing legally designated urban areas which are substantially built-up and has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains.

8.3. CRZ III

The land areas that are relatively undisturbed and those that do not belong to either CRZ I or II which include coastal zone in the rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up.

8.4. CRZ IV

The water area comes under CRZ IV and is further classified into IVA and IVB.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

CRZ IVA: the water area from the Low Tide Line to twelve nautical miles on the seaward side;

CRZ IVB: shall include the water area of the tidal influenced water body from the mouth of the water body at the sea up to the influence of tide which is measured as five parts per thousand during the driest season of the year.

8.5. Regulation lines

The 100, 200 and 500m regulated lines were drawn landward from the HTL. Once the HTL, fishing wards and bays were well defined and demarcated, the above 3 CRZ lines could be drawn without any ambiguity following planimetric methods. In case of mangrove area >1000 sq. m, a 50 m buffer zone was drawn.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

9. HAZARD LINE

9.1. Demarcation of Hazard Line

The word 'hazard line' denotes the line demarcated by MoEF&CC through the Survey of India (hereinafter referred to as the SoI) taking into account tides, waves, sea level rise and shoreline changes. The hazard line is a composite line of the shoreline changes and sea level rise due to climate change, tides and waves. This initiative of the MoEF&CC forms a critical part of its responsibilities towards the planned management of the country's coastal zone. Mapping of the hazard line for the mainland coast of India has been completed by the SoI, in collaboration with NCSCM. The process involves the following steps:

9.1.1. Tidal data processed by the Survey of India

i. Collection of historical tidal data (Annual highest high tide level) of 21 major / primary ports/tidal stations and 180 minor/secondary ports/tidal stations, covering the Indian coast.
ii. Quality check and cleaning of data.
iii. Determination of Tide level with 100 years Return Period for Primary ports, using the Weibull statistical distribution. A one-hundred-year return period Hazard Line refers to a Hazard event that has a 1% probability of occurring in any given year.
iv. Interpolation/ Extrapolation for determining the tide level with 100 year return period for Secondary ports.
v. Interpolation of tide level with 100 year Return Period for intermediate stations i.e., at transects at every 250 m between secondary ports.
vi. Addition of the effect of projected sea level rise in 2100.

9.1.2. Generation of Digital Elevation Models (DEM) by the Survey of India

i. Aerial Photography of the entire coastal areas of the country has been completed for about 78,000 sq. km., and very high resolution Digital Aerial Photographs of resolution 9 cm GSD have already been generated.
ii. Photogrammetric surveys and preparation of Digital Elevation Model (DEM) for the entire mainland coast have also been completed.
iii. Contour surveys with contours at vertical interval of 0.1m till the Flood line (100 year return period maximum tidal elevations) and 0.5 m for the area beyond have been completed.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

9.1.3. Delineation of Flood line by the Survey of India

i. The 100 year return period tidal elevations computed at the intermediate transects at every 250 m along the coast are plotted onto the 0.1 m contour data generated from the high resolution DEM.
ii. The locus of these points will form the flood line.

9.1.4. Delineation of Erosion line by NCSCM

i. Collection of time series high resolution satellite imagery for the period from 1970 to 2010 and geo-referencing.
ii. Delineation of the periodic shorelines from the satellite imagery for the period from 1970 to 2010 and from the high resolution aerial ortho-image of 2012.
iii. Computation of annual rate of erosion/accretion using the Digital Shoreline Analysis System (DSAS) at transects points at every 300 m along the coast, in terms of annual displacement from a fixed base line.
iv. Extrapolation to compute the 100 year erosion/accretion rates at these transect points, in terms of the distances from the fixed base line.
v. Plotting the above transect points on high resolution satellite image.
vi. The locus of these points will form the Erosion line.

9.1.5. Demarcation of the Hazard Line by the Survey of India

i. Overlaying the Flood line and the Erosion line in a GIS environment.
ii. Marking the segments of the Flood line /Erosion line which are the most landward, to get the Hazard line.
iii. Transferring the hazard line to topographic maps for public dissemination.

9.2. Impact of Hazard Line

As per the Minutes of the 33rd Meeting of the National Coastal Zone Management Authority (NCZMA) held at New Delhi on 24.05.2018, the Hazard line shall be used only for the purpose of planning for Disaster Management. The Hazard line as mapped by Survey of India (SoI), shall, however, be reflected in the respective CZMPs.

The Notification dated 02.07.2018 vida S.O. 3197(E) made amendments in the main Notification 2011 where the hazard line was removed from the CRZ jurisdictions and also stated *inter-alia* as follows:-

i. "A 'Hazard line' shall be demarcated by the Survey of India, taking into account the extent of the flooding on the land area due to water level fluctuations, sea level rise and shoreline changes (erosion/accretion) occurring over a period of time, and

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

shared with the coastal States and Union Territories through the National Centre for Sustainable Coastal Management, Chennai;

ii. The Hazard line shall be used as a tool for disaster management plan for the coastal environment, including planning of adaptive and mitigation measures;

iii. With a view to reduce the vulnerability of the coastal communities and ensuring sustainable livelihood, while drawing the Coastal Zone Management Plans (CZMPs), the land use planning for the area between the Hazard line and HTL shall take into account such impacts of climate change and shoreline changes;"

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

10. CRZ CATEGORIES

10.1. CRZ categories of coastal Goa

The CRZ of Goa State consists of CRZ I (CRZ IA & CRZ IB), CRZ II, CRZ III and CRZ IV.

10.1.1. CRZ I

The CRZ IA are those ecologically sensitive and the geomorphological features which play a role in maintaining the integrity of the coast. These are Mangroves, Coral Reefs, Sand Dune, Mudflats, Reserve Forest, Salt Marsh, Turtle nesting grounds, Nesting ground of birds, Archeological & Heritage sites available in Goa coast. These features/ thematic layers were merged to make CRZ IA. In the case of Mangroves having area greater than 1000 sq m, a 50m buffer has been provided which is also considered as CRZ IA.

Total CRZ IA area of Goa coast is 107.11 sq km which includes the buffer area of mangroves. The CRZ IB (inter-tidal area) is the area between HTL and LTL which covers total area of 14.34 sq km (i.e., excluding CRZ IA) which includes aquaculture pond/saltpan area. CRZ I area occupies an extent of 121.45 sq km in Goa state.

10.1.2. CRZ II

CRZ II areas are developed areas up to or close to the shoreline. “Developed area” is referred to as that area within the existing municipal limits or in other existing legally designated urban areas which are substantially built-up and has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains.

The data from existing Municipality/corporation areas were taken from GCZMA for demarcation of CRZ II areas ***(Table 8)***. The total CRZ II area of Goa state is 8.10 sq.km.

Table 8. List of Municipality/Corporation

Sl. No.	District	Name	Type
1	North Goa	Pernem	Municipal Council
2		Mapusa	Municipal Council
3		Bicholim	Municipal Council
4		The City of Panaji	Corporation
5	South Goa	Mormugao	Municipal Council
6		Curchorem-Cacora	Municipal Council
7		Cuncolim	Municipal Council
8		Canacona	Municipal Council

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

10.1.3. CRZ III

The land areas that are relatively undisturbed and those do not belong to either CRZ I or II which include coastal zone in the rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up.

The total CRZ III area of Goa state is 63.64 sq. km.

The calculated area of CRZ III between 200 to 500 m from HTL is 22.40 sq. km. No Development Zone (NDZ) in CRZ III along sea side and creek side comprises an area of 41.14 sq. km.

10.1.4. CRZ IV

The water area comes under CRZ IV and is further classified into IVA and IVB.

i. CRZ IVA: the water area from the Low Tide Line to twelve nautical miles on the seaward side;
ii. CRZ IVB: shall include the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide which is measured as five parts per thousand during the driest season of the year.

The CRZ IVB category covers an area of 102.19 sq. km in Goa state.

1.1. Coastal Regulation Zones of Goa

A) CRZ along sea coast:

Pernem Taluka:

i. Tiracol Fort is classified as CRZ-IA and other areas are classified as CRZ-III.
ii. The sand dune areas in Querim is classified as CRZ-IA, and other areas are classified as CRZ-III.
iii. The Paliem village is classified as CRZ III.
iv. Sand dune, mangrove and 50m mangroves buffer (if area greater than 1000 sq. m) areas falling in Arambol village are classified as CRZ-IA, and other areas are classified as CRZ-III.
v. Sand dune, mangrove, 50m mangroves buffer (if area greater than 1000 sq. m) areas and turtle nesting sites falling in Mandrem village are classified as CRZ-IA, and other areas are classified as CRZ-III.
vi. Sand dune, mangrove, 50m mangroves buffer (if area greater than 1000 sq. m) areas and turtle nesting sites falling in Morjim village are classified as CRZ-IA, and other areas are classified as CRZ-III.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

Bardez Taluka:

i. In Anjuna village, Chapora Fort and sand dune area is classified as CRZ-IA and rest of the area is classified as CRZ-III
ii. Calengute area is classified as CRZ-III except sand dunes, which is classified as CRZ-IA.
iii. Sand dunes and Aguada Fort (except Aguada Jail premises) in Candolim village is classified as CRZ IA, and other areas are classified as CRZ-III.

Tiswadi Taluka:

i. Dona Paula is classified as CRZ-III (NDZ)

Murmugoa Taluka:

i. Murmugoa Fort fall under the CRZ IA.
ii. Areas within Municipal Limits of Mormugao Municipal Council, are classified as CRZ-II
iii. Dabolia, Chicalim, Chicolna, Issorcam and Sarcola areas are classified as CRZ-III.
iv. Pale and Velasso areas are classified as CRZ-III except sand dunes, which are classified as CRZ-IA. Cansaulim and Arossim are classified as CRZ-III except sand dunes, which are classified as CRZ-IA.

Salcete Taluka:

i. The entire villages falling in Salcete Taluka namely, Utorda, Majorda, Consua, Betalbatim, Ccolva Sernabatim. Benaulim, Varca and Cavellossim are classified as CRZ-III except sand dunes, which are classified as CRZ-IA.

Quepem Taluka:

i. The villages of quitol and Naquerim are classified as CRZ-III

Cancanona Taluka:

i. The whole of Cola stretch is classified as CRZ-III except Cabo da Rama Fort, reserved forest which is classified as CRZ-IA
ii. In Agonda the entire Agonda village is classified as CRZ-III except reserved forest, mangrove, 50m mangroves buffer (if the area greater than 1000 sq m) areas and turtle nesting sites which are classified as CRZ-IA.
iii. Nagarcem area is classified as CRZ-II except mangrove, 50m mangrove buffer area (if the area greater than 1000 sq m), which are classified as CRZ-IA. Palolem island is classified as CRZ IA due to the presence of reserve forest
iv. Area falling in Paiguinium village is classified as CRZ-III except sand dune, turtle nesting site, mangrove, 50m mangrove buffer (if the area greater than 1000 sq m) which are classified as CRZ IA.

v. In Loliem, the entire stretch is classified as CRZ-III except reserved forest, mangrove, 50m mangrove buffer (if the area greater than 1000 sq m), which are classified as CRZ-IA.

B) CRZ along bank of river, creek, backwater:

i. Along the rivers namely Tiracol, Chapora, Mandovi, Zuari, Sal, Talpona, creeks and backwaters in Goa influenced by tidal action, the extent of CRZ is either 100 meters or width of the river or creek or backwater which is less.

ii. Along Tiracol River, tidal influence is felt up to Patradevi. All areas up to Patradevi within the CRZ having mangroves, mudflats, saltmarsh, 50m mangrove buffer (if area greater than 1000 sq m) including mouth of Qerim , Paliem, Cargao, Poroscondem, Amberem, Uguem, Tamboxem, and Torxem are classified as CRZ-IA and rest as CRZ-III (NDZ). Pernem municipal area classified as CRZ II.

iii. All along Chapora river areas with mangroves, mudflats, 50m mangroves buffer (if the area greater than 1000 sq. m) including areas of river mouth, Siolim Marna,Marna, Siolim Sodiem, Oxel, Camrulim, Colvale, revora, Dargalim, Virnora, Tuem, Parcem, Agarvado, Chopdem are classified as CRZ-IA and other areas classified as CRZ -III (NDZ).

iv. The areas at mouth of the river having sand dunes of Caranzalem-Miramar and Nerul and all areas along the bank of Mandovi having mangrove, mudflats, saltmarsh, bird nesting ground/Marine protected area, 50m mangrove buffer (if area greater than 1000 sq m) areas are classified as CRZ-IA and rest of the ares classified as CRZ-III (NDZ). The area falls under the municipal/urban boundary such as Panaji, Mapusa and Bicholim are classified as CRZ II.

v. All along Zuary river areas with mangroves, saltmarsh, mudflats, 50m mangroves buffer are classified as CRZ-IA and other areas classified as CRZ -III (NDZ). The area falls under the municipal/urban boundary such as Mormugoa, Cacora are classified as CRZ II.

vi. All along the Sal river, ecologically sensitive areas such as Mangrove, Mudflat, salt marsh, 50m mangrove buffer (if area greater than 1000 sq m) etc are classified as CRZ IA, and rest of the area classified as CRZ III (NDZ). The area falls under the municipal/urban boundary such as Cuncolim are classified as CRZ II.

vii. All along the Talpona river, ecologically sensitive areas such as Mangrove, 50m mangrove buffer (if area greater than 1000 sq. m) etc. are classified as CRZ IA, and rest of the area classified as CRZ III (NDZ). The area falls under the municipal/urban boundary such as Canacona are classified as CRZ II.

viii. All along the Galgibaga river, ecologically sensitive areas such as Turtle nesting site, Mangrove, 50m mangrove buffer (if area greater than 1000 sq. m) etc. are classified as CRZ IA, and rest of the area classified as CRZ III.

ix. Panaji municipal area classified as CRZ II.

10.2. Sheet-wise ESA and CRZ Categories

Sheet wise CRZ categories of Goa are shown Table 9. The changes between the 1996 approved CZMP maps and the present draft CZMP were examined and the details are shown in Annexure-IX. List of villages under the CRZ is given in Annexure X.

Table 9: Sheet wise CRZ categories of coastal Goa

Districts	Sheet No.	OSM 25K Sheet No.	CRZ I		CRZ II (excluding CRZ IA)	CRZ III		CRZ IVB (excluding CRZ IA)
			CRZ IA	CRZ IB (excluding CRZ IA)		NDZ (excluding CRZ IA)	200m to 500m (excluding CRZ IA)	
South Goa	GA 1	D 43 I 1/NW	2.25	0.98	0.98	3.58	3.50	0.53
	GA 2	D 43 B 16/SE	2.55	0.88	0.00	2.84	2.96	0.03
	GA 3	D 43 C 4/SW	1.43	0.29	0.78	0.26	0.02	0.05
	GA 4	D 43 B 16/NE	10.76	1.96	0.06	4.17	3.02	1.43
	GA 5	D 43 B 15/SW	0.34	0.50	0.22	1.66	0.91	0.00
South & North Goa	GA 6	D 43 B 15/SE	3.41	1.48	0.00	2.88	4.11	1.25
	GA 7	D 43 C 3/SW	7.28	0.77	0.21	2.22	0.00	2.46
	GA 8	D 43 B 15/NW	5.66	1.40	4.68	2.94	0.42	59.03
	GA 9	D 43 B 15/NE	23.63	1.16	0.04	2.88	0.00	11.99
North Goa	GA 10	D 43 B 10/SE	0.42	0.62	0.00	1.73	0.00	2.51
	GA 11	D 43 B 14/SW	15.25	1.14	0.48	4.33	0.00	6.24
	GA 12	D 43 B 14/SE	24.16	0.89	0.05	5.35	1.84	7.59
	GA 13	D 43 C 2/SW	0.22	0.00	0.00	0.02	2.24	0.00
	GA 14	D 43 B 10/NE	3.04	1.94	0.00	2.95	3.38	2.92
	GA 15	D 43 B 14/NW	6.70	0.27	0.59	2.57	0.00	5.42
	GA 16	D 43 B 13/SW	0.00	0.06	0.00	0.75	0.00	0.71
Total			107.11	14.34	8.10	41.14	22.40	102.19

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

11. SUMMARY AND RECOMMENDATIONS

1) The High Tide Line, Low Tide Line and Ecologically Sensitive Areas such as mangroves, mudflats etc. have been demarcated from Survey of India Aerial Photographs and by the use of high resolution satellite images in gap areas during 2011-2012 time frame.

2) Based on the CRZ 2011 notification, various regulation lines and CRZ boundaries have been demarcated.

3) Survey of India topographical sheet was used as base map for preparation of CZMP on 1:25000 scale. DSLR provided cadastral sheet was used as base map for preparation of CZMP on 1:4000 scale.

4) HTL, LTL, ESAs etc. were superimposed over the cadastral map. Various administrative boundaries, infrastructure etc. as required in CRZ notification 2011 were overlaid over the above map. The Hazard line was demarcated by Survey of India.

5) The Hazard line demarcated on the CZMP maps based on CRZ 2011 notification.

6) Coastal Zone Management Plan (CZMP) for Goa state in 1:25000 scale has been prepared as per the provision of CRZ notification 2011 and guidelines of Technical Scrutiny Committee of MoEF&CC.

7) CZMP of 1:4000 scale was prepared as per the CRZ notification 2011.

8) Coastal land use maps (i.e. land use map used to define CZMP including Ecologically Sensitive Areas) were prepared on 1: 25000 scale based on the recommendations of the Technical Scrutiny Committee of NCZMA.

9) There are sixteen CZMP maps for Goa in 1:25000 scale. Whereas, there are two hundred fifty-four maps in 1:4000 scale.

10) The total area of CRZ IA in Goa is found to be 107.11 sq.km. The dominant ESAs are mangroves, sand dunes and mudflats.

11) The calculated area of CRZ II is 8.10 sq.km, CRZ III (200-500 m from HTL) is 22.40 sq.km, CRZ III – NDZ is 41.14 sq.km and CRZ IVB is 102.19 sq.km.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

12) All developmental activities listed in CRZ notification 2011 shall be regulated by the State Government, the local authority or the concerned CZMA within the framework of the approved CZMPs prepared under CRZ notification 2011.

13) The following recommendations were received from the Government of Goa vide Department of Environment and Climate Change, Government of Goa Letter. No. GCZMA/GEN-MISC/13-14/PVI/1269 dated 28.01.2021.

i. No further increase in handling of coal at MPT shall be permitted beyond the capacities presently permitted by Goa state pollution control board.

ii. Temporary structures in no development zone along coast and along banks of rivers/ estuaries shall be permitted except in ESA areas shown in CZMP plans with the following conditions.

A. Floor space index not exceed 0.33, open area shall be suitably landscaped with appropriate vegetation cover.

B. The overall height of the temporary structure shall not exceed 9 meters and shall not be more than two floors (ground floor plus one).

C. Swimming pool not exceeding 50 sq. m. in area shall be permitted.

iii. The draft CZMP maps should depict the mangroves in khazan lands as mangroves in khazans and also there should not be buffer for mangroves in khazan lands.

iv. The State of Goa is popular for its beaches and there are high footfalls on the beaches in Goa thereby making it essential to provide adequate infrastructure for visiting tourists such as parking, toilets, changing rooms, floating jetties, sewage treatment plant, solid waste collection system, lifeguard towers, cabins, events and wedding etc will be permitted in NDZ areas except in ESA.

v. For any major infrastructure project in CRZ areas which requires EIA studies, consultation etc. prior approval in principal of the State Government should be obtained before the project is placed in public domain.

As the above recommendations submitted by the Government of Goa do not fall within the purview of NCSCM, the Government of Goa/GCZMA may take-up the above issues separately with NCZMA / MoEF&CC after the public hearing, for final deliberation and final decision.

14) All activities in CRZ area permissible under the Goa Land Development and Building Construction Regulations, 2010 and as provided under the Regional Plan for Goa and the Outline Development Plans shall be subject to the provisions of the Coastal Regulation Zone Notification, 2011 in force and /or as amended from time to time and as per the approved Coastal Zone Management Plan.

15) All activities which requires prior clearance from the Ministry of Environment and Forest, has to be taken as per the provision of CRZ Notification, 2011.

16) All relevant provisions of the CRZ Notification, 2011 shall be strictly followed.

17) For development of Beach, Resorts and Hotels in the designated area of CRZ - III, the guidelines indicated under Annexure- III of CRZ Notification shall be followed.

18) Monitoring & enforcement of the provision of the CRZ regulations would be carried out by the Goa Coastal Zone Management Authority and District Level Committees as notified by the State Government from time to time.

HTL has been updated as per amendment to the CRZ Notification 2011 vide S.O. 1422(E) dt 1st May 2020 (NCSCM Map Version 1.0)

REFERENCES

1. Report On 'Basic Statistics For Local Level Development'goa2010-11& 2011-12, Government Of Goa Directorate Of Planning, Statistics And Evaluation)(http://www.goadpse.gov.in/Basic%20Statistics%20for%20Local%20Level%20Development(BSLLD).pdf
2. ECencus of India 2011. (http://www.dataforall.org/dashboard/censusinfoindia_pca/)
3. Economic Survey 2015-16, Directorate of Planning, Statistics and Evaluation, Govt. Of Goa. (http://goadpse.gov.in/Economic%20Survey%202015-16.pdf)
4. Directorate of Agriculture, Goa, https://www.agri.goa.gov.in/Overview?7
5. Department of Information and Publicity, Goa, https://www.dip.goa.gov.in/pages.php?id=7
6. South Goa District, Govt. of GOA, https://southgoa.nic.in/about-district/
7. http://drs.nio.org/drs/handle/2264/2871) Geomorphology of the GOA Coast, Wagle, B.G Proceedings of the Indian Academy of Sciences (Earth and Planetary Sciences), vol.91; 1982; 105-117
8. https://fisheries.goa.gov.in/wp-content/uploads/2020/10/newmullet.pdf
9. Marine Fisheries Census 2010 (Goa) Published by Ministry of Agriculture & CMFRI
10. https://www.heraldgoa.in/Goa/From-the-tide-and-land-plastic-ruining-Goas-beaches/152025
11. GOA STATE BIODIVERSITY STRATEGY AND ACTION PLAN (https://kalpavriksh.org/wp-content/uploads/2019/05/Goa-April-2002.pdf)

ANNEXURES

I. Data sources used in the preparation of CZMP maps
II. Classification system for coastal land use
III. Accuracy Assessment
IV. Draft Mangrove management plan prepared by Goa State Government
V. Draft Turtle nesting sites Management plan prepared by Goa Government
VI. Draft Khazan land Management plan
VII. Draft Comprehensive Plan for Fisherman community living in CRZ Areas prepared by Goa Government
VIII. Photographs taken during the fieldwork
IX. Comparison of the 1996 approved CZMP maps and 2018 CZMP maps
X. List of villages fall under the CRZ

Annexure_VI

DRAFT KHAZAN LAND MANAGEMENT PLAN

Prepared by the

COMMITTEE FOR PREPARATION OF KHAZAN LAND MANAGEMENT PLAN

CONSTITUTED BY

GOVERNMENT OF GOA

DEPARTMENT OF ENVIRONMENT AND CLIMATE CHANGE

GOVERNMENT OF GOA

1

CONTENTS

Executive Summary

The Government of Goa vide Order No: 2-81-2020/Dir/Env & CC/577 dated 08.09.2020 (***Annexure I***) constituted a Committee to prepare the Draft Plan entitled "Khazan Land Management Plan". The Committee studied various available past Official "Reports / Documents" and Research Papers on the subject matter. Further, the Committee also embarked on site visits and held several meetings to deliberate on issues pertinent to the current status of Khazan Lands in Goa, to come out with a broad Draft Plan for management of the same.

Khazan Lands are estuarine lands reclaimed thousands of years back and served as rice bowls of the territory of Goa, in the past. The Khazan Land Ecosystem was one of the earliest examples of co-operative movement in the world at large and particularly in India. This man-made Agricultural Ecosystem was established by the local farming community ("Gaonkars") mainly for production of Rice, Fish, Coconut, Vegetables and Salt. It was governed by a traditional and intricate but unwritten "Gaonkari" system of joint management. The erstwhile Portuguese Colonial Regime studied the 'Gaonkari" system vis-à-vis the characteristics of Khazan lands in details and came up with written Rules & Regulations to maintain and cultivate such lands jointly owned by the local communities (known as "Comunidades") entitled in Portuguese language as "Codigo de Comunidades". However, after the liberation of Goa from the Portuguese regime in December, 1961 and the consequent enactment of the Goa, Daman & Diu Agricultural Tenancy Act (1964) and Rules (1975) the tenants in the lands owned by the Comunidades (and other entities) became

the deemed owners of the individual land parcels tilled by them. The Agricultural Tenancy Act provided for the formation of Tenants' Associations to "cultivate/maintain" the Khazan Lands jointly under the overall supervision of Mamlatdars in their respective jurisdiction. However, because of the issue of deemed land ownership and the heavy pre-occupation of Mamlatdars with other routine "legal/revenue" issues the fabric of co-operative spirit engrained in erstwhile "Gaunkari" and "Comunidades" systems deteriorated rapidly.

A typical Khazan Land Ecosystem consists of Bunds which protect the agricultural (Rice) fields from tidal water ingress, Sluice Gates (manas) which allow controlled entry and exit of "tidal/fresh" water from the Khazan land, Poins (water bodies) which serve as water reservoirs cum fish rearing medium and the Rice fields. Due to the transformation brought about by the Agricultural Tenancy Act as well as the changes in socio-economic conditions, the maintenance of components of Khazan Lands (such as Bunds) and cultivation of Rice crop have become economically non-feasible since 1980s. As a result, most of the Khazan Lands are either left fallow 'and/or' are in disuse due to inundation of saline water. The only activity which is going on legally as also illegally is fishing at the Sluice Gates. Some privately owned Khazan lands are left fallow and entirely used for unauthorized pisciculture.

After examining the issue in details, the Committee recommends the following steps towards a broad Management Plan for recuperating and cultivating the existing Khazan Land Ecosystems, effectively. The Committee also recommends that a sub-plan be

made for each type of Khazan System based on site specific conditions.

I. Conduct a detailed Agricultural Survey of Goa to determine the present status of **(i)** the extent of Khazan Lands in Goa vis-à-vis Survey Numbers and Ownership, **(ii)** Area under "Kharif" Rice Cultivation and area left fallow, **(iii)** Area under cultivation of "Rabi" rice and Vegetable cultivation, **(iv)** Area of bunds under Coconut cultivation and number of Coconut palms, **(v)** Area under Poins, **(vi)** No. of working and defunct Sluice Gates, **(vii)** Area under functional and defunct Salt Pans, **(viii)** Ownership wise length of Bunds protecting the Khazan Lands and present condition of the same, **(ix)** Number of functional Tenants' Associations and their activities for last five years as mandated in the Act and **(x)** Present status of Sluice Gate auctions for capture fishery, and income earned by the "Associations / Government" through the same for last five years.

II. A State Agricultural Land Use Plan shall be prepared with the express statutory provision of conserving all existing agricultural lands. This is essential not only to make Goa self sufficient in growing its entire requirement of food crops (including Fish) but also because of current food security issues.

III. Demarcate each Khazan Land Ecosystem in four Zones:

(i) Zone **S-3** where salinity is high, and only local salinity resistant Rice cultivation, traditional salt farming and traditional fishery can be practiced.

(ii) Zone **S-2,** on the landward of Zone **S-3,** where salinity is medium and salt tolerant improved Rice varieties can be cultivated.

(iii) Zone **S-1** near the border of Khazan Land abutting the settlement area where salinity is insignificant and shallow fresh water table is present. Here local Vegetables 'and/or' *high yielding Rabi* Rice can be cultivated after the harvest of improved *Kharif* Rice.

(iv) Zone **HS** constituting highly saline and abandoned Khazan lands which are in an uncultivated state for a very long period due to dilapidated conditions of the bunds and where mangroves are regenerating due to marshy conditions created by highly eroded protective bunds.

IV. Devise a special agricultural scheme with crop wise package of practices suitable for each of the above Zones and specific incentives including subsidized costs of hiring agricultural machinery. Adapt and develop a model Khazan Land Farm to demonstrate the profitability of the said package of practices. Organize 'extension/training' camps for Khazan Land farming community and motivate them for the purpose.

V. Substantial financial and technological inputs should be provided for paddy cultivation with special emphasis on Khazan Land Paddy cultivation. This shall be the major responsibility of Department of Agriculture in collaboration with the ICAR Complex for Goa. This

should include appropriate mechanization to tide over labor shortage, better seed, organic fertilization, IPM, price support, better procurement system, market availability, reduction of input costs and crop insurance scheme.

VI. The Committee is convinced that the current provisions of the Agricultural Tenancy Act (1964) and Rules (1975) coupled with the present socio-economic situation in Goa are not conducive for sustainable revival of the Khazan Land Ecosystems in Goa. Hence, it strongly recommends that a new legislation be conceived which shall promote Cooperative 'and/or' Contract farming arrangement amongst the Tenants of the Khazan Lands who are the deemed owners of their land parcels. The pre-requisite for the success of this arrangement is the availability of latest survey data on present status of Khazan land ecosystems and special agricultural schemes mentioned at items **1. & 3.** , above. Hence, as suggested in the RALDP 1992, an Agency on lines of Planning and Management of Estuarine and Khazan Areas (APMEKA) may be constituted to study the situation and conceive the new legislation.

VII. In the interim period until the new legislation is in place, the present Scheme for repair of Bund and Sluice Gates shall be extended also to cover de-silting of Poins, repair of minor Khazan bunds serving as approach pathways to individual land parcels and construction of sunken ponds to tap the ground water table and to store rain water for cultivation of Rabi vegetables in Zone **S-1** of Khazan Land. However, the benefit of this Scheme should

be extended only for those Khazan Lands where the Tenants have demonstrated their sustained interest in cultivation of "Rice / Vegetables" and production of Salt, based on the survey recommended at item **1,** above.

1. Background

The Government of Goa vide Order No: 2-81-2020/Dir/Envt & CC/577 dated 08.09.2020 (***Annexure I***) constituted a Committee to prepare the Draft Plan entitled "Khazan Land Management Plan" comprising of the following members:

1. Dr Simon D'Souza	...	Chairman
2. Dr Naraina P. S. Varde	...	Member
3. Shri Subrai Nadkarni	...	Member
4. Dr Vinod Dhargalkar	...	Member
5. Dr Fraddy D'Souza	...	Member
6. Shri Raya Shankhwalker	...	Member
7. Shri Shrikant Priolkar	...	Member
8. Shri Suraj Pagui	...	Member
9. Shri Bhau Kalangutkar	...	Member
10. Shri Tolentino Furtado	...	Member
11. Shri Neville Alfonso	...	Member Convenor

The Committee held meetings on 17.09.2020, 23.09.2020, 01.10.2020, 09.10.2020, 16.10.2020, 20.10.2020, 23.10.2010, 30.10.2020, 06.11.2020, 17.11.2020, 27.11.2020, 07.12.2020, 14.07.2020 and 21.12.2020 to deliberate at length on various "facts/problems" relevant to Khazan Land Ecosystems gathered from previous official Reports, Documents and Research Literature. Further, additional inputs were sought from concerned Government Departments and some typical Khazan Land sites were visited on 30.11.2020 to see the status at loco. Based on the experience and expertise of the Committee members and other inputs as stated above, a ***Draft Khazan Land Management Plan*** has been prepared and presented in the subsequent chapters.

2. Khazan Lands

Goa, since time immemorial has been an agrarian territory where agriculture and fishery were the main means of livelihood and sustainance. The agricultural lands of Goa are classified into three major categories:

Morod lands: these are uplands either terraced on the slope of hills or bunded on the top of hills and plateaus. These are cultivated to paddy only under rain-fed conditions and are low in plant nutrient status (approx. 8,600 Ha).

Kher lands: These are best Rice lands found mostly on coastal alluvial plains. Soils are well drained, medium in texture with good moisture retention and require addition of organic matter to prevent leaching of nutrients below the depth of Rice roots. High yielding Rice varieties are cultivated on Kher lands both in Kharif and Rabi seasons depending on the availability of irrigation (approx. 17,000 Ha)

Khazan lands: These are artificially reclaimed saline alluvial soils mostly located in the low lying flood plains of Mandovi and Zuari estuaries (approx. 18,500 Ha).

- A Khazan Land Ecosystem ***can be comprehensively defined as a man-made ecosystem of reclaimed estuarine wet lands, salt marshes, and mangroves where tidal influence is regulated by the construction of bunds (embankments) with sluice gates mainly for purposes of rice cultivation, traditional capture fishery or salt production"***

Khazan Land Soils are fine textured and fertile. However, because of saline conditions only local salt tolerant Rice varieties are cultivated

in these soils. These estuarine lands have been reclaimed a long time ago. Being below the mean sea level, the lands are protected by a series of dykes or bunds. The outer bunds have dry lateritic rubble wall on the exterior face of the mound of earth or clay abutting on the inner side to form the main bund body.

Agriculture has been the mainstay of economy of any country over the years and India in general and Goa in particular is no different. Khazan lands were the rice bowls of the territory which yielded unique salinity tolerant varieties of Rice such as *Korgut*.

To know about the Khazan lands, one has to understand the Khazan Land Ecosystem which is versatile and man-made. The Khazan lands are reclaimed estuarine plains located below the mean sea level. The Khazan Land Ecosystem is basically composed of:

a) Bunds
b) Manas or Sluice Gates
c) Internal Water Bodies or the Poins
d) The reclaimed Agricultural Land

Bunds: Bunds are small dykes which were erected to reclaim and protect the reclaimed lands from inundation by saline water. There may be one or more bunds established to protect a particular Khazan Land Ecosystem. The river-side façade of such bunds is normally covered by a dry rubble wall of varying thickness abutting the earthen structure. The bund was normally made of locally available marine clay with a top width of 2 meters. A string of

secondary bunds are also erected either to serve as additional water level control structures 'and/or' used as pathways for approaching individual land parcels..

Sluice Gates (Manas): The bunds have one or more sluice gate/s which in local parlance is called *manas*. The *manas* opens on one side to let out water during low tides and closes during high tides to prevent the ingress of saline water in the fields. Thus the *manas* also regulate the level of water in the water bodies or *poins* inside the Khazan Land. The gate rests on side abutments made of masonary. The sluice gates are strategically located along the bund.

Poins: Poins are water bodies located in the interior of Khazan land. The drainage water from the adjoining areas beyond the Khazan boundary are also connected to the poins by well defined channels. Poins are finally connected to the 'estuary/river' through a sluice gate. Poins are meant to perform the following functions:

i) Act as a buffer to regulate the contents of saline and fresh water
ii) Act as water detention basins
iii) Maintain proper water level in paddy fields
iv) A medium to rear fish
v) Serve as a source of water, for crop fields around the poins, during long dry periods sometimes experienced in monsoon season.

Agriculture Fields: These are agricultural soils on which crops are grown. The fields near the bunds and around the poins cater to salt tolerant crops like Korgut and further away, near the inner

periphery of the khazans land, are used to grow fresh water crops such as banana, vegetables, hybrid rice, etc.

Mangroves growing on the exterior of the Bunds act as a natural barrier for protection against the erosive forces of tides, waves and currents.

As per available records, in Goa, a total area of about 18921 Ha is occupied by Khazan lands which are protected by main bunds with a total length of about 433 km. In addition, there are a number of secondary bunds and smaller bunds which serve to control water level in individual Rice fields (parcels) and also as pathways to approach the said fields for cultivation and allied operations. The total length occupied by all types of bunds is roughly estimated at about 2000 km.

The main activities, traditionally practiced in Khazan Lands, are:

a) Agriculture (mainly Rice, Vegetables, Coconut and Banana cultivation)
b) Fishing
c) Salt extraction
d) Regular maintenance of Khazan Land components such as Bunds, Sluice Gates, *Poins*, Channels and field Pathways.

3. Khazan Land Ecosystem over the Years

Mythology states that the Sage Parshurama shot a powerful arrow which resulted in receding of Sea and exposure of the land mass constituting Goa and the Konkan region along the West Coast of India. Similarly, the Khazan Land Ecosystems in Goa are man-made lands reclaimed from the Estuaries by an intricately constructed system of Bunds meticulously engineered by the nomadic community of Gaudas who migrated from forests to the central region of Goa. Gaudas were also the first settlers to initiate and practice the shifting "kumeri" cultivation for agricultural sustainance in Goa.

The Gaudas led a communitarian way of life known as the Gaunkari system. The new settlers were Brahmins who settled in Goa before the Christian era. For a long time there was a good co-existence between Gaudas, Mith-gaudas and Gaud Brahmins. The said new migrants with superior knowledge, tools and weapons made Coastal Plains more lucrative. The knowledge from Gaud Brahmins and Mith-Gaudas aided by the communitarian way of life of Gaudas, resulted in the evolution of a new Agrarian System based on collective maintenance of bunds, sluices, channels, etc and joint cultivation of Khazan Fields. The profits were shared amongst the members. Historians say that this Gaunkari system was evolved in Goa about 3000 years back.

The Khazan lands show a superb and harmonious blend of men, marine "flora/fauna", land, crops and water. The development of Khazan Land Ecosystem involved the use of traditional knowledge of climate, tidal cycles, geomorphology, monsoon vagaries,

sedimentation dynamics, soil properties, etc, gained by the earlier settlers through years of "trial and error" methods spanning generations.

Various historians also state that the rulers of Goa granted land on saline plains to the people, who converted them into cultivable lands with their collective Gaunkari way of life. There are also some references in literature to the effect that the Khazans enjoyed a tax free regime granted by some rulers subject to the condition that Bunds were provided and maintained to prevent the intrusion of saline water and help land "reclamation/maintenance" for Rice cultivation.

With the advent of the colonial rule, the Gaunkari system was examined and modified by the Portuguese. Portuguese rulers started the re-structuring of Gaunkari system after studying the working of the same and giving it a legal framework. The Government assigned to itself the right to intervene in the management of the Gaunkari system and the 'Codigo de Comunidades' or Code of Comunidades was introduced. The Code provided for the formation of a voluntary body of farmers known as "Bous" which was assigned the responsibility of management of Bunds and Sluice Gates. The "Bous" employed a "kamat" and a "palni" to look after the accounts as well as to keep records of the respective Khazan Lands. A "vigia" was also employed to keep a close watch on the condition of bunds on a day to day basis. Even a minor breach or a tiny infiltration of water through the bund was promptly reported to the "Bous" and immediate steps were taken to implement necessary repairs. The cost of repairs was recovered from the farmers whose fields were protected by the repaired bund. Comunidades raised funds by

auctioning the rights of cultivation to farmers and fishing rights in the water bodies to the fishing community. The Comunidades had to pay 'Jon' (royalty) and 'Foro' (rent) to the Church 'or/and' to the Government. It is said that Comunidades failed to exactly replicate the Gaunkari system of pre-colonial times. Some of the policies of Comunidades were good and favourable for agriculture:

i) Allowing land use only after permission
ii) Levy Fine on persons who bid and yet did not cultivate the land
iii) Prohibition of transferring or sub-letting without permission
iv) Declare the field as waste land if rent is unpaid for ten years
v) No permission was granted to take part in auction if one has not cultivated his land a year back.

4. Present Scenario

On 19th of December 1961, Goa was liberated from the Colonial rule after 450 years and became a part of the Union of India. Farmers of Goa could now avail of various reforms such as land ceiling, land to the tiller, etc. Agricultural income was also made exempt from income tax. In 1964, the Goa, Daman & Diu Agricultural Tenancy Act, 1964 was passed which was followed by Goa Agricultural and Tenancy Rules, 1975. The said Act and Rules vested the ownership of all agricultural lands to the tenants who were cultivating the same and also conferred on them the responsibility of maintaining and managing the Bunds and Sluice Gates which protect the Khazan Land Ecosystems. The tenants became the deemed owners of the lands which were collectively owned in the erstwhile Gaunkari or Comunidade systems. Thus the Gaunkari and the Comunidade systems became redundant, predominantly in Khazan Lands because of the loss of collective and cooperative spirit.

The Agricultural Tenancy Act (1964) also provided for a stronger role of Government in the administration of Tenants' Associations through the respective Mamlatdars. The Sluice Gates are auctioned in the presence of Mamlatdar. The above changes made the Tenants' Associations rely on Government subsidies. Further, fishing became the prime activity and agriculture and salt extraction took a back stage due to strong market forces encouraging fishery.

The works of repairs of bunds and sluice gates were entrusted to the Soil Conservation Division of Directorate of Agriculture. The State Government notified the Pattern of Assistance for repair of bunds as under:

Category I: The "Tenant's Association/Beneficiaries" willing to carry out the repairs of their khazan bunds are provided with a reimbursement of 50% of the expenditure incurred as per the procedure laid out.

Category II: The Khazan bunds requiring major repairs beyond the capability of the Tenant Association/Beneficiaries, as decided by Mamlatdar, are repaired by the Government and 50% of the cost incurred is recovered from "Tenants' Associations/ Beneficiaries" @ 6% rate of interest in ten installments.

Category III: This pattern was implemented from 2003-04 onwards. Under this scheme, bunds are improved through more structurally sound earth, widened and their height increased wherever such improvements are found essential and notified as such by the Mamlatdar. The works are carried out by the Government and only 10% of the expenditure incurred is recovered from the beneficiaries in ten installments.

The Rules make it compulsory to constitute a Tenants' Association of beneficiaries deriving benefits from the notified bunds. Their responsibility is collective and it is mandatory on part of the Tenants' Associations to perform the following:

a) Maintain a regularly updated list of tenants.
b) Take all steps necessary for conservation, "maintenance / repairs" of the bunds.
c) Get estimates prepared for repairs and maintenance from the Soil Conservation Division.
d) Auction the rights of fishing in the vicinity of the sluice gates and lease out bearing coconut trees on the bunds for plucking.

e) Take immediate steps for closure of breach in the bunds and get work executed.

There are a number of provisions in the Agricultural Tenancy Act and the Rules made thereof. However, from the information available, many Tenants' Associations are not functioning as per the Act and Rules and a number of them are defunct. There are clandestine incidents whereby conditions are manipulated for unauthorized increase in production of fish solely for profit motive. In some cases it has been found that some bunds are purposely breached to increase fish catch at the peril of the loss of agricultural soils by flooding and increase in salinity. Due to this the inland fresh water sources are also threatened by salinity ingress.

To summarize, due to unfavorable economic conditions for remunerative Rice cultivation, shortage of agricultural labor, problems of ownership, high cost of bund maintenance, lack of cooperative spirit and high demand for fish, priorities have changed. The focus has shifted to auctioning of the sluice gates for fishing rights and the desire for cultivating Rice and producing Salt have taken a back seat. Consequently, the number of Khazan Land Tenants who genuinely feel the need to maintain the bunds to "protect/cultivate" their Rice fields has dwindled and here too, due to the advent of "subsidy culture" the Government finds it difficult to recover the Tenants' share of the amount spent on bund & sluice gate repairs.

Over the years, 'rapid/rampant' urbanization and allied development works have caused serious encroachment cum pollution stress on khazan lands, especially those near major "urban/tourism" centers.

Developments in and around Panaji, Margao, Calangute, Mapusa and Candolim are typical examples of such cases. The pollution of estuarine water caused by anthropogenic effluents, strewn domestic garbage, construction debris and run-off from mining areas, have adversely affected the Khazan Ecosystems. Further, the increased wave heights due to ore carrying barges have also affected the bunds and the adjoining khazans. The destruction caused by uncontrolled illegal pisciculture has added to its woes. Some Khazan lands near sub-urban settlements have been consumed due to encroachments by illegal scrap yards and erection of slums on bunds.

The change in scenario from community ownership to deemed ownership of tenants has resulted in "bad/poor" maintenance of bunds. The bunds were made of locally available estuarine clay and its structural weakness was reinforced by mixing straw (copto). The bunds are prone to attacks by burrowing marine creatures like crabs. Hence, their regular day to day maintenance is extremely important for their long term sustainance at a very low cost. This is almost impossible in the present socio-economic set up as explained above. Thus small unattended leakages over an extended period result in big breaches which require huge capital costs for repairs "and/or" reconstruction. Thus many bunds are left in a dilapidated condition and the Tenants expect Government to take up the repairs of such bunds at huge capital cost. The fields in many cases are left fallow due to various factors and emphasis is given on pisciculture as discussed earlier. However, even today in some Khazan lands Tenants who are devoted to agriculture and have no other means of income have been cultivating their fields rather satisfactorily. In

some areas even irrigation is resorted to by lathis and traditional irrigation methods for growing local vegetables in Rabi season after harvesting Kharif Rice.

The salt pans in the khazans were earlier a revenue earning activity and the salt was even exported. However, after the advent of iodized salt and other socio-economic issues the salt pans are now mostly in disuse. The salt pans are presently still active in some parts of Tiswadi, Salcete and Pernem talukas.

5. "Findings/Suggestions" of earlier Reports of "Panels and Seminars

Important findings of previous Reports submitted to the Government including the "Report of Agricultural Land Development Panel appointed by the Government" (RALDP 1992) submitted in March 1992:

i) Several Khazan Lands in Pernem, Bardez, and Mormugao talukas were found flooded for more than 15 years (RALDP 1992). Many constantly flooded Khazan landscapes have been reverting back to their original marshy mangrove ecology.

ii) Section 36 of the Agricultural Tenancy Act gives power to the Government to assume management of the uncultivated land and appoint a 'Comunidade/Panchayat' or a Cooperative Society for managing the land. Similarly under sub rule (3) of Rule 8 of Agricultural Tenancy Rules 1975, Mamlatdars have the power to terminate the right of fishing of a person who has taken the same by auction. Any person carrying out unlawful fishing activities could be evicted under sub rule (4) of Rule 8. However, these powers have rarely been exercised and hence the implementation of the Tenancy Act has not at all been effective (RALDP 1992).

iii) Non-invocation of section 36 of the Tenancy Act that empowers the Government to take over the management of Khazan fields which lie uncultivated for three consecutive years, has encouraged the tenants with alternate sources of income to neglect their Khazan farms under the pretext of economic non-viability. If this section was enforced regularly, there would have been a vast area of land available for

cultivation through Farming Cooperatives formed by local youth, with government help, for self-employment.

iv) The RALDP 1992 reported that under the Agricultural Tenancy Rules 1975, 138 Tenants' Associations with a total membership of 19550 Tenants benefitted 183 major bunds protecting a total of 7333 Ha of Khazan Lands. Performance of these Associations from the year of their inception till 1992 was reported as 'very poor'. This is reflected from the fact that all Associations put together have held only 26 % of the minimum number of meetings (one meeting per annum for each Association) mandated under the Act. In many cases Mamlatdars could not provide any data despite reminders, confirming that a large number of Associations were defunct.

v) Despite several attempts to get the data from the concerned Mamlatdars, RALDP 1992 could obtain some financial information only out of the 35 % of the total functional association years of 1715. The limited data indicated that the largest source of income of Tenants' Associations was the revenue earned from auction of fishing rights. The functional associations from five talukas, which reflect the overall situation, collected a total of Rs. 186.00 lakhs from auctions of fishing rights at sluice gates.

vi) During the same period, about Rs. 184.00 lakhs were spent by the Government on repairs of notified bunds till March 1990. Accordingly the Associations were expected to pay back Rs. 139.00 lakhs to the Government. But regrettably they had paid back only Rs. 6.2 lakhs.

vii) Membership Fees as provided in the Act have not been collected in 90 % of the Associations on annual basis for several years, neither the list of tenants is updated and maintained. Attendance is extremely poor for general body meetings of the Associations.

viii) Government should take over Khazan lands consistently and continuously prone to flooding and in accordance to law lease these out for scientific aquaculture under BFDA's supervision.

ix) Auctioning of the Sluice gates for fishing rights has become a major enterprise for most of the Associations and equal attention is not paid for maintenance of bunds, farms or drainage systems.

The Seminar organized by the Goa Chamber of Commerce & Industries in April 1978 made the following recommendation as regards Khazan Land and Fisheries:

Khazan Lands shall be divided in following categories:

a) Land where the *kharif* paddy crop is cultivated regularly and where irrigation facilities are available for *Rabi* crops.
b) Land where only one *Kharif* paddy crop is grown annually (due to lack of irrigation source) and pisciculture can be practiced in the dry season.
c) Land which is continuously kept fallow due to sustained problems of flooding and salinity for a long time.

The second category (b) of land should be allowed for pisciculture in dry season (November-March) and the third category of lands to be used extensively for pisciculture.

The NABARD Seminar on Rural Development, 1989 advised the government to undertake a village wise enumeration of the waste land, Khazan land and marshy land plots in terms of their production potential and suitability for horticulture, forestry, brackish water fishery, paddy yield, ownership status, etc. The seminar also suggested the setting up of a Wastelands Development Corporation to utilize such lands optimally and economically with the assistance of NABARD. The substantial production potential of Khazan Lands was identified during the Seminar and it was suggested that Labour Cooperatives of Agriculturists may be formed for development of waste Khazan Lands on the basis of such existing cooperatives in Konkan for Khar Lands and Forestry. The above mentioned Corporation could get the development works executed through the said cooperatives.

In October 1990, Dr. K. Algarswami of Central Institute of Brackish Water Aquaculture , Chennai, had made certain recommendations with respect to Goa which are as under:

(a) Conversion of the uncultivated, inundated Khazan lands for aquaculture use should be legalized.

(b) Aquaculture should be treated on par with agriculture for all facilities.

(c) Micro-level survey for agriculture versus aquaculture use in Khazan Lands of Goa shall be taken up.

(d) Integrated farming (Rice:Fish), pen culture, cage culture, raft culture, etc. have great potential. These technologies should be developed to suit local conditions and their adoption encouraged.

The statements of the Agricultural Land Development Panel (1992), with respect to the plight of the Khazan Lands and existing Land Tenancy Rules (1975) are reproduced below:

"Recommendations, guidelines and good ideas are plentiful, but there seems to be lack of direction, planning, synthesis of ideas and 'political/administrative' vision. Perhaps, this is the reason why Khazan lands reclaimed by the ancestors of Goans with much toil and labor are gradually reverting back to their original mangrove ecology."

"The Panel is of the opinion that the rules governing the existing Tenants' Associations have not achieved the desired objectives during past 16 years and even if amended comprehensively may not serve any purpose in the future."

xiv) The steps recommended in the RALDP 1992, to revive and manage the deteriorating Khazan Land Ecosystems in Goa are summarized below:

(a) Prepare a State Agricultural Policy framework

(b) Formulate an Agricultural Land Use Plan

(c) Constitute an apex body in the name and style of "Agency for Planning and Management of Estuarine and Khazan Areas" (APMEKA) with the existing Soil Conservation Division of Department of Agriculture as its nucleus. The APMEKA will have jurisdiction over the entire Estuarine and Khazan areas of Goa and form an 'Integrated Estuarine and Khazan Area Development Plan'.

(d) Draft a new Act entitled "Goa Estuarine and Khazan Areas Protection, Conservation, Development and Management Act" based on the positive aspects of the former "Bous" system of traditional Khazan Land Management and practicable provisions of the Maharashtra Act No. XI, 1979. The proposed Act will replace the existing provisions related to Khazan land management made under the Agricultural Tenancy Act 1964. Consequently, under the new Act the overall management of the Khazan lands and estuarine areas will be entrusted to APMEKA and the responsibility of bund management & repair will that of the respective Village Panchayat.

6. Problems leading to the degradation of farming activities in Khazan Lands of Goa

The Committee perused all the earlier Reports placed before it by the Department of Environment & Climate Change, fresh material submitted by "Agriculture / Fisheries / Forest" Departments, views of Committee Members, Research Papers on Khazan Ecosystem & Mangroves of Goa and conducted field visits. Based on the result of the said deliberations coupled with the "expertise/experience" of the Members on issues concerning Khazan Lands the Committee is pleased to present its consensus on problems, present status and steps necessary for revival and sustainable management of Khazan Ecosystems of Goa, as follows.

- Due to the rapid developments of "Mining/Tourism/Real Estate/Services/Industries/Fishery" sectors, during the last four decades, employment and livelihood avenues other than Agriculture have become more lucrative.
- Shortage and high cost agricultural labor force. In particular this discourages the cultivation of a labor intensive crop such as Rice.
- Over the years, the purchase price of Rice has not increased much in comparison to the steep increase in the cost of agricultural inputs needed to cultivate the same.
- Small sizes of Rice land holdings do not allow economy of scale and this is an additional disincentive especially for cultivation of Rice.
- Some owners of agricultural fields (including Khazan fields) tend to keep their fields fallow for a number of years and

attempt to seek change in land use zoning for non-agricultural purposes due to phenomenal growth in other sectors of economy in the State. This tendency is mostly restricted to Khazan lands abutting urban areas such as Mapusa, Panaji, etc.

- Adverse impact of the provisions of the Goa, Daman & Diu Agricultural Land Tenancy Act (1964) and Rules (1975) (hereinafter referred to as "the Act") on the sustainance of Khazan Land Ecosystems.

a) The agricultural lands in a Khazan Ecosystem can only be cultivated and managed as an integrated whole and not as independent individual land parcels. This is obvious because all agricultural fields which form part of the Ecosystem are dependent on proper 'management/control' of common entities such as major bund, internal bunds cum pathways, sluice gates, poins and connecting water channels, all of which are the integral components of the same. The proper upkeep of such common components was easily feasible prior to the Act because all the Khazan farmers jointly owned their fields and hence maintained and tilled the same with the spirit of cooperation. More so their livelihood depended on the Rice and other Crops grown therein and all able bodied family members themselves were involved in field work. During major field operations such as planting, harvesting, etc., needing additional hands, they helped each other and finished the work without significant expenses.

b) The Act was basically conceived for the good purpose of providing land ownership to the tiller of the same and consequently to bring more land under cultivation. However, due to the Act the Tenants tilling the Khazan fields have become deemed owners of the fields tilled by them and Comunidades which were based on the joint ownership of the Khazan fields are defunct for all practical purposes.

c) The Act empowers the Mamlatdar, an officer who is in charge of revenue activities in his jurisdiction, to supervise the management of Khazan Lands through Agricultural Tenants' Associations constituted for the purpose. The prime duties of Tenants' Associations are to cultivate the agricultural fields and to maintain the bunds, sluice gates, poins, pathways & channels which protect and sustain the same. However, under the Act the basic principle of joint ownership and joint responsibility has changed to singular ownership and joint responsibility and (as narrated above) Rice cultivation has become "economically / logistically" non-feasible. Hence, the provisions of the Act are not implemented in the right spirit. This state of affairs has led to breaching of bunds, flooding, salinity and growth of mangroves in the agricultural fields and adversely affected all agricultural activities in the khazan lands. Mamlatdars are overburdened with routine revenue matters and have neither the time nor the "means/expertise" to solve the problems faced by the 'tenants/agriculturists'. Under the circumstances the penal provisions of the Act have never been invoked and the Mamlatdars are practically left with

the only function of supervising the auction of sluice gates for fishing.

7. Steps necessary for revival and sustainable management of Khazan Land Ecosystems

The Committee perused all the earlier Reports placed before it by the Department of Environment & Climate Change, fresh material submitted by "Agriculture / Fisheries / Forest" Departments, views of Committee Members, Research Papers on Khazan Ecosystem & Mangroves of Goa and conducted field visits and based on the same, recommends the following steps which are necessary for revival and sustainable management of Khazan Land Ecosystems:

I Detailed Survey of the Present Status of Khazan Land Ecosystems in Goa

It is observed that no statistical data is available with respect to the present status of Khazan Land Ecosystems in the State. The dearth of data is felt in land related, crop related, ownership related as well as demography related facts on the ground. An effective management plan for any entity can be conceived only when the hard facts of its present status are known. A detailed survey is recommended to determine what is listed below, which will help not only in planning, but also regulating and managing the Khazan Eco-system in an effective manner:

a) Extent of khazan lands (Ha), with Survey Numbers, owned by:

i) Comunidades
ii) Government
iii) Religious bodies
iv) Charity Organizations
v) Private Individuals

b) Area under cultivation of *Rabi* Vegetables 'and/or' *Rabi* Rice.

c) Area within Khazan Lands under *Kharif* Rice Cultivation and area left fallow.

d) Area of bunds under Coconut cultivation and number of Coconut palms.

e) Area under Poins.

f) No. of working and defunct Sluice Gates.

g) Area under functional (Ha) and defunct Salt Pans (Ha).

h) Ownership wise length of Bunds protecting the Khazan Lands and present condition of the same.

i) Number of functional Tenants' Associations and their activities for the last five years as mandated in the Act.

j) Present status of Sluice Gate auctions for capture fishery and income earned by the Associations and the Government (through the same) for last five years.

k) Number of 'farmers/farm families' owning or occupying khazan lands under each of the above ownership categories.

l) Area of Mangroves seen within Khazan Land boundaries (Ha) and all along the outer protective bunds of Khazan Ecosystems (Ha).

m) Sluice gate wise area under saline water for traditional capture fisheries within Khazan ecosystems.

n) Area used for traditional capture fishery if any after *Kharif* Rice harvest beyond the sluice gate capture area, carried out as per rules/acts in force.

o) Bio-diversity of "Flora/Fauna" found within Khazan Land Ecosystems

II Demarcation of the area under each Khazan Land Ecosystem in Distinct Management Zones

It is recommended that each Khazan Land Ecosystem is 'divided / demarcated' in four distinct management Zones for specific "Cropping Pattern/ Activity" suited to each such Zone:

a) Stretches where salinity is high and only local Salinity Tolerant Rice cultivation, conventional salt production and traditional fishing can be practiced. **(S-3)**

b) Stretches on the landward side of Zone **(a)** and in vicinity of poins where salinity is medium and no fresh water is available for *Rabi* cultivation. Here improved (hybrid) salt tolerant Rice varieties can be cultivated in *kharif* season. **(S-2)**

c) Near the border of Khazan Land abutting the settlement area where salinity is insignificant and shallow fresh water table prevails after the end of monsoon rains. Here local and exotic vegetables can be cultivated in *Rabi* season after the harvest of high yielding Rice varieties grown in *Kharif* season. In some areas subject to availability of water a *Rabi* crop of rice can also be cultivated. **(S-1)**

d) Patches of highly saline abandoned Khazan lands which are in an uncultivated state for a very long time and where

mangroves are regenerating due to marshy conditions created by highly eroded system of protective bunds. **(HS)**

Devise a special agricultural scheme with crop wise package of practices suitable for each of the above Zones and with specific incentives including subsidized costs of hiring agricultural machinery. Adapt and develop a model Khazan Land Farm to demonstrate the profitability of the said package of practices. Organize 'extension/training' camps for Khazan Land farming community and motivate them for the purpose.

III New cost-effective "methods/materials" for "repairs/ improvement" and management of bunds:

Although the exact status of bunds will be known after the completion of the recommended survey, it is generally accepted that about 50% to 60% of Khazan land bunds are in a dilapidated condition, and threaten the very existence of the khazan lands. The bunds which are made up of locally available marine clay require constant minor maintenance works which were performed meticulously under the *Gaunkari* and colonial *Comunidades* systems.

Under the present situation there is a need to look for new technology which is environment friendly and cost effective. New approaches such as use of geo-membrane, sheet piling, coir, jute, etc, should be tried on a case to case basis and their performance examined and documented if found to be better than traditional.

While planning for a long term Khazan Land revival & improvement strategy current speculations on possible rise in sea level may be taken in to account to make a provision for appropriate increase in height of main Khazan bunds as the present free board is very small. Also the major bunds in close proximity of main estuaries should be designed for 'higher/stronger' wave surges due to the anticipated heavy aquatic traffic in near future.

It is not only necessary to devise an improved strategy for "repair/ improvement" of bunds and sluice gates but a regular and effective maintenance system should be conceived which can maintain the bunds timely and efficiently without resorting to time consuming archaic and bureaucratic rituals. This will enhance the confidence of farmers to cultivate the Khazans with renewed vigor.

IV *De-silting of Poins (internal water bodies) in Khazan lands:*

The Poins which act as water detention basins and also serve as a buffer between saline and fresh water zones have to be kept in proper shape. Under the *Gaunkari* and *Comunidades* systems the Poins were regularly de-silted and the material was either used for strengthening nearby bunds or spread back in the agriculture fields. However, as per available information most of the Poins have not been de-silted for a long period of time and their efficiency has reduced.

The Poins in each khazan should be evaluated and the areal extent required should be demarcated by an expert. Regular de-silting and deepening of the poins should be taken up without endangering the bunds and the fields and the soil should be used for "improvement/repairs" of the bunds 'and/or' put back in fields. De-silting and deepening of the Poins will increase fish rearing and harvest at the sluice gates and also increase the water retention capacity.

V *Construction of sunken ponds (jal kunds) to promote irrigation:*

Paddy cultivation is a *kharif* (rain-fed) activity in the khazan lands and to motivate farmers to take up *rabi* crop under irrigation, it is recommended to provide sunken ponds or jal kunds with the assistance and guidance from technical experts.

VI) *Internal Bunds:*

The khazan lands are vast lands and each field could be approached by small bunds. These bunds also need to be improved and trees like coconuts could be planted on them wherever feasible. Though the external bunds were provided with financial pattern of assistance, no such assistance was provided for internal bunds. A similar pattern of assistance is necessary for motivation of farmers as internal bunds are a source of income and also logistics for farming activities and also can produce coconuts.

Khazan Lands enjoy protection through the Town & Country Planning Act as well as CRZ Notification of 2011 under the Environment (Protection) Act, 1986 from all developments and activities excluding agriculture, traditional fisheries and salt production. This Committee reiterates that all cultivable agricultural lands including khazans should be protected for posterity. The Committee also recommends buffer zones (setbacks) of 20 m and 10 m from the outer boundary (on landward side) of the Khazan land in rural areas and in urban areas, respectively. This buffer zone shall be designated as No Development Zone.

VIII Salt farming:

Salt extraction was also a source of commercial activity in the khazan lands. Salt pans existed in many of the khazans and salt extraction is still practiced in khazans of Tiswadi, Pernem and Salcete talukas and on a smaller scale in other areas.

It is the need of the hour to give a boost to such salt extraction and give support through a subsidy scheme 'and/or' to provide logistics and marketing facilities by refining the product.

IX Fisheries

Based on the socio-economic considerations, fish rearing and harvesting has become a lucrative business. The fishing trade however is unregulated. Fishing activities should be restricted to the poins and sluice gates, where agriculture is not at all feasible. The auction of sluice gates is a very sensitive issue and needs to be regulated.

Improved technologies of enhancing capture fisheries at sluice gates and promoting aquaculture where agriculture is not feasible shall be promoted through the Directorate of Fisheries under the expert guidance CMFRI and in consultation with the GCZMA.

As suggested at **II (d)**, above, Zone **HS** of Khazan land should be carefully identified and demarcated jointly by a team of technical staff of Departments of "Agriculture /Fisheries /WRD / SLR/ GCZMA/ CMFRI (Goa)/ ICAR (Goa)". The so demarcated stretches of Zone **HS** shall be considered for appropriate use by the concerned Departments of Agriculture and Fisheries by weighing prospects and constraints as per prevalent laws in force.

X Agriculture:

The Khazans were rice bowls of the territory of Goa since time immemorial. Unique salt tolerant rice varieties such as Korgut, Asgo, Babri, Chagar, Giresal, etc., were sown in the khazans. Coconut trees were grown on the bunds which also were a source of revenue to the farmers. As per information made available, ICAR has developed a Rice variety named Goa Dhan-4 which is a cross between Korgut and Jyoti and is resistant to saline conditions. Coconut palms of Benaulim variety should be grown on Khazan bunds wherever feasible, especially on wider bunds. Other crops such as banana, vegetables, pulses and even fodder can be taken up on the periphery of the khazan lands abutting the settlements near fresh water zone ***S-1***

It is necessary to provide special support to assist the Khazan farmers in overcoming the shortage of agricultural labor by giving them subsidized machinery support for planting, weeding, harvesting and threshing of Rice crop. Also, salt tolerant high yielding varieties of Rice such as Goa Dhan-4 or equivalent should be provided to Khazan farmers at special rates for revitalization of khazan lands mostly in Zone **S-2.** Traditional Rice varieties like Korgut and Asgo should be promoted in Zone **S3** of the Khazan Lands recommended for demarcation, as above.

Seeds of Vegetables and Pulses may also be provided and their cultivation promoted in khazans especially in Zone **S-1** which is salinity free and having shallow fresh water table.

The Department of Agriculture should prepare special Package of Practices for all crops recommended as above in the three Zones proposed for demarcation within Khazan Land Ecosystems. The Package of Practices should provide subsidized inputs of improved seeds, agricultural machinery and carefully designed to ensure profitability. Training modules should also be organized to motivate and train the farmers to adopt the new technology described in the said packages. Assistance may also be provided in marketing of the agricultural products of Khazan Lands.

Motivation of farmers should be the main focus for rejuvenating agriculture in the khazan lands. Agriculture department needs to bring out a policy which gives special benefits to the farming families cultivating khazan lands. This needs to be done in conjunction with the improvement and repairs of bunds as

farmers have to be convinced that their fields are safe from saline inundation due to breaches.

It is necessary to promote farmers' cooperatives which can bring desired results. The Directorate of Agriculture should adopt at least two typical Khazan Land Ecosystems (one each) located in North and South Goa, as Integrated Technology Demonstration Plots (ITDPs), with the "consent /participation" of Tenants and in collaboration with the Directorate of Fisheries.

After repairing the Bunds and other components of the said adopted Ecosystems the Department should guide and help the 'farmers/tenants' to cultivate the same scientifically.

The ITDPs should demonstrate improved technologies of "Rice/Vegetables/Coconut" cultivation, Capture fishery, and regular "repair/maintenance" of "bunds/sluice gates" in a planned and phased manner which would instill confidence in the farmers to go for advanced technologies.

The Committee is of the opinion that such demonstration plots will showcase the methodology & economics and instill confidence in the farming community to cultivate their lands. This can be taken up in a planned and phased manner where the bunds are in pristine condition.

The Directorate of Agriculture may also examine the Community and Cooperative farming activities practiced successfully in Majorda, Fatorda, Davorlim, Chorao and St. Estevao in recent years, for promotion and replication under Khazan land conditions.

A State Agriculture Land Use Plan should be evolved with express statutory provisions of conserving all existing cultivable

agricultural lands. This is essential to make Goa self-sufficient in growing its entire requirement of food crops (including fish) and also to provide food security.

XI Small Farm Machinery Stations based on Public-Private Partnership should be maintained at Block levels to hire out power tillers, seed drills, harvesting machinery, weeding implements, sprayers and the like at low costs.

XII Self sustaining model:

Each khazan land should be planned as a self sustaining model with receipts from agriculture, pisciculture and salt farming over and above the expenditure on bund maintenance and other farming inputs. Some 'out- of- the- box' activities such as eco-tourism and nature walk trails in Khazans as a niche product should be explored for additional income.

The Committee also recommends that products from Khazan lands, especially the salt tolerant rice varieties (Korgut, Asgo, Xitto, etc), Salt and tasty Fish can be **GI-tagged** or branded to enhance the essence of the produce and fetch better prices.

The State Directorates of 'Agriculture/Fisheries/Water Resources', the ICAR Complex for Goa, CMFRI (Goa Centre) and NABARD (Goa Branch) should enter in to a time-bound collaborative Project to devise an all encompassing (Rice, Vegetables, Fishery, Coconut, Banana, and 'Bund/Sluice' maintenance) and economically viable scheme for Khazan Land Ecosystems of Goa. The scheme may also

include elements such as provision of loans, crop insurance and subsidies on "seeds/fertilizers/pesticides" and "power-tillers /planters/harvesters". The ultimate objective of this effort should be to make crop (viz. Rice, Pulses, Vegetables, Coco-nut, Banana, etc) cultivation, traditional capture fishery and salt production in Khazan lands a remunerative and sustainable venture. A desire to preserve, conserve and operate the Khazan Land Eco-system should come from the "Farmers/Tenants" themselves, and not from external forces.

XIII The Khazan Land Ecosystems are unique man-made systems established around 3000 years back by our ancestors as a result of intricate ecological, technical and environmental knowledge gained by them through centuries of trial and error efforts. It has been able to sustainably supply the food needs of local communities till date, albeit to a diminishing extent due to several socio-economic realities of modern times discussed above. Therefore the Khazan Ecosystem amply qualifies as a heritage eco-system worth promoting for acceptance as an UNESCO World Heritage Site. The Committee strongly recommends that the State Government may take up the issue for consideration of the concerned authorities.

XIV In the interim period until the new legislation is in place, the present Scheme for repair of Bunds and Sluice Gates shall be extended also to cover de-silting of Poins, repair of minor Khazan bunds serving as approach pathways to individual land parcels and construction of sunken ponds to tap the ground water table and to store rain water for cultivation of Rabi vegetables in Zone

S-1 of Khazan Land. However, the benefit of this Scheme should be extended only for those Khazan Lands where the Tenants have demonstrated their sustained interest in cultivation of "Rice / Vegetables" and production of Salt, based on the survey recommended at item **1.,** above.

XV Legislation encompassing the above points:

The Committee endorses most of the findings recorded in the earlier RALDP 1992 and summarized in brief under **Chapter 5**, above. Importantly, the Committee is also fully convinced that under the present circumstances the provisions of Agriculture Tenancy Act will not be able to conserve, protect and regulate the Khazan Eco-system in any effective manner and there is an ardent need to look into alternate effective means of regulation which will manage, regulate and conserve the Khazan Ecosystems in an effective and sustainable manner. However, the Committee also recognizes that unless the farmers are convinced about the economic viability of cultivation of Rice, Vegetables and other crops in Khazan Lands, no amount of legislative measures will succeed in coercing them to cultivate the land.

A pre-requisite for economic feasibility of agriculture in Khazan Lands is to first conduct a detailed survey to know the present status of agriculture in Khazan Lands and to put in place the package of practices, technological improvements & schemes, as suggested above. The constitution of an apex body in the name and style of Agency for Planning and Management of Estuarine and Khazan Areas (APMEKA) as recommended in the RALDP 1992 will be essential to 'examine/study' in details the outcome of the

survey of the current status of khazan ecosystems, agricultural schemes and other technological interventions recommended above. Based on this study the APMEKA shall recommend an appropriate Legislation to replace the provisions of the Agricultural Tenancy Act (1964) & Rules (1975) which presently govern the management of Khazan Land Ecosystems in Goa.

Members of the Committee

Dr Simon D'Souza **Chairman**	*Dr Naraina P.S. Varde* **Member**	*Subrai T. Nadkarni* **Member**
Dr Vinod Dhargalkar **Member**	*Dr Fraddry D'Souza* **Member**	*Raya Shankhwalker* **Member**
Shrikant Priolkar **Member**	*Suraj Pagi* **Member**	*Bhau Kalangutkar* **Member**
Tolentino Furtado **Member**	*Neville Alfonso* **Member Secretary**	

Annexure I

Constitution of the Committee

Government of Goa
Department of Environment and Climate Change
1st Floor, Pandit Deendayal Upadhay Bhavan,
Behind Pundalik Devasthan, Near Sanjay School,
Porvorim, Bardez Goa
Phone Nos.: 0832-2416581 / 2416583 / 2416584
e-mail: dir-env.goa@gov.in

No. 2-81-2020/Dir/Envt &CC/ 577 Date: 08/ 09 / 2020

ORDER

Government of Goa is pleased to constitute a Committee for Preparation of Draft Plan titled Khazan Land Management Plan comprising of the following members.

1.	Dr. Simon D'Souza Ex-Chairman, GSPCB and Scientist F, National Institute of Oceanography	– Chairman
2.	Dr. N.P.S. Varde Ex-Director, Department of Science, Technology and Environment, Govt of Goa	– Member
3.	Shri. Subrai Nadkarni, Ex-Chief Engineer, Water Resources Department	– Member
4.	Dr. Vinod Dhargalkar, Ex-Scientist, National Institute of Oceanography and Secretary of Mangrove Society of India	– Member
5.	Dr Fraddry D'Souza The Energy ~~Research~~ Institute (TERI) Resources	– Member
6.	Shri. Raya Shankhwalkar Hon Secretary, Heritage Network Group	– Member
7.	Shri. Shrikant. S. Priolkar Member, Khareban Tenant Association, Chodan	– Member
8.	Shri. Suraj Pagui, Akhil Goa Fisherman	– Member
9.	Shri. Bhau Kalangutkar, Chairman, Owleshwar Fisherman Society, Nerul	– Member
10.	Shri. Tolentino Furtado, Dy. Director, Department of Planning, Statistics and Evaluation	– Member
11.	Shri. Neville Alfonso, Director of Agriculture, Agriculture Department	– Member Convenor

The Committee shall:-

a) Call for such records as necessary and analyze all the reports, documents, studies, publications as available in respect of Khazans.
b) Carry out Field visits and consultation with stake holders
c) Study the present laws, rules, regulations in respect of the above subject
d) Prepare Draft Plan for the Management of Khazan Land.

The Committee shall complete the above task within 45 days from the date of publication of this Order.

The Members of the Committee shall be eligible for sitting fee of Rs 2000/- per meeting and Rs 1000/- per day for inspection.

By Order and in the name of
the Governor of Goa

3/4/2020

(Johnson Bedy Fernandes)
Director Environment and Climate Change

To,

1. **The Director, Government Printing Press**, Panaji... ... ... *for favor of immediate publication in the Official Gazette. The matter is checked and fount fit for publication.*
2. Dr. Simon D'souza, Ex-Chairman, GSPCB and Scientist F, National Institute of Oceanography.
3. Dr. N.P.S. Varde, Ex-Director, Department of Science Technology and Environment, Government of Goa.
4. Shri. Subrai Nadkarni, Ex-Chief Engineer, Water Resources Department.
5. Dr. Vinod Dhargalkar, Ex-Scientist, National Institute of Oceanography and Secretary of Mangrove Society of India.
6. Dr. Fraddry D'Souza, The Energy ~~Research~~ Resources Institute. (TERI)
7. Shri. Raya Shankhwalkar, Hon'ble Secretary, Heritage Network Group.
8. Shri. Shrikant.S. Priolkar, Member, Khareban Tenant Association, Chodan.
9. Shri. Suraj Pagui, Akhil Goa Fisherman.
10. Shri. Bhau Kalangutkar, Chairman, Owleshwar Fisherman Society, Nerul.
11. The Director, Department of Planning, Statistics and Evaluation, Porvorim
12. The Director, Agriculture Department, Tonca Caranzalem-Goa.

Copy to:

1. OSD to Hon'ble Minister for Environment & CC, Government of Goa, Secretariat Porvorim Goa.
2. P.A to Secretary Environment & CC, Government of Goa, Secretariat, Porvorim Goa.

Annexure II

List of Khazan lands and Protective bunds

Sr No	Taluka	Village	Name of Khazan	Length of bund	Area Protectd	Notification date
				Mts	Ha	
I	**Pernem**	Keri	Katumban	800	15	20.11.1992
			Kazarkond	1200	25	08.03.1969
		Paliem	Mulak khazan	1100	50	23.01.1981
			Bal Khazan			23.12.1967
		Korgaon	Bal Khazan	1200	50	05.09.1975
			Bandlo, Deossa, Murdi	2000	100	05.09.1975
			Sulcho malo	1000	30	21.02.1975
			Bandpad,ovam.	1500	50	22.01.1971
		Pernem	Karo band	800	50	20.07.1982
			Torpacho band	200	3	07.10.1978
			Paraste band	450	15	
		Varkhand	Kamal Kunge	400	20	09.09.1978
		Kasarvarne m	Kasarvarne	1000	50	
		Dhargal	Fatorde xet	800	30	12.02.1978
			Chinchunchi manus	100	30	
			Dhadeshwar cantor	400	2	
			Mahakhazan	1100	30	13.11.1971

			Ponde khazan	100	35	16.07.1984
			Cole Cantor	500	60	10.02.1976
			Band at Arobo	200	5	23.12.1967
			Ganiya gaocho malo	150	20	
			Bhavnacho cando	250	12	
			Shimracho mali.	200	12	
			Randeche kand	100	5	
			Vaili cantor...	200	15	
			Pilernecho val	100	10	
			Ghanagalcho	100	28	21.02.1975
			Shirat, Kundi..	2000	28	
			Fulacho malo	500	60	13.11.1970
		Virnoda	Chinchnichi manas	150	12	25.05.1977
			Kotoba	500	40	20.06.1972
		Tuem	Mirandiche xet	600	20	
			Canturli	50	1	13.07.1976
			Khetro	400	30	
			Pudacho ank	800	40	
			Pankar madlo	1000	40	22.01.1971
			Ghotung madlo	2000	70	02.01.1971
			Shipyanche chol	800	10	
		Parsem	Parsekar Dessai madlo	2000	100	
			Kalapllar Kaste	500	12	
			Khazan Gundo	800	300	

			Kalagutkar Khazan	800	12	14.12.1975
		Agarwada	Khare khazan	700	20	
			Namacho agor	800	6	
			Tata agar	800	30	
			Khare khazan	800	24	
		Chopdem	Tadche Khazan	600	8	
			Kurman bag	500	15	
			Sarchi mali	200	3	
		Morjim	Namla bhat	300	3	26.09.1973
			Katuband khind	100	10	26.07.1969
			Talpacho bandh	300	10	
		Harmal	Harmal band	1000	24	
			Total	***34950***	***1680***	
II	**Bardez**	Salvador-do-mundo	Mulcnda Khazan	Sluicc gates	300	02.04.1974
			Vithal Cantorla	600	5	02.04.1974
			St Paul Cantor	2500	40	09.01.1970
			Salem khazan	1500	30	01.07.1977
		Ecoxim	Cantor Natekar	1600	16	
			L. cantorla of Cardoz	300	15	01.04.1985
			L. Cantrola of Kamat	300	15	01.04.1985
			Bhat	100	2	12.01.1979
			St Paul Cantor	300	2	11.08.1971
		Pomburpa	Cantra	125		23.08.1976
		Olaulim	Olaulim khazan	800	8	30.04.1977

		Calvim	Calvim khazan	1200	50	06.05.1968
			Ambe cantor	600	10	03.03.1983
			Ponolem Khazan	3500	55	
		Aldona	Carona khazan	700	10	13.02.1979
			Nivim khazan	700	15	20.08.1973
			Zamuchi agurli	200	9	20.11.1985
			Gaun khazan	250	15	13.07.1976
			Goncoi khazan	400	15	23.01.1981
			Ranoi khazan	1000	42	19.01.1982
			Culak & Vaoxet	1500	70	19.01.1982
		Corjuem	Asnoi khazan	1000	20	07.02.1968
			Gouzo khazan	2000	30	31.05.1969
			Noi Khazan	800	20	10.02.1976
			Vantsuo Khazan	400	20	27.08.1983
			Hatal khazan	500	15	30.04.1977
			Camrai khazan	400	5	13.07.1986
			Canturli	200	4	20.07.1982
			Bakra khazan	400	5	13.07.1986
			Porvotacho cantor	300	3	04.02.1974
			Ranoi khazan	500	20	
			Van Khazan	400	10	23.01.1981
		Nachnola	Binal bund	200	3	23.12.1967
		Moira/ Ucassaim	Pirzona bund	1000	25	01.07.1977
			Calizor atafondem	2000	50	23.01.1981
			Marachi Canturli	400	10	

			Poin Xet	600	15	10.01.1972
			Canturiacho bund	200	25	04.05.1982
			Candlem	300	5	10.01.1972
		Mapusa	Camar khazan	1000	12	23.01.1981
			Acoi khazan	1500	295	27.06.1983
			Braganza cantor	200	2	01.12.1982
		Bastora	Dutone khazan	300	5	24.06.1985
		Guirim	Simecho band	700	30	10.10.1977
			Jacnoi band	500	20	18.04.1968
		Tivim	Danua	1000	25	
			Vatechi canturli	300	5	01.12.1982
			Bamul khazan	900	25	02.04.1985
			Dhamde Khazan	1200	25	19.07.1968
			Gavoi khazan	400	15	07.05.1979
			Vadachai	500	80	21.08.1969
			Dhakte Copra	600	10	21.10.1970
			Bodiem khazan	1500	20	30.04.1977
			Cumonem Khazan	1600	30	30.04.1977
		Sircaim	Sircaim khazan	600	20	
		Assnora	Malai khazan	500	20	20.07.1982
			Dhar khazan	1000	25	19.01.1982
		Revora	Kundai khazan	500	12	04.03.1972
		Colvale	Dokacha dat	700	25	
			Male cantor	800	20	28.05.1976
			Dade cantor	800	25	20.03.1987
			Tuanolle xet	300	12	20.03.1987

			Chicalim Khazan	1200	12	26.01.1978
			Bhati	300	10	10.02.1976
		Camurlim	Bhailo cond	700	25	20.06.1968
			Bhati of S. Fds	700	10	
			Antiongon	300	6	31.02.1974
			Ghotkal	500	10	
			Ladache Bhat	200	7	07.10.1978
			Nanerem bund	150	5	13.11.1973
			Manchesho udo	100		21.08.1969
		Oxel-siolim	Code cantor	2000	75	21.08.1969
			Mansecho band	400	30	21.08.1969
			Pesucho bund	900	15	
			Vodle khazan	700	15	28.03.1969
			Bund at oxel			
		Siolim	Tariche khazan	400	10	21.04.1971
			Cursacho vato	500	15	20.06.1968
			Manilo vato	150	10	
			Gude bund	300	15	20.06.1968
			Kerem khazan	900	20	28.12.1971
		Arpora	Cordinicho agor	200	3	13.02.1979
		Calangute	Bati	200	6	13.01.1982
			Dr Egipcio's Khazan	250	5	
			Anabaichocantor	150	5	28.05.1976
		Candolim	Buta khazan	2500	80	28.03.1969
			Malkhazan	300	10	24.08.1977
		Nerul	Confriancho	600	20	19.08.1982

			agor			
			Adso xet	600	5	25.05.1977
			Apte khazan	600	16	21.02.1975
			Bund at Nerul	2000	50	14.10.1969
		Verem	Ambe cantor	700	30	
		Pilerne	Navoti khazan	100	30	23.01.1981
			Sapal	400	11	23.01.1981
			Cantor	100	5	24.08.1977
			Mahakhazan	1500	100	24.08.1977
			Panachi canturli	500	10	
			Khazan of Dumig	100	5	
			Cantor of o deago	150	10	10.02.1976
			Total	***68825***	***2458***	
III	**Bicholim**	Sirgao	Kharat khazan	1800	60	03.01.1973
			Sawat khazan	1300	40	03.01.1973
			Cantor	100	2	27.07.1978
		Mulgao	Karat & Sawat	300	15	11.05.1973
		Mayem	Pongarpat	2000	70	02.04.1974
			Mulak khazan	1700	70	18.04.1974
			Evacui bund	150	30	18.04.1968
			Cantorla of Hoble	400	5	
			Barcoi	1500	40	16.07.1970
			Vaiguinim	1100	30	01.07.1970
			Tikhakazan	1600	50	09.07.1976
		Naroa	Tikhakhazan	1200	20	16.11.1974
			Donxi	700	80	04.07.1977

			Cantorla (E)	600	4	23.01.1981
			Hindale	700	20	23.01.1981
			Digui of Roghuvir	900	12	22.05.1971
			Tonte of Victor	700	3	28.03.1968
			Tonte of Malbara Sardessai	400	5	26.10.1967
			Sancola khazan	50	5	23.01.1981
		Pilgao	Dokecho, mundi	400	20	13.01.1975
			Sluicegate(Sa)	500	40	
			Amiye khazan	1500	40	15.10.1967
			Bhailo cantor	300	2	25.10.1967
			Coswan	1000	30	27.02.1970
			Coswan bailipad	600	10	27.02.1970
			Cudcho cantor	300	8	19.01.1982
		Carapur	Virnole	1000	25	03.01.1990
			Cudcho cantor	800	4	16.11.1974
			Balkum xet	1800	35	
			Cudap	2500	135	25.11.1997
			Didicho cantor	300	8	19.01.1982
		Virdi	Moli	200	10	21.08.1979
			Dhabe khazan	700	22	23.01.1981
			Canturli of kamat	300	7	
			Canturli of Davaskar	200	3	21.08.1979
		Virdi	Bage cantor	500	6	09.09.1978

			Vithe cantor	600	4	23.01.1981
			Muli	200	10	19.10.1971
			Dolcho cantor	800	6	01.10.1992
			Vaghacho Goindo	400	2	09.09.1978
			Khare khazan	1500	35	23.01.1981
			Talcho cantor	500	10	10.12.1968
			Golcho cantor	800	30	19.10.1971
		Cudnem	Bhovado	600	10	23.01.1981
			Colombo, Anko	500	3	22.01.1971
			Barazanachi manas	300	30	01.12.1981
			Mop khazan	750	10	04.03.1972
		Navelim	Sanstacho ank	650	50	01.07.1977
			Dhakul main	300	5	08.12.1971
			Khazan of Borkar	1200	50	
		Surla, Pale...	Maxe bhat	200	2	06.06.1978
			Taricho ado	300	2	28.01.1971
			Bamnem xet	200	2	06.06.1978
			Hudo, Aco cantor	200	2	28.01.1971
		Amona	Cantor of Gawas	700	20	
			Mae cantor	600	6	
			Agapuri cantor	700	8	09.04.1975
			Rumad palipad	400	6	
			Udatto & Vaotoli	800	300	
			Talyache	500	20	19.10.1967

			khavate			
			Cantorla of Suresh Porob	500	6	
			Cantor of Vithal Porob	300	6	
			Cantor	15500	60	
			Bhaile xet	1800	40	09.02.1978
			Boka cantor	700	10	
			Uniyem cantor	600	10	19.04.1975
			Bhaile xetach pat	300	10	10.02.1976
			Thorli Devkhadi	900	25	16.11.1974
			Vagacho goindo	400	2	16.01.1969
			Total	***64800***	***1758***	
IV	**Tiswadi**	Merces	Murda, Cole..	1500	167	11.12.1972
			Morombi-o-grand	150	100	
			Cantor santanach	1000	100	
			Sinaricho bund	500	25	
			Ranodi bund	400	20	
		Calapur	Pate cantor	1800	100	11.12.1972
			Nevgi band	1000	20	
			Fulacho Pauni	1000	35	
			Zium, kotiem	1000	40	04.03.1972
			Padd, polos, naya	250	30	10.02.1976
		Siridao,Cudc	Bund of	300	5	21.11.1984

		a	Mascarinhas			
			Wodval	600	10	
			Khazan near church	1000	20	
			Aframento curca	500	50	09.12.1968
			Dempo bund	500	20	31.01.1989
		Santana	Santana khazan	1500	80	20.06.1968
			Cantor	680	15	14.03.1989
			Danaitacho	500	5	
			Cauntecho cantor	600	6	
		Gaolim moula	Gaolim khazan	800	30	
			Bhati	400	10	
			Naye khazan	800	12	09.09.1978
			Ordacho Khazan	350	10	09.09.1978
			Cantoria	500	24	14.01.1982
			Motto band	700	20	21.08.1979
		Goa Velha	Birmal, Amle..	250	10	10.10.1977
			Erco band	400	10	04.12.1984
		Agassaim	Tilkhazan	630	20	25.10.1967
			Olijua khazan	200	10	03.03.1983
		Neura	Pilo	2000	80	25.10.1967
			Silpa	1900	100	25.10.1967
			Nerda	1900	75	25.10.1967
			Amta	2000	80	25.10.1967
			Cantra	800	65	25.10.1967
			Neura khazan	800		06.05.1991
			Cantoria	200	15	23.08.1976

			Damda khazan	3200	150	21.02.1975
			Tolap	200	2	
			Velfanim Khazan	200	70	05.09.1975
		Dongri, Mandur	Mandur khazan	30	20	
			Dongri xet	300	6	02.04.1974
		Azossim	Azossim Khazan	1300	200	28.05.1978
			Internal bund	150		30.04.1977
			Porne offol	500	30	21.02.1975
		Carambolim	Kholi ofla donzuo	30	100	24.08.1977
			Ofla Donzua	3780	400	08.07.1968
			Motto	1000	10	23.01.1981
			Cauzua	1500	70	
			Naganzo khedo	2500	200	
			Sawat khazan	500	100	
			Cantor	430	4	27.12.1988
			Kulwal cantor	600	50	13.07.1976
			Dhado	5000	200	19.10.1967
			Kulwal int bund	600	50	13.07.1976
		Corlim	Corlim khazan	1800	250	
			Dhavant	1500	40	
			Unico, lenco ..	500	30	20.11.1970
			Mayem sant	500	10	19.10.1971
		Cumbarjua	Imte	500	20	07.10.1972
			Thirkhazan	500	30	07.10.1972
			Cundaikar cantor	1000	20	14.12.1969

			Chune cantor	1000	40	21.02.1975
			Vantsuo	500	20	14.12.1969
			Kegdi Aco	300	7	30.01.1985
			Panchlai	500	20	
		Dauji-Ela	Dauji cantor	2500	70	
			Marques cantor	100	4	02.04.1974
			Cotopo, sepal,..	700	70	07.10.1976
		St. Pedro	Aframento	25	1	16.11.1974
		Gaundalim	Bor Khazan	300	5	28.05.1978
			Tivo cantor	700	20	06.05.1968
			Durga poi, vaglo	500	10	06.05.1968
		Capao	Vanxi bund	2000	50	
		St Estevem	Vai Khazan	2000	80	21.04.1971
			Marques cantor	200	5	10.10.1977
			Vantsuo	1800	100	21.10.1967
			Garekarnicho ban	400	7	
			Chune cantor	700	30	
			Panchlai	500	20	
			Palni	1500	60	13.07.1976
			Acaro band	1200	10	28.03.1969
			Tagre valai	1500	125	07.02.1968
			Madapoi	300	50	07.02.1968
			Causuo cantor	2500	120	07.02.1968
			Babal	700	6	10.02.1976
			Sapal of silva	2000	25	05.09.1975
		Navelim, Divar	Goltim	3000	250	09.09.1978
			Antucho bund	700		04.05.1982
			Zuamvoilo	2500	180	11.09.1970

			bund ..			
			Boro, Garximo..	2900	200	11.09.1970
			Amboi	1800	100	24.08.1977
			Sapal cantor	500	30	25.01.1969
			Noronnacho,...	200	5	06.05.1968
			Naroa khazan	1800	75	05.09.1975
		Navelim, Divar	Sancorla, kakulo	200	13	02.03.1976
			Cantoria	400	5	
			Noi Inzonho, Tor	1700	50	13.11.1976
			Cono of Menezes	2400	30	19.10.1967
		Chorao	Sorel, Tivo cantor	8000	300	16.03.1970
		Chorao	Kerem	600	25	
			Bhobecho cantor	600	15	
			Sapal budule	900	30	
			Soryakaracho bund	500	30	
			Dhotracho	400	8	
			Budule	800	10	
			Karadi khazan	1400	100	
			Jambiacho	200		
			Cantor	2000	100	
			Candlem	2500	100	
			Cantoria Carepa..	300	20	05.09.1975
			Sapal of Jaganat	250	5	04.02.1974

			Nagvekar			
			Canturli of Chopdekar	300	10	07.02.1968
			Bandoni	3000	300	07.02.1976
			Loyola Nunes Khazan	600	25	
			Pongaracho	350	7	
			Cantoria Gonsalves	1000	15	
			Dubane	500	10	21.02.1975
			Van Khazan	100	20	13.07.1976
			Sorel, Voron,...	1500	200	16.03.1970
			Total	***12465 5***	***6704***	
V	**Ponda**	Banastarim	Powda cantor	700	45	
			Bailo cantor	500	5	25.05.1977
			Cosme betal bhat	700	10	27.06.1968
			Duklo cantor	100	2	30.04.1977
		Marcela	Cundaikar cantor	600	15	
			Bund at marcel	1000	25	
			Madapai	600	25	
			Coste khazan	1000	30	16.11.1974
			Coste bhat	600	5	16.11.1974
			Vishar poile	300	4	23.01.1981
		Khandola	Ambige khazan	600	5	
			Sapal & Cantorla	600	20	28.05.1976
			Cupel khazan	400	10	11.09.1970

			Adorna at Khandl	800	40	11.08.1971
			Adorna,Breach m	800	20	11.08.1971
		Betki	Maramon, monteman	1500	70	05.06.1970
			Vhoddi, Cuso	500	30	13.02.1979
		Savai Verem	Rampurush band	600	30	05.06.1970
		Vaghurme	Kharo bandh	200	40	01.07.1977
			Betul cultem	100	8	27.08.1984
			Zuvem	200	10	01.07.1977
		Panchwadi	Visor, bandavizor.	2000	40	10.01.1972
			Amlai khazan	800	50	07.05.1979
			Altecho	300	4	06.06.1978
		Shiroda	Manke cantor	1000	16	14.12.1973
			Costi vadoli	700	20	16.11.1974
			Ovli cantor	200	5	16.11.1974
			Bi cantor	600	10	20.12.1967
			Barbot cantor	200	3	28.03.1969
			Socrem khazan	1100	40	06.05.1968
			Shirdotte	1500	60	02.04.1974
			Bhati of Laxmiknt	800	40	
			Kurmane Khazan	1700	75	04.02.1974
			Raicondo	450	4	06.01.1993
			Vincent jua cantr	600	15	

			Apkare, Sonali..	600	15	19.01.1982
			Lliat & Cono ..	650	106	11.09.1970
			Cantor of Philip	500	10	
			Dabolim cantor	300	5	07.05.1979
		Borim	Bet, Bhitarlo...	700	10	01.07.1977
			Borkhazan	600	15	19.08.1969
			Babje cantor	1500	50	20.06.1968
			Devti, Figred..	1550	75	17.01.1973
		Vaddi-Talaulim	Khazan talle..	500	50	05.06.1970
			Naga,Bhutnath	450	50	05.06.1970
			Khazan Kutumban	1200	40	17.01.1973
		Durbhat-Agapr	Khalil cantor	350	6	13.01.1989
			Narsinhprassad	1800	65	26.07.1969
			Babal Narsule	500	14	16.03.1970
			Mahadev narsule	500	20	04.02.1974
		Bandora	Benal, Und..	1500	12	
			Naite at undir	100	3	13.11.1976
			Kharewada bund	200	10	31.12.1974
			Petcantor	300	30	
			Deva khazan	700	10	
		Marcaim	Devli bund	200	40	31.12.1974
			Parampai	1200	30	28.03.1969
			Rampoi, Madacm	400	10	16.11.1974
			Nivcl cantor	800	18	21.10.1967
			Bar, vage cantor	2000	120	21.10.1967

			Ambre khazan	900	40	21.10.1967
			Adon, Vazrea ...	200	10	15.04.1987
		Cundaim	Sasurpoin	800	50	25.01.1969
			Chikalpoin	1600	75	25.01.1969
			Juvem cantor	1500	31	14.12.1973
			Naila cantor	740	25	11.12.1972
		Bhoma	Dhado Nainado	3500	150	21.10.1967
			Bund of Kenkare	200	10	21.10.1967
			Jafaralem	60	10	
			Mushifond, Usale	500	10	27.08.1983
			Total	***53650***	***2056***	
VI	**Sacette**	Lotulim	Goltem khazan	600	7	
			Sakal fondi	500	10	11.08.1971
			Copre cantor	1000	10	11.08.1971
			Deorbhat..	2000	70	11.08.1971
			Cantor of Pilomen	400	5	11.08.1971
			Vatlaim	800	10	11.08.1971
		Lotulim	Combo cantor	300	5	11.08.1971
			Catbhat cantor	2000	10	11.08.1971
			Bebdo cantor	300	50	11.08.1971
			Nocasana	2500	60	11.08.1971
			Menino cantor	800	10	11.08.1971
			Sapal cantor	500	10	11.08.1971
		Ambora	Costi vadoli	1800	60	
			Bamna bhat	700	50	
		Raia	Novor khazan	1000	75	
			Sapal	75	30	

			Dhakte ord,	1600	80	
			Voldem ord..	2000	100	
			Odlim khazan	700	30	
			Banda poi	500	50	
		Rachol	Cantor de Sailim	500	15	
			Shial cantor	900	20	
			Khod khazan	600	12	
			Fosso cantor	35	25	
			Canator de Digaim	150	5	
			Digaim khazan	1000	75	
		Curtorim	Solbem	2000	100	
			Bund de Estibero	300	10	
			Cottombo	700	100	
			Galche cantor	200	7	
			Porne khazan	900	32	
			Novo cantor	300	25	
			Bhati khazan	400	15	
			Morondi cantor	1200	20	
		Macazana	Varzea khazan	1000	20	
			Batim khazan	1000	10	
			Bhate khazan	700	20	
			Voldem khazan	3200	250	
			Saibinicho cantor	1000	15	
			Jule Khazan	1200	40	
			Surla khazan	300	15	
		Chandor	Paklo bund	700	40	

			Add Xet	900	35	
			Bir Khazan	500	40	
			Munde Add	300	10	
			Kodvoi vaddi	300	19	
			Pasco bund	700	10	
			Bass, Babjer xet	2500	150	
			Tollem bund	300	25	
		Girdolim	Maria poim	1200	70	
		Betalbatim	Khare khazan	30	50	28.05.1976
			Viliad	500	20	
			Dalalacho bund	300	20	
		Colva	Khazan norte ,sul	500	40	
		Carmona	Vanca	500	20	13.01.1975
			Marinha calata	300	150	26.09.1973
			Bokapoicho canto	1200	50	19.10.1967
			Dongafodi	1000	40	24.07.1971
			Code Reprosa..	1200	150	20.04.1970
			Aframento costa	1300	10	15.06.1989
			Dugale khazan	1000	125	05.09.1975
			Comfre agor	510	3	04.02.1974
			Machabachetale	500	20	11.12.1972
		Cavelossim	Isle at Zunga	1000	6	07.02.1968
			Deu Patre Orem	400	40	05.08.1974
		Sequetim	Band o Peda	250	10	06.01.1993
		Chichinim	Ortem at	500	3	28.02.1989

			Deusua			
			Deusua	500	10	24.07.1989
			Donacholecho bund	1500	80	
			Ker Khazan	2000	150	
			Durga bund	2500	100	
			Uskini bund	100	50	
			Naiquinicho agor	1000	150	10.10.1977
			Bandao Pedda	500	15	23.08.1976
		Assolna	Ambole, Satole	500	20	07.05.1979
			Doncon	900	40	
			Bund at assolna	700	60	
			Bund at Monteiro	300	50	
		Velim	Bund at Velim	500	100	
			Total	***67050***	***3544***	
VII	**Quepem**	Xelvona	Kapad,Dig,..	400	70	
			Muxe khand adya bandh	300	38	25.02.1971
		Cotombi	Cotombi bandh	500	40	25.02.1971
			Adi bund	150	28	19.04.1978
		Curchorem	Khandiwada band	150	20	27.12.1988
		Cacora	Kolmorod, Chikmuli	1250	60	19.10.1989
			Total	***2750***	***256***	
VIII	**Mormago**	Chicalim	Mixibandh	1400	4	20.06.1972
			Sapal	300	5	23.12.1967
		Sancoale	Bund at	2000	25	

			Sancoale			
		Cortalim	Sapal of de silva	500	9	07.05.1979
			Batem cantor	600	20	
			Dando, Tolcantor	700	15	04.03.1972
			Gaudi khazan	1000	15	
		Quellossim	Bund of Rodrigue	2000	40	
			Gudi mudi khaza	1000	15	
			Maste khzan	1000	12	
			Zeo band	2500	75	
			Total	***13000***	***235***	
IX	**Canacon**	Khol	Salerichi Al	150	18	
		Agonda	Dandomorod...	500	12	
		Palolem	Partagalmat band	300	20	
		Kindalebag	Donim, Tonda...	300	12	
		Poiguinim	Caria Gosne ..	200	15	
			Chandrapad	200	10	
			Cole	150	18	
		Sadolshem	Taga band	200	10	
		Nuvem	Band at Nuvem	150	9	
		Loliem	Gorjin jirayat	200	10	
			Vani band	100	80	
			Ben Khazan	200	16	
			Total	***2650***	***230***	

Annexure III

References:

1. Goa, Daman & Diu Agriculture Tenancy Act, 1964 and Rules, 1965

2. Report of the Agricultural Land Development Panel, March 1992

3. Sangeeta M. Sonak, 2013, Khazan Ecosystems of Goa, Springer

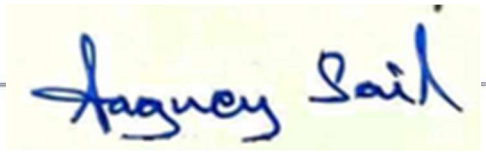
4. Sangeeta Sonak, Saltanat Kazi and Mary Abraham, 2005, Khazans in troubled Waters, TERI Press, TERI

5. Goa-Political, The Comunidades

6. Reyna Sequeira, 2013, "As Dear As Salt", Goa 1556

7. Codigo de Communidades

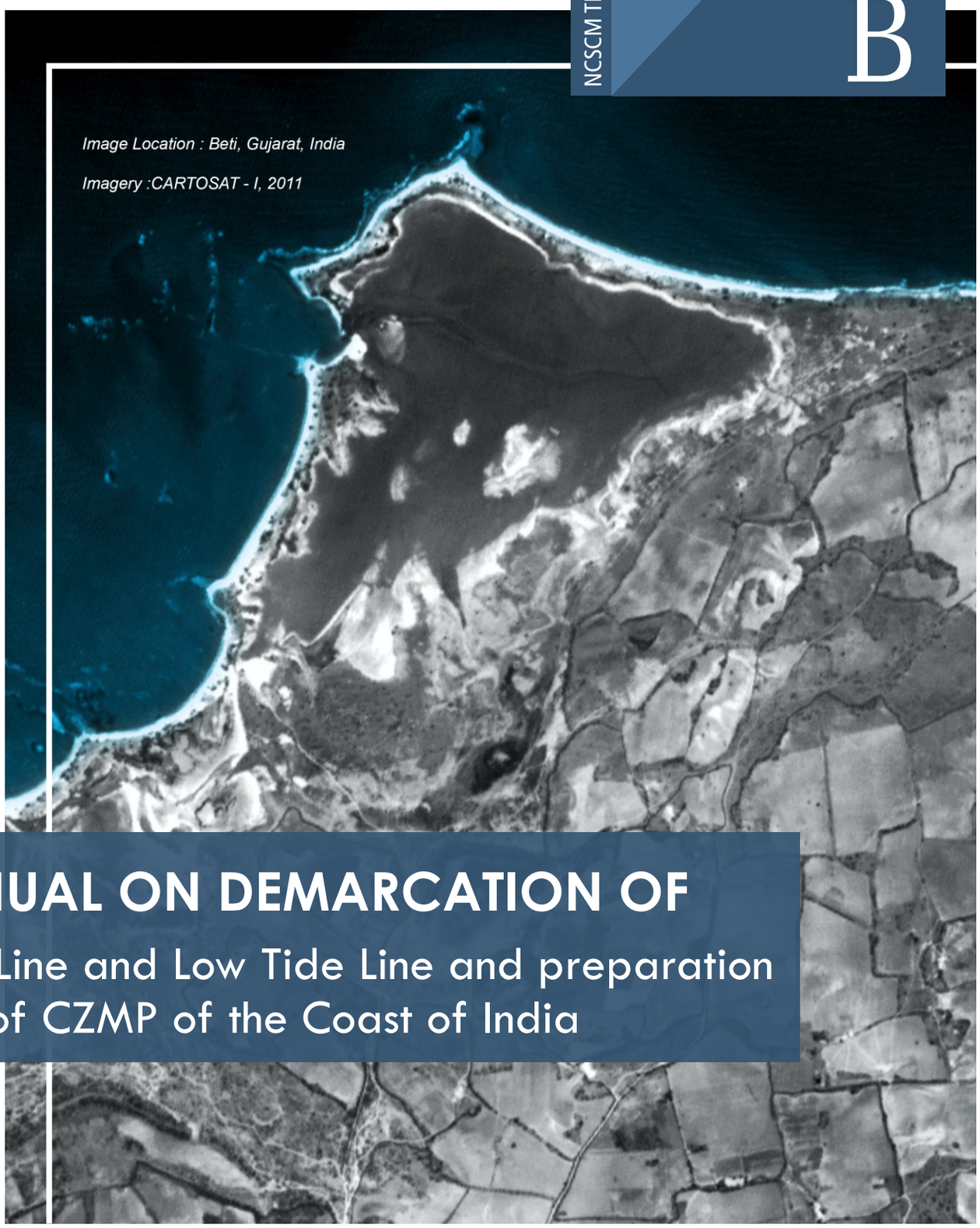
8. Anant Ramkrishna Sinai Dhume, 1986, The Cultural History of Goa (10000 BC to 1352 AD)



--TRUE COPY--

ANNEXURE - C

NCSCM TECHNICAL REPORT SERIES 23 B



MANUAL ON DEMARCATION OF

High Tide Line and Low Tide Line and preparation of CZMP of the Coast of India

2015

Ministry of Environment, Forest and Climate Change

National Centre for Sustainable Coastal Management

Manual on Demarcation of High Tide Line and Low Tide Line and Preparation of CZMP of the Coast of India

Prepared by

The Committee on Standardization of the Methodology for Demarcation of HTL/LTL

1. Chairman, Earth System Science Organization & Secretary, MoES
2. Space Applications Centre, Ahmedabad
3. National Centre for Earth Science Studies, Trivandrum
4. Institute of Remote Sensing, Anna University, Chennai
5. Institute of Environmental Studies and Wetland Management, Kolkata
6. Naval Hydrographic Office, Dehradun
7. National Institute of Oceanography, Goa
8. National Institute of Ocean Technology, Chennai
9. National Centre for Sustainable Coastal Management, Chennai

Contents

Preface

The Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India has taken several policy initiatives and enacted environmental and pollution control legislations towards sustainable management of natural resources. One such initiative is the Coastal Regulation Zone (CRZ) Notification issued on 06.01.2011 under the provisions of Environment (Protection) Act, 1986. The Notification declares the coastal stretches of India and the water area up to its territorial water limit (excluding the islands of Andaman and Nicobar and Lakshadweep and the marine areas surrounding these islands up to its territorial limit), as Coastal Regulation Zone. This Notification regulates establishment and expansion of any industry, operations or processes and manufacture or handling or storage or disposal of hazardous substances in the CRZ, with a view to ensuring livelihood security to the fisher communities and other local communities living in the coastal areas, as well as to conserve and protect coastal stretches and its unique environment. It promotes development through sustainable manner based on scientific principles taking into account the likely impact of natural hazards in the coastal areas and sea level rise due to global warming.

The CRZ Notification 2011 is defined with reference to two coastal baselines: i) the landward baseline or the High Tide Line and ii) the seaward baseline or the Low Tide Line. These lines have been drawn by authorized agencies of the MoEF&CC. However, these agencies have used diverse methods, which resulted in variations in demarcation of these lines. Hence it became imperative to ensure uniformity in the precise demarcation of HTL/LTL and achieve desired accuracy levels.

This Manual is now being brought out by MoEF&CC, Government of India as part of the continued efforts of the Ministry to ensure standardization and uniformity in methodology and procedures for delineation of HTL and LTL. The Manual has been designed to cover the whole range of issues such as standardization of the methodology for demarcating HTL, LTL, mapping of CZMPs, standardize the classification system and definitions for tidal wetlands and coastal landforms and use of aerial photographs and satellite imagery for mapping and development of a coastal database. It is hoped that the authorized agencies, project proponents, consultants, regulatory authorities and the coastal community in general will find this Manual useful.

I wish to thank the Ministry of Environment, Forests and Climate Change, Government of India for this initiative to harmonize the methodology for the delineation of baselines. I am grateful to all Committee Members for their support and useful interaction.

Dr. Shailesh Nayak
Chairman, Earth System Science Organization & Secretary, MoES
Government of India

Acknowledgement

On behalf of the Committee for Standardization of the Methodology for Demarcation of HTL/LTL, the following members of the Committee, experts and invitees whose names are listed below, are acknowledged for their technical expertise and contributing to the proceedings of the Committee and for reviewing the draft HTL Manual.

Members / Representatives of Authorized Agencies:

1. Dr. A.S. Rajawat, Head, Geosciences Division, SAC, Ahmedabad
2. Dr. K.V. Thomas, Head Marine Sciences Division, NCESS Trivandrum
3. Dr. S.S. Ramakrishnan, Director IRS, Anna University, Chennai
4. Dr. Debajyoti Bhowmik, IESWM, Kolkata
5. Cdr. Anirban Banerjee, NHO, New Delhi
6. Dr. A.K. Chaubey, Chief Scientist and Scientist-in-Charge, NIO-RC, Mumbai
7. Dr. M.A. Atmanand, Director, NIOT, Chennai
8. Dr. R. Ramesh, Director, NCSCM, Chennai

Invitees:

1. Dr. M. Baba, Former Director, NCESS, Thiruvananthapuram
2. Dr. Anjali Bahuguna, Environment Consultant, Ahmedabad
3. Dr. A. Senthil Vel, Additional Project Director, SICOM, MoEF&CC, New Delhi
4. Dr. Purvaja Ramachandran, Scientist-G, NCSCM, MoEF&CC, Chennai
5. Mr. M. Dharma Raj, Senior Consultant, NCSCM, Chennai
6. Dr. Badarees K.O. Scientist-D, NCSCM, MOEF&CC, Chennai
7. Mr. S. K. Sinha, Director, Survey of India
8. Mr. G. Varun Kumar, Survey of India

We are also thankful to Dr. M. Baba, Dr. A S Rajawat and Dr. Anjali Bahuguna in particular for agreeing to our request to provide their expert inputs in the preparation of the HTL Manual and for attending many additional meetings in NCSCM, Chennai, at short notices, for reviewing the draft manual.

Sincere thanks are due to the Director SAC, Ahmadabad and Dr. A S Rajawat Head, Geosciences Division, SAC, Ahmedabad, for providing their primary data along with detailed reports of National Wetland Atlas and Coastal Zone Information System (CZIS) to NCSCM, Chennai to carry forward the work on HTL, LTL, ESA and mapping of CRZ, under the ICZM project.

Dr. R. Ramesh
Member Convener

Dr. Shailesh R. Nayak
Chairman

List of key abbreviations

CRZ	Coastal Regulation Zone
CVCA	Critically Vulnerable Coastal Areas
CZM	Coastal Zone Management
CZMP	Coastal Zone Management Plan
DEM	Digital Elevation Model
DTM	Digital Terrain Model
ESA	Ecologically Sensitive Areas
GIS	Global Positioning System
GIS	Geographic Information System
HTL	High Tide Line
ICRZ	Island Coastal Regulation Zone
ICZMP	Integrated Coastal Zone Management Plan
IMD	India Meteorological Department
IMP	Integrated Management Plan
IMSL	Indian Mean Sea Level
IOM	Institute for Ocean Management
IRS	Indian Remote Sensing
IRS	Institute of Remote Sensing
IESWM	Institute of Environmental Studies and Wetland Management
LISS	Linear Imaging Self-Scanning Sensor
LTL	Low Tide Line
LWL	Low Water Line
MoEF&CC	Ministry of Environment, Forests & Climate Change
NCESS	National Centre for Earth Science Studies
NCSCM	National Centre for Sustainable Coastal Management
NHO	National Hydrographic Office
NIO	National Institute of Oceanography
NIOT	National Institute of Ocean Technology
NRSC	National Remote Sensing Centre
OSM	Open Series Map
RMSE	Root Mean Square Error
SAC	Space Applications Centre
SoI	Survey of India
UT	Union Territory
UTM	Universal Transverse Mercator
WGS	World Geodetic System

Executive Summary

The National Coastal Zone Management Authority (NCZMA) in its meeting held on 25th June 2013 constituted a committee under the Chairmanship of Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences (MoES), Government of India, with seven authorized agencies as members and Director, National Centre for Sustainable Coastal Management (NCSCM) as Member Convener, to standardize the methodology for demarcation of HTL/LTL. Accordingly, the Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India, constituted the said Committee, on 11 April 2014.

The following were the Terms of Reference (ToR) of the Committee.

i. To review/ evolve uniform guidelines/ methodology for demarcation of HTL/LTL.
ii. To suggest the format of the report on HTL/LTL demarcation, including map of 1:4000 scale with coordinates, land features, etc.
iii. To prescribe the time schedule for demarcation of HTL/LTL.
iv. To prescribe cost for demarcation of HTL/LTL.

The Committee discussed the ToRs in detail during several sittings and recommended concrete methods for mapping of the HTL and LTL. Since the MoEF&CC has already acquired high resolution aerial photographs of the entire coastline during 2011-12 as part of the ICZM Project through the Survey of India (SoI), the Committee felt it prudent to utilize this information for the demarcation of HTL and LTL. Hence the Committee recommended NCSCM to undertake the demarcation of HTL and LTL to achieve uniformity in mapping and to achieve required accuracy. It was decided that the tidal data, orthophotos and Digital Elevation Model (DEM) available with SoI will be utilised by NCSCM to undertake the demarcation within a limited period. In areas where orthophotos are unavailable (gap areas), the Committee recommended the use of the high resolution remote sensing data from Indian satellites of the same period.

The Committee recommended that the digital data of HTL and LTL, along with base maps covering the entire coastline of mainland India will be provided by NCSCM to the authorized agencies for the preparation of the CZMPs. This manual provides the methodology for demarcation of the HTL and LTL by NCSCM and preparation of CZMPs by the authorized agencies.

Accordingly, the Committee held two meetings in New Delhi and Chennai to finalise the manual on Demarcation of High Tide Line and Low Tide Line & Preparation of CZMP of the Coast of India.

The Committee, based their deliberations on the fact that the Coastal Regulation Zone (CRZ) Notification 2011 is defined with reference to the coastal baselines - the landward baseline or the High Tide Line (HTL) and the seaward baseline or the Low Tide Line (LTL). Such baselines represent the intersection of the coastal surface with a particular tidal datum plane/ elevation. Delineation of these boundaries is challenging due to complexities of the coast, various uncertainties such as unavailability of accurate tidal data or the use of improper survey methods making the precise marking of the physical boundary line along the coast a complex task. Nevertheless, it is a fundamental requirement to have an accurate coastal baseline for the implementation of CRZ 2011 and the various setbacks prescribed therein. Delineation of these coastal baselines is also vital for effective coastal zone management.

In order to effectively address the issues more specifically in the ToR, the Committee has designed specific sub-tasks for ToRs **i** and **ii** as follows:

i. Review/ evolve uniform guidelines/ methodology for demarcation of HTL/LTL

a. Standardize the methodology for demarcating HTL, LTL and mapping of CZMPs;

b. Standardize the classification system and definitions for inventorying the different features such as tidal wetlands and coastal landforms;

c. Use of aerial photographs and satellite imagery (2011) for mapping

d. Development of a coastal database

ii. Suggest the format of the report on HTL/LTL demarcation including map of 1:4000 scale with coordinates, land features

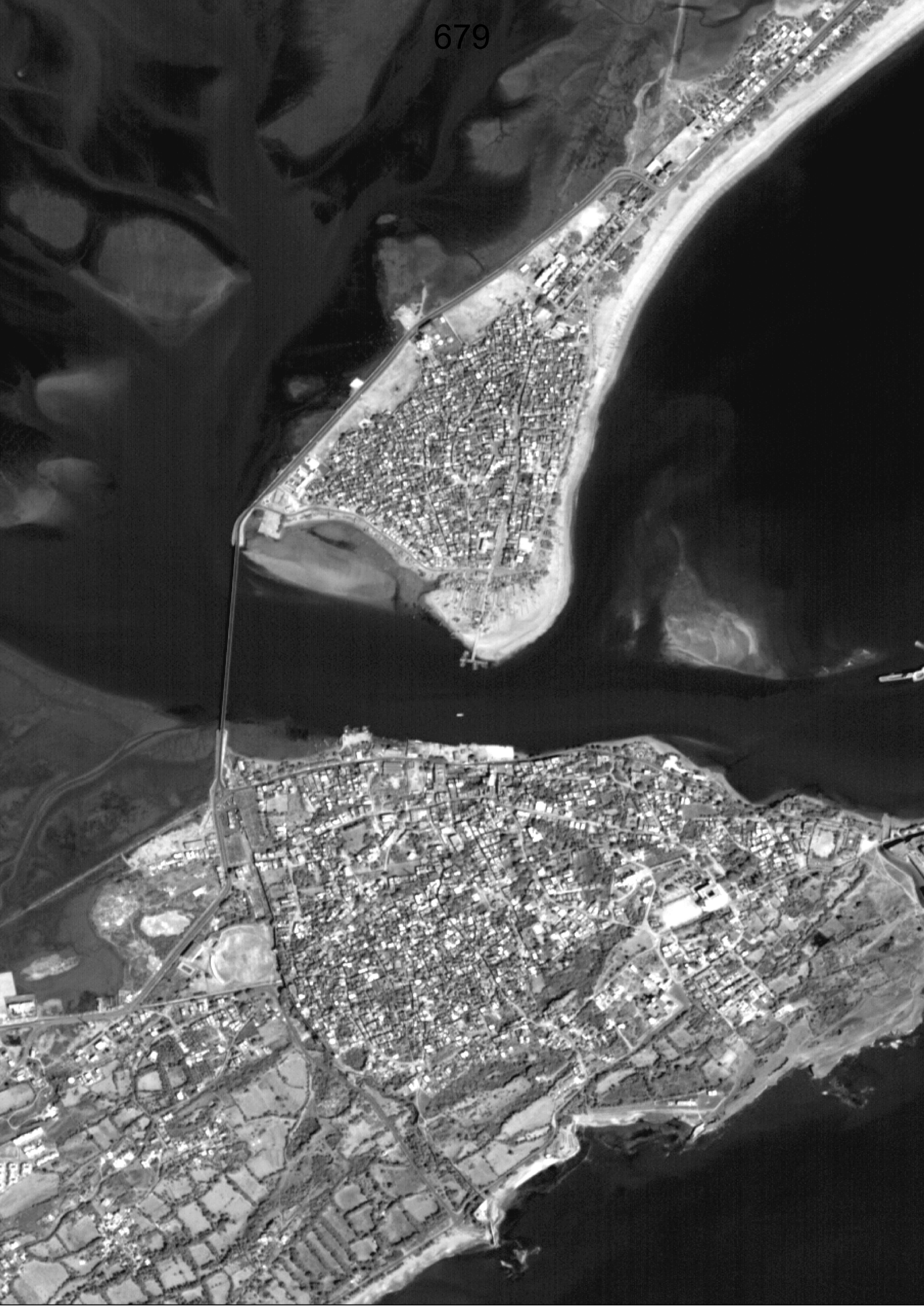
a. Achieve uniformity in output with respect to the content, format, legend, colour scheme in the maps;

b. Suggest the format of the 'report on HTL/LTL demarcation' with co-ordinates, land features, and so on;

iii. Prescribe the time schedule for demarcation of HTL/LTL

iv. Prescribe the cost for demarcation of HTL/LTL

The Manual contains detailed guideline/ methodology for each of the above tasks, which have been given as separate chapters/ sections, to serve as a guide to the authorized agencies in the preparation of CZM Plans. The manual also contains definitions of specific terms related to the contents of the manual in the main text, a general glossary (Annex 1) of all associated terms, image interpretation and coastal land use / land cover classification systems and positional & classification accuracy specifications.



1. Introduction

The Coastal Regulation Zone (CRZ) Notification 2011 is defined with reference to the coastal baselines - the landward baseline or the High Tide Line (HTL) and the seaward baseline or the Low Tide Line (LTL). Such baselines represent the intersection of the coastal surface with a particular tidal datum plane/ elevation. The precise delineation of these boundaries is challenging task due to complexities of the coast, various uncertainties such as unavailability of accurate tidal data or the use of improper survey methods. Nevertheless, it is a fundamental requirement to have an accurate coastal baseline for the implementation of CRZ and the various setbacks prescribed therein. The delineation of these coastal baselines is vital also for effective coastal zone management.

Hence, the purpose of this manual is two-fold:

i. To provide recommendations for an acceptable clarity to the HTL and LTL, based on which the boundaries of the CRZ 2011 Notification are determined and

ii. To provide the baselines and guidelines to coastal managers on the methods of applying this for the preparation of Coastal Zone Management Plans (CZMPs).

1.1 Requirements of CRZ 2011 Notification

For the implementation of CRZ 2011 Notification the HTL/LTL need to be demarcated in the CZMP. These baselines are also required for the following purposes:

- Mapping of Ecologically Sensitive Areas (ESAs) including preparation of Integrated Management Plans (IMPs)
- Delineation of CRZ-I, CRZ-II, CRZ-III and CRZ-IV for CZMP
- Demarcation of hazard line along the entire coast of India taking into account erosion and flooding of the coast.
- Preparation of Island Coastal Regulation Zone (ICRZ) and Integrated Island Management Plans (IIMP) as per the Island Protection Zone 2011 Notification.

1.2 Demarcation of HTL and LTL

As per the CRZ 2011 Notification, demarcation of HTL and LTL will be undertaken by one of the agencies authorized by MoEF&CC and marked on the Coastal Zone Management (CZM) Maps of 1:25,000 scale and cadastral scale, the latter for local level regulations. Local level CZM Maps on cadastral scale are for the use of local bodies and other agencies to facilitate implementation of the CRZ. The eight agencies authorized by MoEF&CC who are mapping HTL/LTL are adopting different methods resulting in some variations in the accuracy levels. Hence it is necessary to establish uniformity and accuracy levels required in the mapping of

HTL/LTL.

1.3 Objectives of the Manual

In order to effectively address the issues more specifically in the ToR, the Committee has designed specific sub-tasks for ToRs 1 and 2 as follows:

i. **Review/ evolve uniform guidelines/ methodology for demarcation of HTL/LTL**
   a. Standardize the methodology for demarcating HTL, LTL and mapping of CZMPs;
   b. Standardize the classification system and definitions for inventorying the different features such as tidal wetlands and coastal landforms;
   c. Use of aerial photographs and satellite imagery (2011) for mapping and
   d. Development of a coastal database

ii. **Suggest the format of the report on HTL/LTL demarcation including map of 1:4000 scale with coordinates, land features**
   a. Achieve uniformity in output with respect to the content, format, legend, colour scheme in the maps;
   b. Suggest the format of the 'report on HTL/LTL demarcation' with co-ordinates, land features, and so on;

iii. **Prescribe the time schedule for demarcation of HTL/LTL**

iv. **Prescribe the cost for demarcation of HTL/LTL**

1.4 Approach

The Ministry of Environment, Forests & Climate Change (MoEF&CC), Government of India had constituted a committee for the preparation of this manual / guidelines. The committee discussed the objectives in detail and came out with concrete suggestions for the mapping of HTL and LTL. Since the MoEF&CC has already acquired high resolution aerial photography of the entire coastline during 2011-12 as part of the World Bank ICZM Project through the Survey of India (SoI) it will be expeditious to utilise this information for the demarcation of HTL and LTL. Hence the committee recommended that the demarcation of HTL and LTL may be carried out by the National centre for Sustainable Coastal Management (NCSCM) for achieving uniformity and for maintaining accuracy. It was decided that the tidal data, orthophotos and Digital Elevation Model (DEM) available with SoI will be utilised by NCSCM to undertake the demarcation within a limited period. Wherever there are gaps in aerial photographs or if aerial photos are not of good quality; high resolution remote sensing data from Indian satellites

of the same period will be utilised for this purpose. The digital data of HTL and LTL along with base maps covering the whole coast line will be provided by NCSCM to the authorized agencies for the preparation of the CZMPs. Since there should be uniformity in the CZMPs prepared by the authorized agencies the committee recommended that guidelines need to be provided to them for the same along with the HTL and LTL information. Thus this manual provides the methodology for demarcation of the HTL and LTL and preparation of CZMPs by the authorized agencies. A glossary of terms relevant to the preparation of CZMPs is given in Annex – 1.

2. Guidelines/ Methodology for Demarcation of HTL/LTL

2.1. Background

The Coastal Regulation Zone (CRZ) Notification 2011 defines the **H**igh **T**ide **L**ine (HTL) as '***the line on the land up to which the highest water line reaches during the spring tide***'. It is pertinent to note that in this definition the HTL depends on 'the spring tide' and the '***highest water line***'. Since high water levels during the spring tides vary over a period of 18.6 years, which is known as a Tidal Epoch, the HTL can be derived from the long-term data. However, it is known that the tides leave their distinct signatures in the form geomorphic formations on the coast and they can be easily recognized in aerial photographs or high-resolution satellite images.

The **L**ow **T**ide **L**ine (LTL) is the lowest water line during the spring tides. However, unlike in the case of HTL the signatures left by the low tides are not easily discernable in aerial photograph and satellite images, it would be expedient to utilize the available long-term tidal data and the DEM generated for the demarcation of LTL.

The CRZ 2011 Notification requires the HTL and LTL to be demarcated in the tidal influenced water bodies like estuaries, creeks, rivers, backwaters, etc. For the upper limit of tidal influence in these water bodies the committee recommended aerial photos/ satellite images to be used along with the approved CZMPs.
The following accuracies (Table 1) shall be achieved for HTL/LTL and for the spatial information in the CZMPs:

Table 1: Accuracies for HTL/LTL and for the spatial information in the CZMPs

S.No.	Map Scale	Planimetric / Positional Accuracy	Thematic / Classification accuracy
1.	1: 25,000	Accuracy for HTL and LTL demarcation: 1m and 2m respectively	90 % classification accuracy at 90 % confidence interval
2.	1: 4,000		90 % classification accuracy at 90 % confidence interval
3.	1: 1,000		NA

Accuracy for CZMP using satellite imagery: 5m

2.2. Demarcation of HTL Using Aerial Photograph

A Memorandum of Understanding was signed in May, 2010 between the Ministry of Environment and Forests (MoEF) and Survey of India (Department of Science and Technology), for mapping, delineation and demarcation of the hazard line along India's coast. The process involves, among others, Digital Aerial Photography at 9cm GSD and photogrammetric surveys for preparation digital terrain model at 0.5m elevation contour map on 1:10,000 scale as base map to delineate the Hazard Line for the entire mainland coast of India up to the maximum width of 7 km from shore line on the landward side. Generation of Ortho photographs have been made at 10 / 30 cm ground spatial distance, for the entire mainland coast. The mainland coast of India is divided into 8 (eight) blocks. The objective is to delineate, map and benchmark the coastal hazard line all along the mainland coast of India under the "Integrated Coastal Zone Management" (ICZM) project.

For the purpose of delineation of High Tide Line these high-resolution aerial photographs (stereo/ ortho images) render themselves highly suitable for direct visual/ on¬screen interpretation. For this purpose ortho photos, stereo images and DEMs are already archived in Hyderabad and Bangalore centers of SoI. The following are the steps by which the deliverables of digital photogrammetry such as DEM, ortho image, stereo/ 3D feature datasets, contours and so on are derived from a set of stereo aerial photographs covering a project area:

a. establishing block control by field GPS surveys and levelling;
b. aerial triangulation and block adjustment;
c. DEM collection and processing and contour generation and
d. ortho image production.

2.2.1 Image Interpretation

The ortho photos shall be used for interpretation of HTL line considering the various geomorphic units and photographic interpretation elements. The basic elements which aid in identifying such objects on aerial photographs are tone, size, shape, texture, pattern, shadow, site and association (Jensen, 2000).The various geomorphic units such as berm crest, cliff, head land, line of permanent vegetation are to be considered while demarcating the HTL line on the shore.

2.3. Demarcation of HTL Using Satellite Imagery

Though the HTL would be demarcated using aerial photographs. However, in areas wherever there are gaps in aerial photographs or if aerial photos are not of good quality; high resolution remote sensing data from Indian satellites of the same period will be utilised for this purpose. Primarily, the Indian Remote Sensing (IRS P6) satellite, Resourcesat 1&2 LISS-IV and Cartosat (1&2) digital data of 2011 are to be used. Salient characteristics are given in Table 2.

Table 2: Salient characteristics of Resourcesat LISS-IV 1&2 and Cartosat 1&2

S. No	Satellite	Sensor	Spectral bands (µm)	Spatial resolution (m)	Swath	Radiometry	Repeat cycle (days)
1	Resorcesat - 1/2	LISS IV (multispectral)	0.52–0.59 0.62–0.68 0.77–0.86	5.8	23.9 km MX and 70.3 km in mono mode	Res-1: 7 bits Res-2:10 bits	5 days sampler
2	Cartosat-1	Panchromatic (Fore +26°, Aft -5°)	0.50–0.85	2.5	30 km	10 bits	5 days
3	Cartosat-2	Panchromatic	0.50–0.85	0.8	9.6 km	10 bits	3 days

The LISS IV sensor with multispectral capability in visible and IR bands and ground resolution of 5.8 m gives us spectral and spatial capabilities to interpret the coastal land use/ land cover classes considerably up to Level III and Cartosat 1&2 Panchromatic data with ground resolution up to 2.5 and 0.8 m give details on coastal land use/land cover classes. LISS-IV and PAN merged digital precision products provide required digital enhancement for improved interpretation.

Cloud free satellite data during low tide conditions should be selected so that demarcation of HTL/LTL can be easily carried out. The selection can be done using tide tables available from the SoI. These tide tables enlist predicted time and height at low and high water periods and are published for the entire Indian coast every year. The tide tables, in conjunction with the satellite calendar, can help in selecting the imagery of low-tide conditions, if required tidal conditions for the secondary ports can be calculated.

The reproductive cycle of the vegetation present in the wetland areas should be taken into account for the selection of data. Mangroves are evergreen (perennial) plants, but algal growth on rocks, reefs, and so on is seasonal (occurs from October to February under favourable conditions, and senescence takes place in April). Owing to this, the images of the period from October - March (2010-12) should be selected (Nayak et al., 1991; Joseph, 2003)

Satellite data pre-processing involves georeferencing, ortho-rectification, image fusion and seamless mosaic generation. Georeferencing and image rectification involves removal of random and systematic errors in the image and transforming image to UTM projection system and WGS-84 datum. About 4–5 well-distributed GCPs for each image are used for georeferencing. The image is rectified using GCPs in first-order polynomial transformation with RMSE ***xy*** accuracy better than 1 pixel at each checkpoint. The relief distortions are rectified by ortho-rectification of the image using standard procedures available in the image-processing software.

The removal of relief distortion is followed by image fusion, which is used to combine different images with complimentary information into one single composite. The image fusion is required to obtain both high-spatial and high-spectral resolution. Standard PAN-sharpening techniques available in the image-processing software packages are used to merge the co-registered high-resolution panchromatic data with the multispectral image. In case, the coastal region is covered in more than single image, a single seamless mosaic is generated and image interpretations are carried out.

2.3.1 Image Interpretation

Interpretation of satellite image for demarcating HTL and LTL should be carried out using the following steps:

a. preparation of Image interpretation key;
b. preliminary interpretation;
c. modifications and
d. final interpretation.

Image interpretation is carried out using basic elements of visual interpretation such as tone/colour, size, shape, texture, pattern and association. Using these elements, various wetland/ land use features have to be identified and interpreted based on the image interpretation key (Annex 2). Image interpretation key helps to organize the information present in the image form and guides in arriving at correct identification of unknown objects. The image interpretation key originally developed for mapping coastal wetland coastal land use inventory was suitably modified to include additional coastal features (Nayak et al., 1991, 1992).

2.4. Identification of HTL using geomorphological features in aerial photographs and satellite images

Typical geomorphologic features which are discernible in aerial photographs and satellite images can be used for HTL demarcation; e.g. berms, cliffs, sand dunes, headlands, etc. Other features like line of permanent terrestrial vegetation, upper limit of mangroves and flotsam are indicators of the reach of tide into land. Coastal protection structures such as seawall, embankment, bunds and revetments also limit the intrusion of tide and can be easily detected in images. Such features are time tested to withstand the onslaught of the highest of the high spring tides. Hence, HTL (line of maximum reach of tide into the land during spring tide) can be demarcated with respect to these features and tied to the reference points, as detailed below.

The following signatures/ geomorphologic/ man-made structures (Figs. 1 to 9) used to demarcate the HTL are explained below through suitable illustrations.

Berm Crest: Berm is the nearly-horizontal deposition of materials by wave action at the time of high tide. Some beaches have no berms, others have one or several. HTL will be the most landward crest of the berm (monsoonal) in the case of wide sandy beaches. Since the tidal waters do not reach the coast beyond this landward berm crest, it may be demarcated as the HTL (Fig. 1).

Fig 1: HTL – Landward monsoonal berm crest.

Permanent terrestrial vegetation: There are several locations which do not have any berm or have only one berm, and the beaches undergo severe erosion during the monsoon. In such cases, permanent vegetation, particularly well-grown coconut trees, casuarina plantation or terrestrial shrubs, which are the main vegetation prevalent along the Indian coast, can be used as an indicator. Permanent vegetation is distinctly seen on images and is easy to interpret and its boundary towards sea shall be used as HTL (Fig 2).

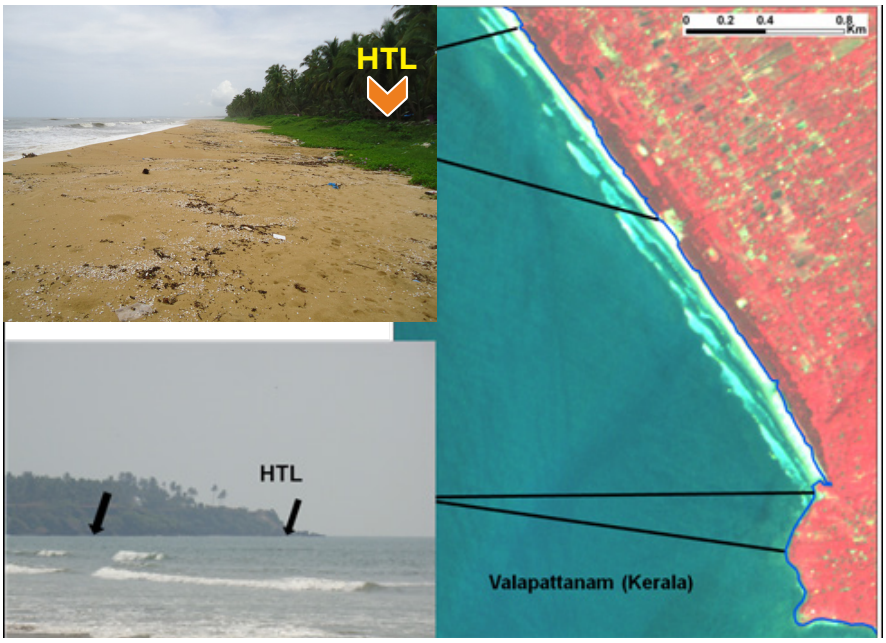


Fig 2: IRSLISS IV image showing parts of the Kerala coast and its field photo. HTL demarcation of rocky cliff at promontory and permanent vegetation along sandy beach

Coastal sand dune / paleo-aeolian dune: Coastal sand dunes are ridges or a series of ridges that form at the rear of the beach. Sometimes sand dunes are covered with vegetation. If the vegetation is present then the seaward limit of vegetation boundary is considered as HTL. For eroding dunes, the toe of the foreshore face of dune is considered as HTL (Fig. 3).

Fig. 3: Toe of the dune as HTL

Cliff / Rocky Headlands: At the rock outcrops, headlands, cliffs or other elevated coastal stretches, the sea face is steep and the water is quite deep, so virtually there is no spatial displacement in the water line. This land–water boundary is easy to identify on images. However, at the eroding cliff, the latest position of the toe shall be used (Fig. 4).

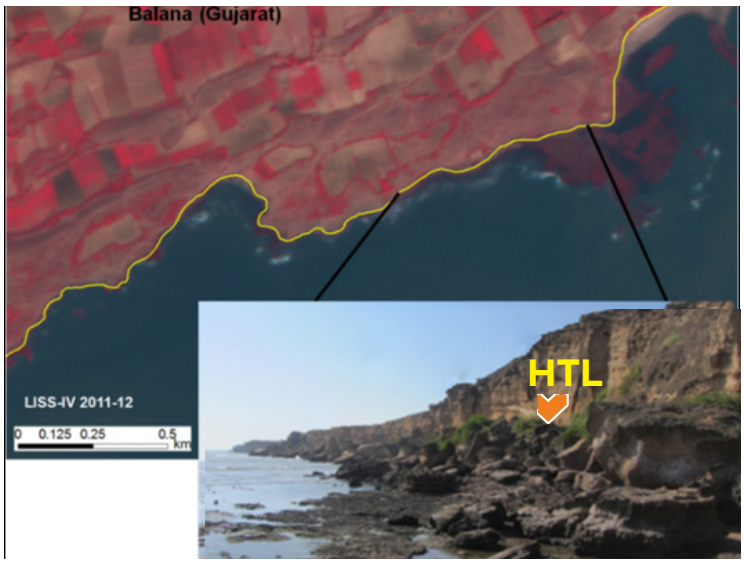


Fig 4: IRS LISS IV image showing parts of the Saurashtra coast with field photo. Toe of rocky cliff as HTL.

Seawall/ Embankment: In highly erosion-prone areas, generally seawalls/ revetments/ embankments/ bunds are constructed to protect the coast. During the monsoon season, a majority of these areas are devoid of beaches. The waves impinge upon the seawall during the monsoon season, especially during the high tide. Thus, they are 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 side should be considered as the HTL. At places there may be two or three lines of seawalls, in such cases, the landward-most seawall should be considered; however, care should be taken to select a seawall up to which the highest high-tide water reaches. Landward limit of seawall/ embankment is considered as the HTL (Fig. 5).

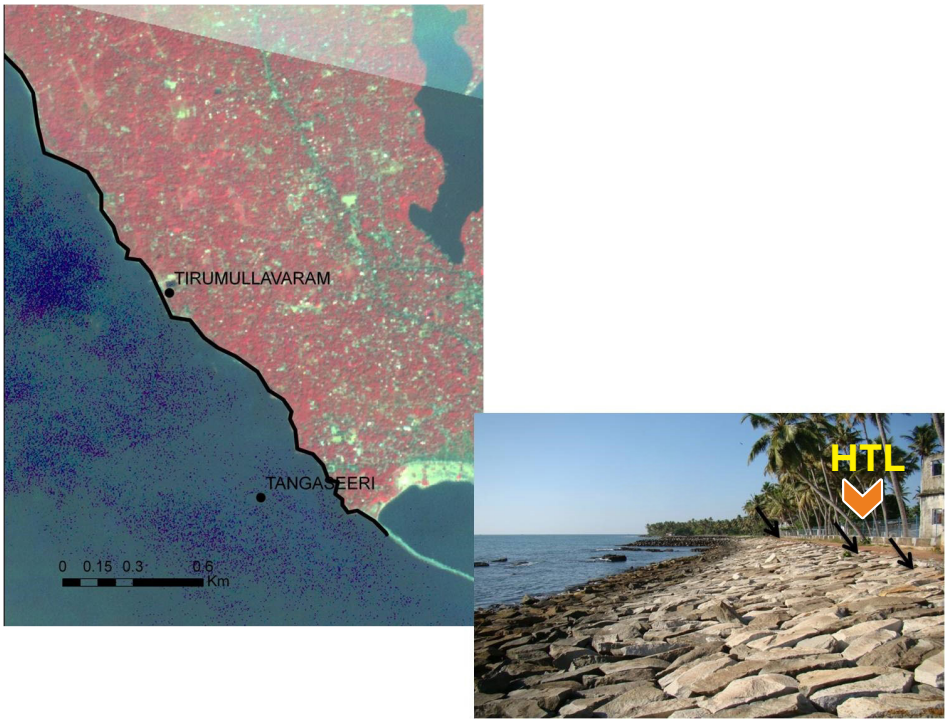


Fig 5: IRSLISS IV image showing parts of the Kerala coast and field photo. HTL depicted landward boundary of seawall.

Flotsam: Floating materials on the sea surface are deposited on the beach forming one or several lines, depending on the seasonal variations of the wave climate and tidal positions. HTL is demarcated by more or less continuous landward deposit of flotsam on the coast (Fig. 6).

Fig 6: Location of HTL between monsoonal debris and landward of daily debris deposits

Mangroves: These are evergreen, tropical coastal tidal plants/ trees occurring in the intertidal zone, bays, estuaries, deltas, lagoons, creeks or any low energy zones of the coast. Landward boundary of mangrove to the extent where tidal water reaches, is considered as the HTL (Fig. 7).

Fig 7: Landward boundary of mangrove as HTL.

Mudflat/ tidal flat: Mudflats/ tidal flats are formed by fine-grained silt and clay in a medium to- large tidal environment. They have a fairly large intertidal zone, fringed by euryhaline vegetation and may or may not be interlaced with individual mangroves or creeklets. In such cases, HTL can be demarcated as the line of permanent stenohaline terrestrial vegetation/ bund/ road/ embankment (Fig. 8).

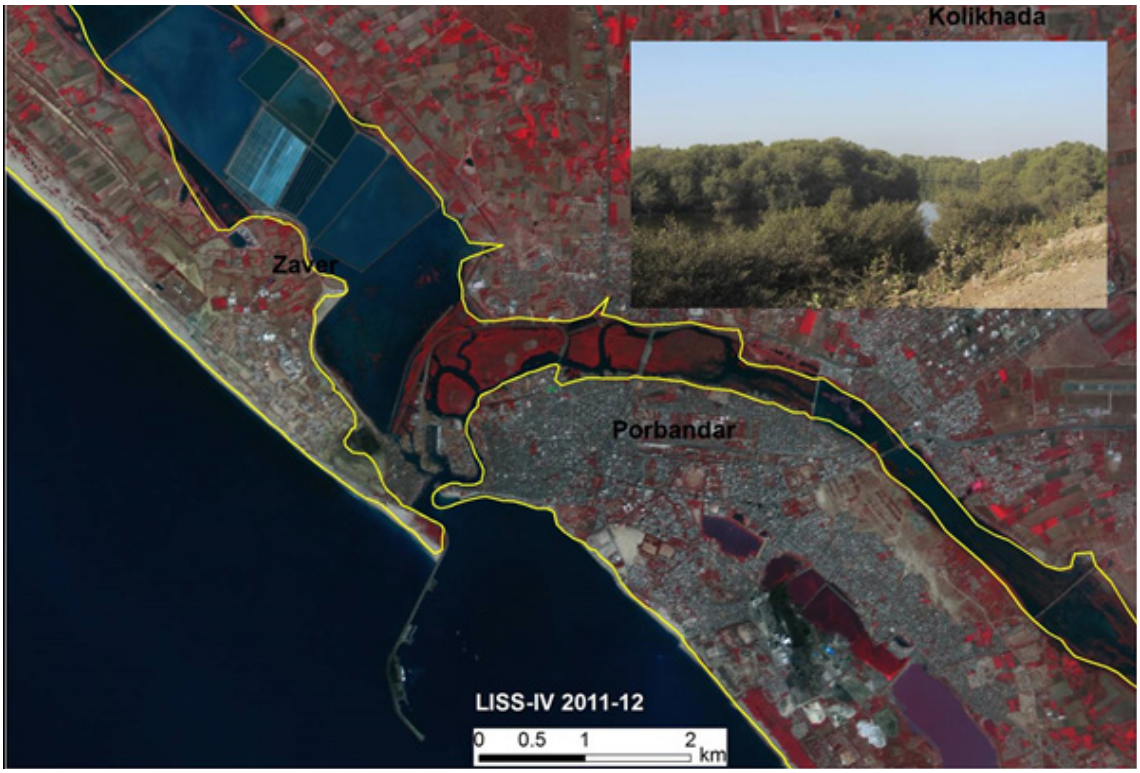


Fig 8: IRS LISS IV image showing parts of the Saurashtra coast, Gujarat and its field photo. HTL demarcation is on the basis of tonal discontinuity, natural salt pans, landward side of mangroves, land–water boundary and boundary of urban built up area towards creek/sea.

Other geomorphic/land cover features

Some coasts have a fairly large inter-tidal zone fringed by vegetation or coastal alluvial plain. In such cases, the HTL is demarcated using tonal differentiation between clayey or silty clay region along with salt encrustation up to supra-tidal mudflat and adjoining sandy alluvial plain. Other geomorphic/ land cover features such as marshes, mangroves, fringing corals, saltpans, aquaculture ponds, seaward side of agricultural/ horticulture land and so on are also used for some of the coastal regions.

2.5. Demarcation of LTL using Tide Data and DEM

There are two components involved in demarcating the low tide line:

- The tidal datum, i.e., Low Tide Level and
- The intersection of the tidal datum with the topography of the coast.

India, with a coastline more than 7500 km (including the islands), tidal variations

are not uniform. Hence it is necessary to take these variations into account while demarcating LTL. The tidal datum will be related to topography of the coast using the most recent survey data provided by the SoI in a GIS environment as a Digital Terrain Model (DTM). The topography used in the DTM will be related to the Indian Mean Sea Level (IMSL) by the SoI and thus will coincide with the datum referred to by the tidal data. Intersection of the horizontal plane representing the tidal datum with the DTM can be carried out in a GIS environment to demarcate LTL.

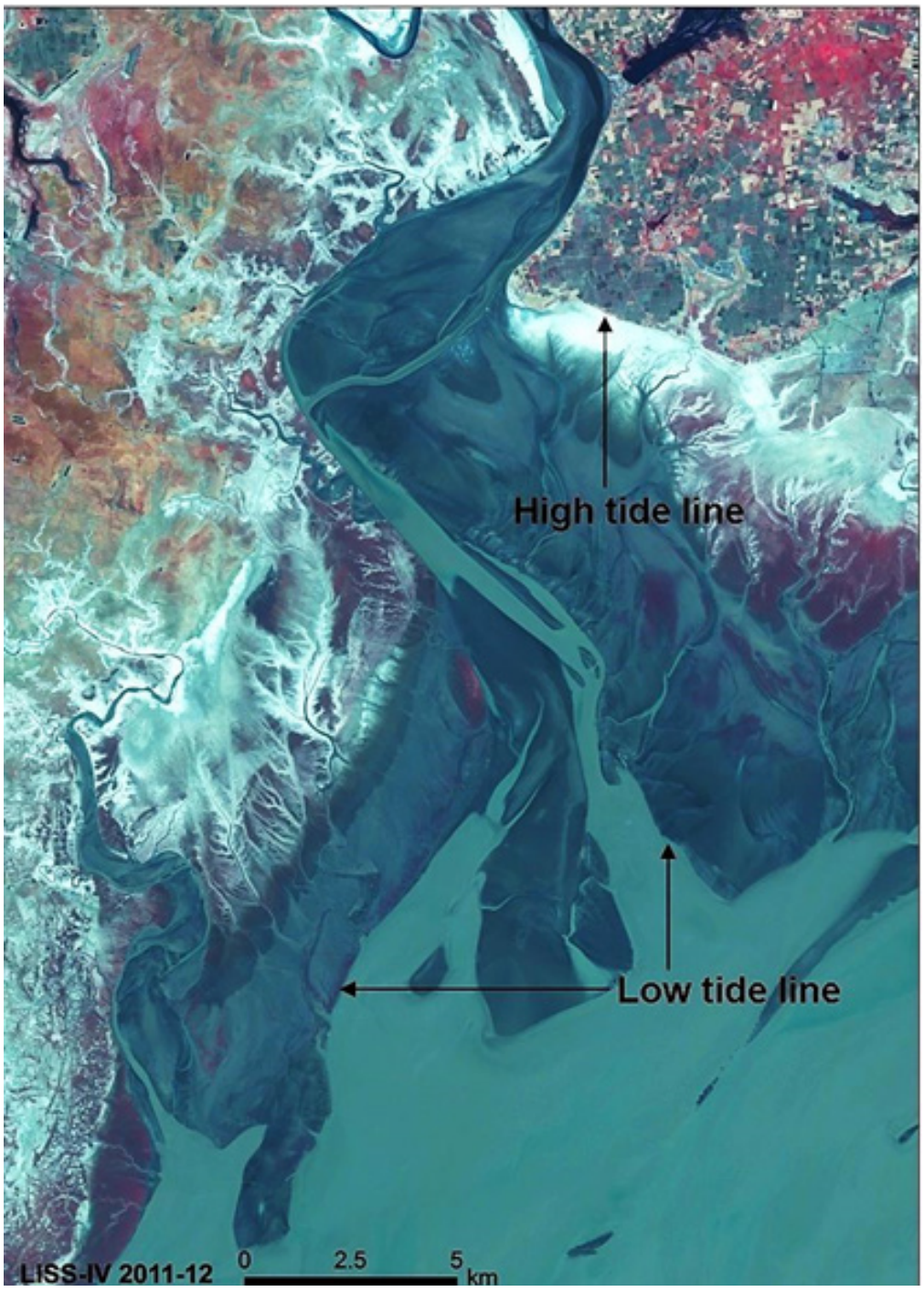


Fig. 9: Low Tide Line (LTL) near Rahtalav, Ahmedabad, Gujarat

The Survey of India has analyzed tidal data for the entire set of 21 primary ports (where tide gauge data for more than 10 years is available are named primary ports) and 131 secondary ports (where tidal data of less than one year is available). Wherever data gaps are there the LTL can be demarcated using high resolution satellite images as illustrated in Fig. 9. In such cases the Low Water Line (LWL) available in the topographical maps is transferred to the base map as such. This could be corrected from the satellite imagery by identifying the shoreline position during fair weather when the beaches have maximum width. The imagery could be selected for a spring tide low. The land (beach)–sea boundary being one of the most distinguishable lines in the imagery, corrections can be done without much difficulty. Inlets (openings of river to the sea) being dynamic features do not conform to their base map positions. All the changes in their position, as obtained from the satellite imagery are to be incorporated. The information obtained during any coastal survey can also be made use of.

2.5.1 Methodology for Calculating Low Tide Level and Demarcation of Low Tide Line (LTL)

Low Tide Levels at transect points at 250 m intervals along the coast will be interpolated using the data from nearest primary/secondary ports on both sides by direct linear interpolation method. Low Tide Level can then be delineated by plotting these levels at the various transect points taken at the above intervals on the high resolution DEM. Tidal data are obtained at centimetre level accuracies. The optimum resolution recommended for the DEM on which the tide levels would be plotted is 0.1 m contour interval. The horizontal accuracy of demarcated LTL should be ±2 m.

2.6. HTL/LTL provided by NCSCM

A shapefile containing HTL and LTL along with their coordinates will be provided by NCSCM to the authorized agencies for the preparation of CZMPs. As explained above, the data on the position of HTL and LTL at 1 m interval with its coordinates are generated. The shapefiles of HTL and LTL with essential control points will be generated based on SoI 1:25000 OSM (WGS84 datum and UTM projection) toposheets. The authorized agencies will be provided with the following:

a. HTL and LTL as features
b. HTL and LTL as coordinates
c. Uniformly distributed essential image control points with ground photos, description of the control points, latitude / longitude and ellipsoidal height.
d. Uniformly distributed essential map control points

3. Guidelines/Methodology for the preparation of CZMP / ICRZ / IIMP

3.1. Introduction

CZMPs in 1:25,000 scale have to be prepared by the concerned coastal states/ UTs on the base map provided by NCSCM with the information on HTL and LTL for the approval of the MoEF&CC as per the CRZ 2011 Notification. For the local level application CZMPs are to be prepared at the cadastral level. There are occasions where for the project approval detailed project level CZMPs superimposing the project details are also required. These are to be prepared by the agencies authorized by the MoEF&CC. For this purpose the committee recommended that each agency will prepare coastal information system for the state or UT on GIS platform. The above CZMPs will be generated from this information system as and when required.

3.2. Development of a coastal database and information System

Coastal Information System refers to GIS applied to the coastal zone for acquiring, storing, organizing, analysing, modelling and managing geospatial data of the coastal zone. This data will be utilised for the purpose of CZMPs / ICRZ / IIMPs and also may be useful for various other applications related to Integrated Coastal Zone Management (ICZM), particularly in the area of

i. hazard management
ii. coastal protection
iii. fisheries
iv. aquaculture
v. tourism
vi. mining
vii. ports and harbour

For the preparation of the CZMPs / ICRZ / IIMPs the following essential details are to be inducted in the information system:

i. NCSCM base layer based on SoI OSM Grid
ii. HTL/ LTL and CRZ categories
iii. Coastal land use and land cover and infrastructures (satellite/aerial)
iv. Administrative Boundaries

v. Cadastral information

vi. Ecologically Sensitive Areas (ESA), Geomorphologically Important Zones and Archeologically Important and Heritage Sites and Critically Vulnerable Coastal Areas (CVCA) (satellite/ aerial)

vii. Hazard Line

In this base layer, which is based on SoI OSM Grid, HTL/LTL details and control points are provided by NCSCM as explained above. The authorized agencies have to create spatial information on coastal land use / land cover and infrastructure from the high-resolution satellite images of 2010-12. The detailed methodology for this is given in the following sections. Additional infrastructure details can also be supplemented from local sources. The information on the administrative boundaries such as district, taluk, village, panchayat, ward, municipality, corporation and such others may be created. The cadastral information such as survey numbers and boundaries, road network, rivers/canal boundary and other infrastructure available has to be generated. The basic approach to be followed for integrating the cadastral information is also explained in this chapter. The information on ESAs, Geomorphologically Important Zones and Archeologically Important and Heritage Sites and CVCA shall be provided by NCSCM and integrated to the system. The hazard line is being mapped by SoI for the whole country and as required in the CRZ Notification has to be obtained from MoEF&CC.

Subsequently in connection with the preparation of ICZMPs whenever required the data on sediment cells, shoreline change and socio-economic data can also be included in the information system. Some activities related to generation of this information are already in progress in NCSCM.

3.3. Definition of Terms

The definitions of the basic terminologies contained in the land use / land cover classification system described in Section 3.4 of this Manual, which is used to generate the coastal information system for CZMPs / ICRZ / IIMPs are given below. Additional terminologies related to coast and in particular CRZ notification are given as glossary in Annex - 1.

Algae: A large and diverse group of autotrophic organisms that range in size from unicellular to gigantic multicellular forms. They contain different types of chlorophyll and obtain food via photosynthetic activities. Unlike plants, they don't have root, stem or leaves. They can move freely or spend life attached to the rocks or sea bottom. Morphologically, they can be classified in couple of level of organisation: colonial, capsoid, coccoid, palmelloid, filamentous and parenchymatous types. Algae can reproduce asexually, via simple cellular division, or sexually, via complex

forms of reproduction. The most complex forms of marine algae are called seaweeds. (http://thesciencedictionary.org/algae/)

They are photosynthetic, almost exclusively aquatic plants belonging to thallophytes, including seaweeds. They normally prefer hard substrate (Campbell, 1972)

Algae refer to the exclusively aquatic, photosynthetic plants of Thallophytic division, which grow on hard substrate (like rock, coral reefs, etc.) by means of a holdfast. They lack proper vascular and root systems (Gerlech, 1973). They are non-flowering and their plant body (thaloid) is not differentiated into root, stem and leaves They colonize the reef flat. They are broadly classified into marine and freshwater type.

Bars or Sand Bars: Bars are submerged ridges of detrital sediments which are larger and less regularly spaced than ripple marks (Fairbridge, 1968, p. 55). They are formed typically in shallow epicontinental or shelf waters by waves and currents. They are found singly or together and internally laminated. Bars are named by their positions/offshore bar, bay bar. Bars are generally submerged during high tides. They are generally parallel to the shore. The waves generated by onshore winds blowing from the direction transverse to the shore, when they approach the shore, where the water is relatively shallow on the continental shelf are likely to erode sediments from the sub marine floor. These sediments are built up into ridges or offshore bars above the sea level.

In many cases, probably the bars have been pushed into inland, so that they are merged with the shore zone or beach zone of sand dunes near the shoreline or converted into spits by their appendage at one or the other end to some headland. It may be mentioned here that what have been marked in the maps are mostly sub aqueous ones, while some of them could be sub-aerial also.

Bay: A bay is a well-marked indentation whose penetration is in such proportion to the width of its mouth as to contain land locked waters and constitute more than a mere curvature of the coast. The foregoing provision does not apply to so called "historic" bays. (United Nations Convention on the Law of the Sea, 1982).

Beach: The shore-parallel linear deposition of sand, shingle or gravel by the waves is commonly known as beach. Beach also known as shore is a gently sloping zone of unconsolidated material, typically with a concave profile, that extends landward from the low water line (LWL) to the place where there is a definite change in material or physiographic form or the line of permanent vegetation. Most often beach material is of sand grade (2-1/16 mm size). But sand may be replaced by cobbles, shingles or mud in certain areas (Fairbridge, 1968). The

material of the beach is supplied from the erosion of the headlands and cliffs, the sediments brought by rivers, floods and slope wash of land surface and from the pre-existing beaches and offshore marine floor. Beach material is transported along the shore by longshore drift for long distances. The extent and height of the beach is variable. It varies from a width of a few metres to several kilometres. Beach is the primary protector of the coast that absorbs the impacts of waves and currents.

Bund/embankment: A term used mainly in India and southeast Asia for an artificial embankment, usually of earth or gravel, built along the coastline or the banks of a river or estuary (Glossary – Encyclopaedia of Coastal Science[1]).

Coastal sand dunes: Single or multiple ridges or mounds of loose wind-blown material, usually sand on the coast. Coastal sand dune covers small area and is defined as topographical feature of aeolian origin composed of sand grain deposited downwind from a natural source of sand (Fairbridge, 1968). They are developed in any environment in which loose sand size particles are exposed to wind action and are free to migrate and accumulate as unconsolidated masses. The sand dunes function as a buffer for the beach to reduce the impact of coastal erosion.

Coral reef: Corals are exclusively polypoid, marine organisms (which belong to Class: Anthozoa of Phylum: Coelenterata/ Cnidaria), capable of secreting a massive calcareous skeleton. Hermotypic or reef building corals, colonize suitable sea floor substrates in tropical and sub-tropical shallow waters with appropriate ecological conditions (summer maximum mean temperature is 28°C and winter minimum mean temperature generally is above 18°C, colonizing mainly photic depths, salinity 35±2 psu etc (SAC, 2012). Coral reef is defined as 'a complex organogenic framework of calcium carbonate (primarily of corals), which forms a rocky eminence on the sea floor and customarily grows upwards to the tide limit' (Fairbridge, 1968).

Creek: Creek is a small tidal channel of the sea generally perpendicular to the coast through tidal swarms. Sometimes small streams of fresh water drain into the creek in their upstream region.

Estuary: A semi-enclosed body of water which has free connection with the open sea and within which sea water is measurably diluted with freshwater derived from land drainage.

Hazard line: The hazard line for the CRZ purposes is being demarcated by the MoEF&CC through the SoI taking into account tides, waves (water level

[1] http://moodle.up.pt/pluginfile.php/18105/mod_resource/content/1/Glossario_Encyclopedia_of_Coastal_Science.pdf

fluctuations), sea level rise and shoreline changes as the most landward boundary of the reach of the above-mentioned parameters (CRZ, 2011).

HTL: It is the line on the land up to which the highest water line reaches during the **spring tide** (CRZ, 2011). The highs related to the spring tides vary every time, and there is a cycle which is estimated to be repeating every 18.6 years. Hence, in hydrography and sea surveying, the usually defined high sea level connected with tides is the MHWS which is the average of all spring tides over a period of 18.6 years.

Jetty: On open seacoast, a structure extending into a body of water, and designed to prevent shoaling of a channel by littoral materials and to direct a confines the stream or tidal flow jetties are built at the mouth of a river or tidal inlet to help deeper and stabilize a channel. (Glossary of Geology, AGI).

Lagoon: A lagoon is an elongated body of water lying parallel to the coastline and separated from the open sea by barrier islands or by a narrow strip of land or a sand bank (Fairbridge, 1968). Usually, it lies across from side to side of mouth of streams (estuaries). Lagoons are most common along coasts bordering

lowlands. The entrance of a lagoon is restricted by the narrow tidal inlets through the barrier islands and complex of sand bars which form on both the lagoon side and sea ward side of the inlet.

LTL: It is the line on the land up to which the lowest water line reaches during the spring tide. The lows related to the spring tides vary every time and there is a cycle which is estimated to be repeating every 18.6 years. Hence, in hydrography and sea surveying, the usually defined low sea level connected with tides is the mean low water springs which is the average of all spring tides over a period of 18.6 years.

Mangroves: Mangroves are trees of various species of several families which grows only where they can come into permanent contact with sea water or brackish water. They occur at the edges of the tropical or subtropical seas, bays, lagoons and estuarine regions (Gerlech, 1973). Mangroves occur in quiet depositional coastal environments. Although mangroves grow in a variety of sediments including coral sands, they attain full development on the fine grained, soft organic mud deposited on the sheltered coast. Mangrove roots help accumulation of the silt which gradually builds up to form dry land, thus extending the coastline. Mangroves support in maintaining a rich coastal biodiversity.

Mudflat, Tidal: They are wide expanse of fine grained soft mud along the shore. They generally consist of deposits of clay, silt, ooze etc. (King, 1972).

The tidal mudflats are further classified on the basis of tidal influence into three types (Davies, 1972) i.e., i) high tidal mudflats; ii) intertidal mudflats, and iii) sub-tidal mudflats.
High-tide mudflats are more or less flat and near high waterline. Deposition here is caused by material brought during the very highest tides. Intertidal slope areas which are unstable are affected by daily tides. The sub-tidal zone is normally exposed during very low tides.

Reef flat: The nearly flat surface that gets exposed as the summit level of the reef at low tide is known as reef flat. Under low tide condition, water depth on reef flat is extremely shallow, at the most a few meters. Reef flat is commonly composed of loosely cemented coralline sand or coarser reef debris and may consist of shallow pools, irregular gullies, low islands or cays of sand or rubble, vegetated and widely scattered colonies of hardy species of coral.

River: A general term for a natural, freshwater surface stream of considerable volume and generally with a permanent base flow, moving in a defined channel toward a larger river, lake or sea. (NRCS, USDA[2]).

Rock: Any formation of natural origin that constitutes an integral part of the lithosphere. The naturally occurring material that forms firm, hard, and solid masses." (c-coast glossary - NOAA).

Rock outcrop: It includes residual hills, hillocks and rocky knobs which are exposed in the coastal zone.

Salt pan: An undrained, usually small and shallow, rectangular, man-made depression or hollow normally in the mudflats in which saline water is allowed to accumulate and evaporate leaving a salt deposit is called salt pan.

Sand: The deposition of sand results in various features like beach, coastal dunes, spits and bars. A sediment consisting of rock particles with a diameter between 0.125 and 2.0 mm. Subdivisions are very coarse sand (1-2 mm), coarse sand (1/2 or 0.5^{-1} mm), medium sand (1/4 or $0.25^{-1/2}$ or 0.5 mm), fine sand (1/8 or $0.125^{-1/4}$ or 0.25 mm) and very fine sand (1/16 or $0.0625^{-1/8}$ or 0.125 mm). Glossary - Encyclopedia of Coastal Science.

Sea grass /Sea grass bed: Seagrasses are marine flowering plants forming extensive beds or meadows, which can be either monospecific (made up of a single species) or in mixed beds where more than one species coexist. They occur in the infratidal and midtidal zones of shallow and sheltered localities of sea, gulf, bays, backwaters and lagoons. Seagrasses are often found in association with coral reef areas, especially in the Palk Bay (Tamil Nadu) and off the coast of

[2] http://www.nrcs.usda.gov/wps/portal/nrcs/detail//?cid=nrcs142p2_054230

Maharashtra (Malvan). They form a habitat for rare and endangered animals such as marine turtles and dugongs, apart from economically important species of fish and shellfish.
Advanced flowering plants complete with both vascular and root systems (Gerlech, 1973). The root rhizome system anchors sea grasses on to soft sediments of low energy environment. (Fine sand mixed with silt and shell debris below which lies fine black sediments/sands rich in decomposing organic matter).

Seawall: It is an embankment or wall built parallel to the shore for the protection of the coast against waves or tidal action along a shore or water front.

Shoals: shoals are either submerged ridge, bank or bar producing a shoal, consisting of or covered by sand, mud, gravel or other unconsolidated material (AGI Glossary, 1972, p. 653). These can be within rivers, lakes, lagoons and offshore, and in all cases, beneath water and most often recognizable in aerial photographs and satellite images essentially because of their occurrence at shallow depths.

Shoreland: This covers the area from the tidal flat inland upto the nearest foothill with some features on the coast as well. Categories like delta, paleomudflat, coastal dunes, relict alluvium, paleochannel, terrace, ox-bow lake, reclaimed mudflat and strandline etc. are classified in this category.
Shoreland include coastal watershed and flood-prone areas. Coastal watersheds are those lands that drain directly into coastal water of 0.5 ppt water salinity (Clark, 1977). The term flood-prone area means the lowland and relatively flat area adjoining wetland. The area is subject to a 1% or greater chance of flooding in any given year.

Spit: Spit is a small point or low tongue or narrow embankment of land commonly consisting of sand or gravel deposited by longshore drifting and having one end attached to the mainland and other protruding into open water, usually the sea, across the entrance of a bay or an estuary, a finger like extension of the beach (AGI, Glossary, 1972, 682 p). Spits have been found to lengthen as well as shorten during the course of years. This may be due to the changes in currents. Spits are likely to come into existence when the currents are tangential to a headland and do not pursue the irregularities of the shore (Thornbury, 1969). The spits are curved at the distal ends which probably indicate changes of current directions or dominant monsoonal drift. Several factors influence the curvature of the spit landward resulting in curved/hooked spits.

Tanks: These are artificial impoundments of water used for irrigation.

Water bodies: The areas that are persistently water covered like estuaries, lagoons, back waters, lakes and creeks are included in this category.

Wetland: Wetlands are land transitional between terrestrial and aquatic system where the water table is usually at or near the surface of land is covered by shallow water. The land areas that are periodically (at least once a year) exposed and flooded by salt or brackish water through tides and normal storm action and having mangrove swamps and marshes, they are referred to as "Coastal wetlands" (Cowardin et. al. 1979).

Wetland Non-vegetated: They are normally barren areas of rock or having a cover of mud and sand. They are with or without swamps and without any dominant vegetation types and may have sparse cover of vegetation. Non vegetated wetlands can be sub divided into various types on the basis of nature of material, nature of tidal influence and location.

Wetland Vegetated: Vegetated wetlands are dominated by vegetation. They include mangroves swamps, marsh, algae etc. They can be detected and mapped by seasonal (Winter/Summer) imagery.

3.4. Classification System

The classification system has been designed in order to generate information on CZMPs / ICRZ related to coastal features at the national level. In this classification system, attention has been given to the first and second level of categorization. Level III classes are introduced for detailed mapping. The classification system was developed by SAC (Nayak ***et al***., 1991) and fine-tuned by the committee. The classification system for coastal zone maps is based on the following criteria (Nayak, 2002, 2009):

i. *Accuracy*: The minimum level of accuracy in identification of wetland categories (at the minimum) should be of the order of 90% at 90% confidence level. At the same time, the level of accuracy for various wetland categories should be more or less same.

ii. *Repeatability*: Repeatable or repetitive results should be obtainable from one interpreter to another and from one time mapping to another.

iii. *Applicability*: The classification system should be applicable to extensive areas, i.e. throughout the nation's coastline.

iv. *Suitability*: The classification system should be suitable for use with different remote sensor data obtained at different times of the year.

v. *Flexibility*: Effective use of sub-categories that can be obtained from ground surveys or from use of aerial photographs should be possible.

The classification system is given in Table 3.

Table 3: Classification system for coastal land use / land cover database

Level I	Level II	Level III
Agricultural land		
Forest (Nontidal)	Natural	
	Manmade	
Wetlands	Mud/tidal flat	Sub-tidal
		Inter-tidal
		High tidal (with/without salt encrustations)
		Mud with vegetation
	Sand	Beach/ Sand Patch
		Spit
		Sand Bar/ Barrier Island
		Shoals
		Sand vegetation
	Rocks	Rocky coast
		Rock exposure
	Coral Reef	Reef flat
		Sand Patch /Beach
		Coral Lagoon
		Coralline shelf
	Mangroves	Dense/sparse/degraded
	Marsh vegetation	(Density wise)
	Algae	(Density wise)
	Seagrass	Dense/sparse/degraded
Water bodies	Estuary	
	Creek	
	Lagoon	
	Bay	
Barren land	Mining areas /dumps	
	Rock outcrops/ Gullied land	
Shoreland	Saline area	Vegetated
	Coastal dune	Vegetated
	Reclaimed mudflat	
Built-up land	Habitation/ settlement	With vegetation
	Open/vacant land	
	Transportation	Roads
		Railways
		Port/Harbour/ jetty
		Waterways
		Airport
Other features	Aquaculture pond	
	Reclaimed area	
	Salt pan	
	Seawall / Embankment	
	Tanks/ Ponds/ Lakes	
	Rivers/ streams/ Drains	
	outfalls/effluents/ canals	
HTL		
LTL		
Hazard Line		
Village/ Taluk/ District/ State/ MPA/ Forest boundary		
CRZ boundary	100m/ 200m/ 500m/ 50m buffer zone of mangroves/ width of the creek/	

3.5. Selection of satellite data, processing, image analysis and interpretation

The Indian Remote Sensing (IRS P6) satellite, Resourcesat1&2 LISS-IV and Cartosat (1&2) digital data of 2011 are to be used. Salient characteristics of these images and pre-processing required are given in Section 2.3. Interpretation of satellite image for identifying coastal wetlands/landforms/land use/land cover should be carried out using the following steps:

a. preparation of Image interpretation key;
b. preliminary interpretation;
c. ground truth collection;
d. modifications and final interpretation;
e. accuracy estimation

Image interpretation is carried out using basic elements of visual interpretation such as tone/colour, size, shape, texture, pattern and association. Using these elements, various wetland/land use features are to be identified and interpreted based on the image interpretation key given in Annex 2 (modified after Nayak, et al., 1991). Geometrically corrected IRS LISS IV image is to be interpreted using the classification and interpretation key explained above. All doubtful areas are to be identified and listed for ground truth verification. Ground truth data for those doubtful areas, which are accessible in the field, are to be collected. GPS can be used for locating on the ground during fieldwork. The corrected information on the landuse/ landcover categories shall be utilised in the information system after verifying classification accuracy explained in the Annex 3 (Nayak, et al., 1991)

3.6. Cadastral data generation and integration

For the preparation of the CZMP at the cadastral level the village cadastres available need to be integrated to the information system. The cadastral maps available in the country are in 1:3960 / 1:7820 or 1: 5000 / 1:10000. The cadastral maps contain survey boundaries and survey numbers of individual plots, the basic infrastructure such as roads, institutions including religious and the like, rivers / canals / ponds and survey stone locations. These maps are prepared in planar coordinate system. These maps are generally not available in digital form and hence the primary task is to digitise the information contain in them.

One of the challenges faced while digitising and integrating cadastral information with the existing normal projection system is related to geo-referencing. In geo-referencing the first step is to transfer the control points from the base map (rectified high resolution imagery) to the cadastre. While transferring the control

points care must be taken for the selection of control points and if required uniformly distributed GCPs can be collected from the field using DGPS. After this the cadastral information can be digitised and brought to the information system.

3.7. CZMP/ ICRZ / IIMP map generation in required scales

Once the information system is equipped with the necessary details enumerated above it can be utilised for the generation of the CZMP / ICRZ / IIMP maps in the required scales. Before doing this, with the available information on HTL the 500m CRZ line on the sea coast and the 100m or width of the water body line for the tidal influenced water bodies can be drawn using GIS. The boundary lines of CRZ I (ESAs, geo-morphologically important zones, archaeological and heritage sites), CRZ II (municipal areas) and CRZ III (rural areas) have to be incorporated. In the case of CRZ III there is a requirement of 200 m line to be drawn on the maps. In the case of mangrove areas of more than 1000 sqm a buffer line of 50m has to be provided around those areas. Other buffer lines may also be drawn on these maps wherever necessary, as specified in the Notification. In the case of A & N islands and Lakshadweep islands wherever IIMP is applicable the development setback line identified by the islands / authorized agencies based on the criteria for the same prescribed in the Notification also need to be demarcated. With this information the final maps in 1:25000, 1:4000 and project scale can be generated. Standard symbols, colours and patterns to be used for mapping are given in Annex 4.

4. Time Schedule, Prescribed Cost and Format of CZMP Report

4.1. Background

As there is a time limit for the demarcation of HTL/LTL and preparation of CZMPs the work on the above activities has to be scheduled as required. Similarly there is a cost involved in the preparation of CZMP by the authorized agencies. It is found by the committee that the different agencies are costing the CZMP preparation differently and hence the committee recommended that there should be uniformity in the costing. Whenever CZMPs are prepared for project level approval a report is also prepared by the agencies and at present it does not have a uniform pattern. Hence the committee suggested that there should be a uniform pattern for the report.

4.2. Prescribed cost for preparation of 1:25000 and 1:4000 scale CZMP maps

The cost is based on the various tasks / components that are involved in preparation of 1: 25,000 / 1: 4000 CZMP maps and are only indicative. Cost of HTL/LTL mapping should be based on the layout/size of the maps. The cost estimate for preparing 1:25000 or 1:4000 scale maps have been worked out and an approximate cost as given below plus actual travel cost and taxes as applicable has been recommended (Table 4). This cost is based on the broad guidelines given below and will be subject to revision depending on wages/tax structure and other factors to be considered from time to time.

Table 4: Prescribed cost for preparation of CZMP maps

S.No.	Tasks involved in producing one 1: 25,000 scale (7 ½′ x 7 ½′ - 196 sq. km) / 1: 4,000 scale (1 ½′x 1 ½′ - 2.7 km X 2.7 km or 7 sq. km approx.) CZMP map	No. of scenes/ sheets/ mandays	Unit cost [per manday/ sheet/scene]
1	Cost of HR satellite image	1 scene	12000
2	Image pre-processing, GCP collection from base map, geo-referencing & image rectification.	1 manday	4000
3	Merging of Cartosat and LISS IV and mosaicing [PAN-sharpening & mosaic generation]	1 manday	4000

S.No.	Tasks involved in producing one 1: 25,000 scale (7 ½' x 7 ½' - 196 sq. km) / 1: 4,000 scale (1 ½'x 1 ½' - 2.7 km X 2.7 km or 7 sq. km approx.) CZMP map	No. of scenes/ sheets/ mandays	Unit cost [per manday/ sheet/scene]
4	Image interpretation and preparation of coastal GIS / database	10 mandays	4000
5	Geo-referencing cadastral maps, base map preparation, digitization & transfer of village boundaries, survey numbers etc., from the cadastral base map.	2 mandays	4,000
6	Ground truth collection (random points) excluding travel costs	5 mandays	10000
7	Overheads	@10%	
8	Institutional cost	@10%	
9	Service Tax	@12.36 %	
10	Travel expenses	actuals	

4.3. Format of project level CZMP report

The following format is recommended for the preparation of the project level reports:

i. Introduction
ii. Geomorphology &topography of the area
iii. Land use
iv. Data used
v. Methodology
vi. Details of CZMP of the project area
vii. Summary &conclusions
viii. Appendix, figures and maps

References

Campbell, I. 1972. Glossary of Geology. American Geological Institute, Washington. D. C.

C-COAST Glossary. Coastal Cartographic Object Attribute Source Table – NOAA. http://www.ngs.noaa.gov/RSD/shoredata/c_coast_def.htm#num6 last accessed 10 August 2014

Encyclopedia of Coastal Science. Schw artz. M. (editor) - 2005, Springer, Netherlands, 1211p

Fairbridge, R.W. 1968. Encyclopedia of Geomorphology. Encyclopedia of Earth Sciences Series, Vol. III. Dowden, Hutchinson & Ross.Inc. Stroudsburg, Pennsylvania.

Jensen, J.R. 2000. Remote Sensing of the Environment: An Earth Resource Perspective. Prentice Hall, pp. 544.

Joseph, G. 2003. Fundamentals of Remote Sensing. Universities Press (India) Pvt Ltd, Hyderabad, India. 433 p.

Nayak, S. 2009. Application of Remote Sensing and GIS for Coastal Zone Management. In the Manual of Geographic Information Systems (ed. M. Madden), The American Society for Photogrammetry and Remote Sensing, Bethesda, MD. pp. 1075-1094 (Invited contribution)

Nayak, S. 2002. Use of satellite data in coastal mapping, Indian Cartographer, 2002 CMMC-01 147-156

Nayak, S. and Sahai, B. 1985. Coastal morphology: a case study in the Gulf of Khambhat (Cambay). Inter. J. Remote Sens., 6(3 & 4): 559-568

Nayak, S., Bahuguna, A., Shaikh, M. G., Chauhan, H. B., Rao, R. S. and Arya, A.S. 1992: Coastal Environment: Scientific Note, RSAM/SAC/COM/SN/11/92, Space Applications Centre, Ahmedabad, 114 p.

Nayak S., Bahuguna, A., Shaik., M., Rao, R.S., Trivedi, C.R., Prasad, K.N., Kadri, S.A., Vaidiya, P.H., Patel, V.B., Ananda Rao, T., Sheriff, A.N. and Suresh, P.V. 1991. Manual for mapping of Coastal Wetland/ landforms and shoreline changes using Satellite Data.Technical Note, Space Applications Centre, Ahmedabad, India.IRS-UP/SAC/MCCCE/TN/32/91, 63 p.

NRCS, USDA. Part 629– Glossary of Landform and Geologic Terms. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052234.doc

SAC, 2012. Coastal Zone of India, Space Applications Centre (ISRO), 2012, 601p. ISBN: 978-81-909978-9-8

ANNEXES

Annex 1: Glossary

Algal ridge: Algal ridge is a prominent, wave resistant, slightly elevated seaward (outer) margin of the reef flat, which rises from the reef edge and culminates into the steep sea-facing side of the reef crest or the reef front zone. This ridge is mainly composed of the calcium carbonate secretions of actively growing calcareous algae. The algal pavement of encrusting coralline algae provides a hard, resistant surface which bears the main force of the breaking waves and reduces their destructive power before they sweep into reef flat behind the rim (Maxwell, 1968). Very little fine sediments are retained on the algal ridge because of their exposure to the breaking waves.

Anthropogenic Feature: An artificial feature on the earth's surface (including those in shallow water), having a characteristic shape and range in composition, composed of unconsolidated earthy, organic materials, artificial materials, or rock, that is the direct result of human manipulation or activities; can be either constructional (e.g., artificial levee) or destructional (e.g., quarry). (NRCS, USDA).

Aquifer: A saturated, permeable geologic unit of sediment or rock that can transmit significant quantities of water under hydraulic gradients (NRCS, USDA).

Atoll: Reef forming islands with a central lagoon. If the lagoon is deep and large, is called oceanic atoll. Atoll with a shallow lagoon is known as shelf atoll. Very small atoll is known as faros atoll.

An atoll is a basic type of coral reef formation, which appears annular or ring-shaped (roughly circular or elliptical or horse-shoe shaped) in its plan view. An atoll is often topped by low sand island(s), enclosing a body of water (i.e. the lagoon) and is surrounded by deep water of the open sea, either oceanic or of continental shelf.

Backshore: The upper or inner, usually dry, zone of the shore or beach, lying between the high-water line of mean spring tides and the upper limit of shore-zone processes; it is acted upon by waves or covered by water only during exceptionally severe storms or unusually high tides. It is essentially horizontal or slopes gently landward, and is divided from the foreshore by the crest of the most seaward berm. (NRCS, USDA).

Backswamp: These are swampy or marshy, depressed areas developed on a flood plain with poor drainage, behind the natural levees of the river. Swamps which are developed on Channel Islands are also considered as backswamp.

Backwater: The water that is retarded, backed up or turned back in the coast from the land towards the sea by the movement of the tide, e.g. the water obtained at high tide to be discharged at low tide. This is always behind (on the landward side) the coast, with varying spread on either side of tidal creeks, depending upon the gradient of the adjoining land.

Backwater Island: Islands found in the backwaters are called backwater islands (CRZ, 2011).

Barrier Beach: A narrow, elongate, coarse-textured, intertidal, sloping landform that is generally parallel with the beach ridge component of a barrier island or spit and adjacent to the ocean (NRCS, USDA)

Barrier reef: reef separated from the coast by a deep channel.

Bathymetry: Science of measuring water depths (usually in the ocean) in order to determine bottom topography. (Ellis 1978) NOAA Shoreline Website Glossary (http://shoreline.noaa.gov/glossary.html#partg).

Beach ridge: Beach ridge is a low essentially continuous mound of beach or beach and dune material (sand, gravel, shingle) heaped up by the action of waves and currents on the backshore of a beach beyond the present limit of storm waves or the reach of ordinary tides and occurring singly as one of a series of approximately parallel deposits. The ridges are roughly parallel to the shoreline and represent successive position of an advancing shoreline.

Beach Scarp: An almost vertical slope along the beach caused by wave-induced beach erosion. It may vary in height from a few centimeters to few meters depending on wave action and nature and composition of the beach.

Berm: A nearly horizontal part of the beach or backshore formed by the deposition of material by wave action. Some beaches have no berms, while others have one or several depending on the seasonal variations of the wave climate and tidal positions.

Berm crest: The crest of the berm is berm crest. This is used as a geomorphological feature indicating the HTL in CRZ mapping.

Bioshield:A vegetation belt along the coast that protects from wave and tide action, especially during storms. Coastal bioshields include mangroves, casuarina plantations etc.
Biosphere reserve: Designated resource area featuring multiple use management systems whereby nature protection and uses for farming, forestry, fisheries, etc. are accommodated (note: an international system of such reserves is endorsed and guided by UNESCO). (IOM Glossary)

Brackish water:A dilution of fresh water by the sea; brackish water may be defined as containing between 5 and 30 parts per thousand (ppt) of dissolved solids. (IOM Glossary)

Breakwater: An artificial structure built into the sea, often curved, and designed to impede wave action so as to shelter a harbor or protect a stretch of coastline. The terms jetty and pier are sometimes used as synonyms. Glossary - Encyclopedia of Coastal Science.

Buffer area:A protective, often transitional, area of controlled use-in coastal management, a peripheral zone separating a developed area from a protected natural area.

Cadastral map: Village level survey maps depicting the individual land holdings and the plot boundaries for revenue purposes are available throughout the country. They are generally in 1:3960, 1:5000 or 1:7920 or 1:10,000 or other near scales.

Cliff: Any high, very steep to perpendicular or overhanging face of rock or earth rising above the shore of the sea (Campbell, 1972).

Coast / Coastal Zone: The term coastal zone means the coastal waters, wetlands and adjacent shorelands, strongly influenced by marine water or vice versa. Thus coastal zone includes the nearshore marine waters, islands, beaches, intertidal areas, wetlands and inland area to the limits of the coastal watersheds and flood-prone areas in which natural and man-made activities can affect the coastal waters.

Coastline: It is the water's edge, moving to and fro as the tides rise and fall, so that there is a low-tide shoreline, a mid-tide shoreline, and a high-tide shoreline. The term has been used as a synonym for Shoreline (q.v.), but it is useful to maintain a distinction between the two terms, taking coastline as equivalent to the high-tide shoreline. Where the tidal range is large and the shore profile is gently sloping, there is much variation in the position of the various shorelines.

Coastal Plain: A low, generally broad plain that has as its margin an oceanic shore and its strata horizontal or gently sloping toward the water, and generally represents a strip of recently prograded or emerged sea floor; (NRCS, USDA)

Coastal protection: Works or management operations intended to control coastal erosion. (IOM Glossary).

Coastal sand dunes: Single or multiple ridges or mounds of loose wind-blown material, usually sand on the coast. Coastal sand dune covers small area and is defined as topographical feature of aeolian origin composed of sand grain deposited downwind from a natural source of sand (Fairbridge, 1968). They are developed in any environment in which loose sand size particles are exposed to wind action and are free to migrate and accumulate as unconsolidated masses. The sand dunes function as a buffer for the beach to reduce the impact of coastal erosion.

Coastal watershed: Coastal watersheds are those lands that drain directly into coastal water of 0.5 ppt water salinity (Clark, 1977). The term flood-prone area means the lowland and relatively flat area adjoining wetland. The area is subject to a 1% or greater chance of flooding in any given year

Coastal Zone Management: A governmental process for achieving sustainable use of resources of the coastal zone whereby participation by all affected economic sectors, governmental agencies and non-government organizations is involved; unified or integrated coastal zone management when the management actions of the various stakeholders are formally unified and community participation is emphasized. (IOM Glossary).

Contour Map: a topographic map on which the shape of the land surface is shown by contour lines, the relative spacing of the lines indicating the relative slope of the surface.

Coral: Corals are marine invertebrates in class Anthozoa of phylum Cnidaria (formerly Coelenterata) typically living in compact colonies of many identical individual «polyps». The group includes the important reef builders that inhabit tropical oceans and secrete calcium carbonate to form a hard skeleton. (Wikipedia).

Coral Head: Coral head refers to the massive, rounded/knobby or mushroom shaped protuberance of corals usually formed on the submerged part of a reef.

Coral Knoll: An isolated, rounded, massive, often knobby or mushroom shaped protuberance or growth/structure of coral colonies, which develop locally and upward rather than outward or laterally is commonly termed as coral knolls (Darwin, 1842). These isolated mounds are commonly associated with lagoons of the atoll reefs. The term was first used by Tiddeman (1890) for a reef feature that originated as a knoll. . The term was used by Emery in 1948 to differentiate a coral head from a coral pinnacle. The size of knolls may vary from very small (<10 feet across and 3feet high) to several hundred feet or more than a mile but are characterized by the gentle slope (Ladd, 1977).

Coral Pinnacles: Very small, reef forming islands without central lagoon.

Coral reef - Barrier reef: Reef separated from the coast by a deep channel.

Coral reef - Fringing reef: Reef adjacent to the coast or separated by a shallow channel.

Coral reef - Platform reef: Large reef forming islands without central lagoon.

Coral reef - Patch reef: Small, reef forming islands central lagoon.

Coral reef - Coral pinnacles: Very small, reef forming islands without central lagoon.

Coral reef - Atoll: reef forming islands with a central lagoon. If the lagoon is deep and large, is called oceanic atoll. Atoll with a shallow lagoon is known as shelf atoll. Very small atoll is known as faros atoll.

Critically Vulnerable Coastal Areas (CVCA): Critical Vulnerable Coastal Areas (CVCA) are ecological sensitive areas which shall be managed with the involvement of the local coastal communities including the fisher folk (CRZ 2011).

CRZ map: Map depicting the HTL, LTL and the CRZ boundaries.

Cyclone: A warm-core, non-frontal synoptic-scale cyclone, originating over tropical or subtropical waters, with organized deep convection and closed surface wind circulation about a well-defined centre.

(WMOhttp://severe.worldweather.wmo.int/tc/cnp/acronyms.html#c)

A tropical cyclone is a rotational low pressure system in tropics when the central pressure falls by 5 to 6 hPa from the surrounding and maximum sustained wind speed reaches 34 knots (about 62 kmph). It is a vast violent whirl of 150 to 800 km, spiraling around a centre and progressing along the surface of the sea at a rate of 300 to 500 km a day. (IMD: http://www.imd.gov.in/section/nhac/dynamic/faq/FAQP.htm#q1)

CZM Plan/ Map:CZM plan/map depicting the HTL, LTL, the CRZ boundaries and all other details required for identifying and classifying the CRZ areas within the respective territories in accordance with the guidelines given in Annexure-I of the CRZ 2011 Notification and for regulating the activities prohibited / permitted in the CRZ Notification.

Datum: For marine applications, a base elevation used as a reference from which to reckon heights or depths. It is called a tidal datum when defined in terms of tidal phenomena and is based on a 19-year tide cycle (in the USA)- the datum is referenced to a fixed point typically known as a bench mark. (IOM Glossary).

Delta: Delta is a product of rapid deposition of stream-borne sediments into relatively still standing bodies of water. The river supplies and deposits sand, silt and other detrital material more rapidly then they can be removed by currents (Fairbridge, 1968). Delta is essentially a land surface through a part of it may be subaqueous. The subaqueous part will be beneath a bay of lagoon or open sea.

Developed area: Developed area refers to areas within the existing municipal limits or in other existing legally designated urban areas which are substantially built-up and have been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains. (CRZ 2011).

Dredging: The excavation of sediments and other material from aquatic areas for the purpose of maintaining adequate depths in navigation channels and berthing areas, as well as for other purposes (IOM Glossary).

Ecotourism: Tourist activity attracted to environmental resources and based, usually, on a conservation theme. (IOM Glossary).

EIA: Environmental Impact Assessment: Detailed prediction of the impact of a development project on environment and natural resources with recommendations as to acceptability of the project, need for minimizing/eliminating/offsetting adverse effects, and a management plan to accomplish these countermeasures; a generic term for all types of impact assessment is Environmental Assessment (EA). (IOM Glossary).

Erosion: Transportation of weathered (decomposed) rock material or soil by natural forces. NOAA Shoreline Website Glossary (http://shoreline.noaa.gov/glossary.html#partg).

Erosion control Measure: Methods to control coastal erosion such as the use of seawalls, groynes (hard control measures) or beach nourishment, bioshields (soft control measures).

ESA: The areas that are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast as listed in the CRZ 2011 Notification. These include mangroves, coral reefs, sand dunes, mudflats, national parks [marine parks, sanctuaries, reserve forests, wildlife habitats and ther protected areas under the provisions of Wildlife Protection Act 1972, the Forest (Conservation) Act 1980 or Environment (Protection) Act 1986 including biosphere reserves], salt marshes, turtle nesting grounds, horse-shoe crab habitats, sea grass beds and nesting grounds of birds, Areas or structures of archaeological importance and heritage sites are also grouped under this category for regulatory purposes in the CRZ 2011 Notification.

Eutrophication: The process of enrichment of water which leads to excessive growth of algae and other aquatic plants from the introduction of an oversupply of nutrients such as nitrates or phosphates. (IOM Glossary).

Faros Atoll: Faros atoll is a miniature atoll with a lagoon either forming part of the rim or found in the central lagoon of a much larger atoll reef system.

Flotsam: Floating materials on the sea surface which get deposited on the beach forming one or several lines depending on the seasonal variations of the wave climate and tidal positions are known as flotsam. It is used to identify a line of deposit indicating HTL in coastal mapping (***considered as a coarse method***).

Flood plain: Flood plains represent the surface being constructed by the river. They run parallel to the river, and are subject to periodic overflow of river water.

Foredune: A coastal dune or dune ridge oriented parallel to the shoreline, occurring at the landward margin of the beach, along the shoreward face of a beach ridge, or at the landward limit of the highest tide, and more or less stabilized by vegetation (NRCS, USDA).

Foreshore: The intertidal part of a beach or the part of the shorefront lying between the beach head (for upper limit of wave wash at high tide) and the ordinary low water mark that is ordinarily traversed by the uprush and backrush of the waves as the tides rise and fall. (IOM Glossary).
Foreshore Facilities: The expression "foreshore facilities" means those activities permissible under the CRZ 2011 notification and they require waterfront for their operations such as ports and harbours, jetties, quays, wharves, erosion control measures, breakwaters, pipelines, lighthouses, navigational safety facilities, coastal police stations and the like.

Fracture / fault: The term 'Fracture' as herein used is any linear break or cut in the rocks. It may be joint or a fracture or a fault or a trace or any of these (Rumsey, 1971). Displacement and abrupt truncations of rocks, variations in the foliation trend, long and straight and right-angled off setting stream courses and linear sharp tonal variations are the main criteria for the recognition of the fracture/faults in the imagery.

Fringing reef: Fringing reef is one of the basic types of reef formation, which is adjacent to the continental or island coastline separated by a shallow channel from the mainland. These reefs are generally characterized by rough, table like surfaces exposed at low tide and their seaward edges are marked by sharp steep slopes down to the sea floor. These surfaces may extend over a width of a kilometer or more and show ecological zonation parallel to the shore. They are further classified into Platform, Patch and Pinnacles on the basis of their relative size.

Groundwater: Groundwater is the water located beneath the earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water (Wikipedia).

Groyne: A wall built out at right angles from the coastline, intended to intercept drifting beach material. American spelling: groin. Glossary - Encyclopedia of Coastal Science.

Gulf: A relatively large part of an ocean or sea extending far into the land, partly enclosed by an extensive sweep of the coast, and opened to the sea through a strait; the largest of various forms of inlets of the sea. It is usually larger, more enclosed, and more deeply indented than a bay. (NRCS, USDA).

Headland: A high protrusion of the land into the sea, usually cliffed. Glossary - Encyclopedia of Coastal Science / An irregularity of land, especially of considerable height with a steep cliff face, jutting out from the coast into a large body of water (usually the sea or a lake); a bold promontory or a high cape / The high ground flanking a body of water, such as a cove / The steep crag or cliff face of a promontory. (NRCS, USDA).

High Water Mark: A line or mark left upon tide flats, beach, or along shore objects indicating the elevation of the intrusion of high water. The mark may be a line of oil or scum on along shore objects, or a more or less continuous deposit of fine shell or debris on the fore shore or berm. This mark is physical evidence of the general height reached by wave run up at recent high waters. It should not be confused with the mean high water line or mean higher high water line. NOAA Shoreline Website Glossary (http://shoreline.noaa.gov/glossary.html#partg).

Hill: A generic term for an elevated area of the land surface, rising at least 30 m (100 ft.) to as much as 300 meters (approx. 1000 ft.) above surrounding lowlands, usually with a nominal summit area relative to bounding slopes, a well-defined, rounded outline and slopes that generally exceed 15 percent. A hill can occur as a single, isolated mass or in a group. A hill can be further specified based on the magnitude of local relief: low hill (30 – 90 m) or high hill (90 - 300 m). Informal distinctions between a hill and a mountain are often arbitrary and dependent on local convention (NRCS, USDA).

Horseshoe crab habitat: Horseshoe crabs (family Limulidae, order Xiphosura or Xiphosurida) are arthropods that live primarily in and around shallow ocean waters on soft sandy or muddy bottoms. They are found only on the eastern coasts of the world. Tachypleusgigas (Muller) and Carcinoscorpiusrotundicauda (Latreille) are found within Indian limits, the former in north-east coast of Odisha (especially Balramgari) and the latter in the Sunderbans area of West Bengal; also reported in some parts of north coastal Andhra Pradesh coast.

ICZM: Integrated coastal zone management (ICZM) is a dynamic, multidisciplinary and iterative process to promote sustainable management of coastal zones. It covers the full cycle of information collection, planning (in its broadest sense), decision making, management and monitoring of implementation. ICZM uses the informed participation and cooperation of all stakeholders to assess the societal goals in a given coastal area, and to take actions towards meeting these objectives. ICZM seeks, over the long-term, to balance environmental, economic, social, cultural and recreational objectives, all within the limits set by natural dynamics. 'Integrated' in ICZM refers to the integration of objectives and also to the integration of the many instruments needed to meet these objectives. It means integration of all relevant policy areas, sectors, and levels of administration. It means integration of the terrestrial and marine components of the target territory, in both time and space. See also: Coastal Zone Management. (IOM Glossary).

IMP: Integrated Management Plan prepared for CVCA keeping keep in view the conservation and management of mangroves, needs of local communities such as, dispensaries, schools, public rain shelter, community toilets, bridges, roads, jetties, water supply, drainage, sewerage and the impact of sea level rise and other natural disasters (CRZ 2011). The IMPs are prepared in line with the other guidelines for preparation of Coastal Zone Management Plans.

Integrated Coastal Zone Management Plan: See ICZM

Integrated Management Plan: See IMP

Intertidal Zone: land area between HTL and Low Tide Line (hereinafter referred to as the LTL) (CRZ 2011).

Island: An island may be defined as a relatively small body of land surrounded entirely by waters. Islands include backwater islands, channel islands, bay mouth islands (barrier islands) and lake islands.

Khar land: Khar land refers to tidal land which is made cultivable or otherwise beneficial in any matter whatsoever by protecting it, by means of an embankment, from the sea or tidal river, and includes all such land in whatever manner described, whether as khar (in Maharashtra), khazan (in Goa), pokkali (in Kerala), kharepat, gazni or otherwise.

Khazan Land: In Goa: ecosensitive low lying areas influenced by tidal action seasonally used for paddy cultivation.

Land Reclamation: See 'reclaimed land'

Landward monsoon berm: In the case of beaches with multiple berms, the landward berm represents the berm generated due to the monsoonal waves. The crest of it is the landward monsoonal berm crest and is prescribed as one of the geomorphological feature in delineating HTL.

Littoral Drift: The movement of sand and other material by littoral (long shore) currents in a direction parallel to the beach along the shore; usually wind driven. The sedimentary material moved in the littoral zone under the influence of waves and currents. (IOM Glossary).

Littoral Transport: The movement of littoral drift in the littoral zone by waves and currents, including movement parallel to the shore (long-shore transport) and movement perpendicular to the shore (onshore-offshore transport). (IOM Glossary).

Marsh: marshes are grassy wetland areas in standing or slow moving water, usually treeless vegetation, composed of grass and low shrubs (Sedge sods), frequently interspersed with channels or pools of open water (Kennet, 1982). Maritime salt marsh as distinct from inland salt marsh, is essentially confined to the temperate regions of the world (Chapman, 1977).

Muddy Reef Flat: The part or portions of the reef flat where either thin or thick veneer of silt and mud gets deposited on the reef is the muddy reef flat.

Mudflat Paleo: Paleo mudflats are defined as mudflats lying above high tide flats and are formed by marine deposition of the past sea level (Nayak and Sahai, 1984, 1985). These mudflats are related to the phenomenon of regression of the sea. They represent the sites of older mudflats when the sea level was several meters higher than the present.

Mudflat, reclaimed: It is a mudflat which is reclaimed by the construction of bunds across creeks. The bunds stop the inflow of sea water.

Nearshore Zone: A subaqueous marine or lacustrine landform area that generally parallels the shore and extends seaward or lakeward from the low water line to beyond the breaker zone including longshore bars. In the nearshore zone, waves steepen, break, and reform during passage to the beach. Sediment transport occurs both along and perpendicular to the shore via wave and current action (NRCS, USDA).

Non-vegetated wetland: See Wetland, Non-vegetated.

Other Features: Other features include cliffs, high and low waterlines and salt pans.

Other Vegetation: Any vegetation growth which could not be identified under any of the permanent vegetation classes is kept in this category.

Oxbow Lake: The cut-off portion of the meander of a river.

Photogrammetry: Photogrammetry is the "art, science and technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant imagery and other phenomena" (American Society of Photogrammetry, 1980). Digital photogrammetry is photogrammetry as applied to digital images that are stored and processed on a computer.

Paleochannel: A paleochannel is an abandoned course of a river. It represents the former levels of the river bed.

Paleomudflat: paleomudflats are defined as mudflats lying above high tide flats and are formed by marine deposition of the past sea level (Nayak and Sahai, 1984, 1985). These mudflats are related to the phenomenon of regression of the sea. They represent the sites of older mudflats when the sea level was several meters higher than the present.

Patch reef: small, reef forming islands central lagoon.
Patch reef is less extensive than a platform reef (generally less than a kilometer) and also without a lagoon. They frequently form a larger reef complex. These mound-like, flat-topped reefs are also known as 'shelf', 'bank', 'table' and 'hummock' reefs.

Pediments: A broad, flat or gently sloping, rock floored erosion surface or plain of low relief, typically developed by sub-aerial agents (including running water) in an arid or semiarid region at the base of an abrupt and receding mountain front, and underlain by bedrock (occasionally by older alluvial deposits) that may be bare but more often partly mantled with a thin and discontinuous veneer of alluvium derived from the upland masses and in transit across the surface (AGI Glossary, 1972, P. 522).

Permanent vegetation: Vegetation on the non-eroding or accreted portion of the coast firmly attached to the substratum and unaffected by the erosional and tidal cycles. Well-grown coconut trees, palms, cashew trees, desert scrubs such as persopis,

and so on found along the Indian coast create a firm seaward vegetative boundary line often used to demarcate the HTL.

Plantations on Sand: These plantations include cassuarina, cashew, eucalyptus commercially grown by the government as well as private organizations all along the coast on beach sands and dunes. The plantations specially on the sandy coast are developed extensively for the protection of the coast from high tide surge.

Platform reef: large reef forming islands without central lagoon.
Platform reef is an extensive/large reef without lagoon having a rounded or ovoid shape in plane, with a flat upper surface, sometimes forming an island with shallow pools. They are found in waters of moderate depth (generally 20-40m) on the continental shelves, sometimes dotted in random manner, but more often in recognizable belts, suggesting an evolution from former (drowned) shorelines. Probably they grew on upward as the sea level continued to rise (Fairbridge, 1968).

Pond: (a) A natural body of standing fresh water occupying a small surface depression, usually smaller than a lake and larger than a pool. (b) A small artificial body of water, used as a source of water. (NRCS, USDA).

Reclaimed land: (a) A land area composed of earthy fill material that has been placed and shaped to approximate natural contours, commonly part of land-reclamation efforts after mining operations. (b) A land area, commonly submerged in its native state, that has been protected by artificial structures (e.g., dikes) and drained for agricultural or other purposes(NRCS, USDA).

Reclaimed mudflat: It is a mudflat which is reclaimed by the construction of bunds across creeks. The bunds stop the inflow of sea water.

Relict alluvium: Relict alluvium comprises patches of high grounds of alluvium, surrounded by mudflats, unaffected by the action of sea-level changes.

Revetment: Sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water. (Wikipedia).

Ribbon reef: Ribbon reef is a linear chain of reefs, emergent at low tide, commonly having inwardly curved extremities, and form a festoon along the precipitous edge of the continental shelf.

Rip-rap: A layer of broken rock, cobbles, boulders, or fragments of sufficient size to resist the erosive forces of flowing water and wave action (c-coast glossary – NOAA).

Rolling Plain: A plain with low to gentle undulation with varying altitude of about 25 to 30 m forms this unit: the material composition is almost the same as colluium, with variations in the percentage of gravel and sand, far away from the hills, as this unit enters the 'level plain'. This comparatively finer materials, like sand and silt, are deposited by stream in the lower parts.

Salinity: Salinity is a measure of the concentration of dissolved salts in water. A common way to define salinity values is parts per thousand (ppt). The average salinity of the ocean typically varies from 32 to 37 psu. By definition it is 'the weight in grams (in vacuo) of solids that can be obtained from 1 kg of seawater (also

measured in vacuo), when all of the carbonate has been converted to oxide, the bromine and iodine replaced by chloride, all organic matter oxidized, and the residue dried at 480°C to constant weight'.
Salinity Ingress: Also seawater intrusion. Mainly in the case of groundwater, the intrusion of seawater due to excess withdrawal of groundwater as compared to its recharge from coastal aquifers resulting in increased salinity of groundwater.

Salt marsh: «a flat or gently sloping vegetated wetland in the upper intertidal zone on sheltered parts of the coast (estuaries, inlets, lagoon shores). Often in the form of a depositional terrace, periodically submerged, with halophytic grasses, herbs, and shrubs; dissected by tidal creeks, and may contain enclosed Salt Pans» Glossary - Encyclopedia of Coastal Science

Salt marsh is a community of organisms dominated by plants that are tolerant of wet, saline soils, generally found in low-lying coastal habitats which are periodically wet and unusually saline to hyper-saline. The term salt marsh summarizes the saline conditions of the habitat as well as the emergent vegetation which dominates it. Plants which grow in salt marshes are thus tolerant of two conditions: saline and wet.

Sandy reef flat: The lee side/inward part/portions of the reef flat where fine coralline sand and broken molluscan shells get deposited are known as the sanded reef flat. However, the deposition may be migratory in nature and may have a seasonal cover of algae or sea grass. The sand is mainly coralline in nature, consisting of fine sand and broken molluscan shells (Fairbridge, 1968).

Satellite Imagery: Visual representation of energy recorded by remote sensing instruments. These imageries are taken by satellites using various sensors that record electromagnetic energy associated with an environmental phenomenon or feature (IOM glossary).

Scrub: Scrub are low growth or stunted vegetation, growing on poor soil or in semi-arid region.

Sea front: The land area exposed to the sea is the sea front.

Sea level: The level at which the sea stands against the coast, conventionally taken as mean sea level, the arithmetic mean of the calm sea surface (excluding waves and oscillations related to winds and atmospheric pressure variations) measured at hourly intervals over at least 18.6 years. Glossary - Encyclopedia of Coastal Science.

Sea level rise: The long-term rise in the sea level due to global warming is called the sea level rise.

Shallow sandy lagoon: Shallow lagoon with less than 2m depth having carbonate sands white in colour and well aerated (Nayak et. al. 1989).

Shoreline: The water's edge which moves to and fro as the tides rise and fall forms a low tide shoreline, a mid-tide shoreline, and a high tide shoreline. The term has been used as a synonym for coastline (q.v.), but it is useful to maintain a distinction between the two terms, taking coastline as equivalent to the high-tide shoreline.

Where the tidal range is large and the shore profile is gently sloping there is much variation in the position of the various shorelines (C-COAST Glossary - NOAA).

Shoreline change: Change over time of the shoreline due to processes of accretion and erosion. These can be analyzed in a geographic information system (GIS) by measuring differences in past and present shoreline locations. (http://shoreline.noaa.gov/apps/).

Silt: A sediment consisting of particles with a diameter between 1/256 (about 0.004) and 1/16 (0.0625) mm. Glossary - Encyclopedia of Coastal Science.

Spring Tide and Neap Tide: The spring tide occurs at or near the time of the new or full moon and rises the highest and falls lowest from the mean sea level. It is ‹an augmented tide range when the sun and the moon are in alignment with the earth, so that their gravitational effects are combined› (Glossary - Encyclopedia of Coastal Science). Approximately twice a month, the tidal force due to the sun reinforces that due to the moon. The tide›s range is then at its maximum: this is called the spring tide, or just springs. Neap tide occurs when the difference between high and low tide is least; the lowest level of high tide. Neap tide comes twice a month, in the first and third quarters of the moon.

Storm surge: The difference between the actual water level under the influence of a meteorological disturbance (storm tide) and the level which would have been attained in the absence of the meteorological disturbance (i.e. astronomical tide). (WMO http://severe.worldweather.wmo.int/tc/cnp/acronyms.html#c)

A rising of the sea as a result of wind and atmospheric pressure changes associated with a storm. Usually associated with cyclones, storm surge can travel long distances inland especially in areas of flat topography such as deltas and low elevation coastal zones.

Strandline: The term strandline is generally preserved for ancient shorelines i.e. shoreline out of reach of present wave action. As an ancient shoreline, strandline refers collectively to the assemblage of various features characteristics of the former coastal area (Fairbridge, 1968).
Substrata material: Refers to the underlying layer or materials or substances, in particular a layer of rock or soil or minerals beneath the surface of the ground.

Subtidal: Continuous submergence of substrate in an estuarine or marine ecosystem; these areas are below the mean low tide. (NRCS, USDA).

Sustainable Development: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Swale: The swale is a long, narrow generally shallow trough like depression between two beach ridges and aligned roughly parallel to the coastline.

Swash Zone: The sloping part of the beach that is alternately covered and uncovered by the uprush of waves, and where longshore movement of water occurs in a zigzag (upslope-downslope) manner. Compare – shoreline (NRCS, USDA).

Terrace: Terrace is an abandoned flood plain and thus represents former levels of the flood plain. They demarcate episodic formation of valley landscapes. They work on previous levels of valley fill and stream plantation. Climatic hydrologic, eustatic and tectonic changes are involved in the interpretation of terraces.

Territorial limit: As defined by the 1982 United Nations Convention on the Law of the Sea, territorial sea is a belt of coastal waters extending at most 12 nautical miles (22.2 km; 13.8 mi) from the baseline (usually the mean low-water mark) of a coastal state. The territorial limit is taken as 12 nautical miles.

Tidal-influenced water bodies: These are the water bodies influenced by tidal effects from sea, in the bays, estuaries, creeks, backwaters, lagoons, connected to the sea or creeks and the like.

Tidal inlet: Any inlet through which water alternately floods landward with the rising tide and ebbs seaward with the falling tide (NRCS, USDA)

Tidal range: The tidal range is the vertical difference between the high tide and the succeeding low tide. Tidal data for coastal areas is published by the national hydrographic service of the country concerned. Tidal data is based on astronomical phenomena and is predictable. Storm force winds blowing from a steady direction for a prolonged time interval combined with low barometric pressure can increase the tidal range, particularly in narrow bays. (Wikipedia)
Tidal surge: See 'Storm surge'.

Tide: Tide is the periodic (few hours) rising and falling of the sea surface resulting from gravitational attraction of the moon and sun and other astronomical bodies acting upon the rotating earth as opposed to the wind-generated waves. A tide with one high water and one low water every day is the diurnal tide and the tide with two high and two low waters every day is the semi-diurnal tide.

Tsunami: Long seismic sea waves, generated by a major disturbance within an ocean basin (mainly due to earthquakes, but sometimes explosive volcanic eruptions or submarine landslides). They are of subdued form in deep water, but on entering shallow nearshore areas their height increases greatly, and can exceed 30 m when they break over the coastline. Glossary - Encyclopedia of Coastal Science.

Turtle nesting Grounds: Sea turtles or marine turtles are generally found in waters over continental shelves; females come ashore to sandy beaches where they dig nests and lay eggs during the nesting season. These beaches are known as turtle nesting grounds/sites. India has five of the seven species of known sea turtles. Mass nesting occurs along sandy beaches on the west and east coast. Female turtles come ashore on sandy beaches where they were born, dig a nest and bury their eggs in it. After hatching the turtles find their way back to the sea.

Vegetated wetland: See Wetland, vegetated.

Waterfront: With reference to CRZ 2011 Notification, activities that require waterfront for their operations include ports and harbours, jetties, quays,

wharves, erosion control measures, breakwaters, pipelines, lighthouses, navigational safety facilities, coastal police stations and the like.

Wave: The term wave indicates the short-period (few seconds) undulations observed on the sea surface due to the action of wind. Wind-generated wave at the generating area is called 'sea' and that have travelled outside their generating area is called 'swell'.
Undulations produced on the sea surface by disturbance, generally the frictional drag of wind action, but see Giant Waves (q.v.).Wave height is the vertical distance between adjacent crests and troughs, wave length the horizontal distance between successive wave crests, wave period the time taken by successive crests to pass a fixed point, wave steepness the ratio of wave height to wave length, and wave velocity the speed at which a wave crest moves forward. Wave energy is taken as length multiplied by the square root of the height. Glossary - Encyclopedia of Coastal Science.

Wave built terrace: A gently sloping coastal feature at the seaward or lakeward edge of a wave-cut platform, constructed by sediment brought by rivers or drifted along the shore or across the platform and deposited in the deeper water beyond (NRCS, USDA).

Wave-cut platform: A gently sloping surface produced by wave erosion, extending into the sea or lake from the base of the wave-cut cliff. This feature represents both the wave-cut bench and the abrasion platform. (NRCS, USDA).

References

C-COAST Glossary – NOAA. Coastal Cartographic Object Attribute Source Table– NOAA. http://www.ngs.noaa.gov/RSD/shoredata/c_coast_def.htm#num6 last accessed 10 August 2014

Clark, J.R. 1977. Coastal ecosystems management: A technical manual for the conservation of coastal zone resources. Wiley-Interscience, New York. 928p.

Cowardin, L. M; Carter, V; Golet, F. C. and La Roe, E. T. 1979. Classification of Wetlands and Deep Water Habitats of the United States. FWS/OBS 79/31. Office of Biological Services, U. S. Fish and Wild Life Service, Washington, D. C.

Darwin, C. 1842: The structure and distribution of coral reefs. Being the first part of the geology of the voyage of the Beagle, under the command of Capt. Fitzroy, R.N. during the years 1832 to 1836. London: Smith Elder and Co.

Ellis, M.Y. 1978. Coastal Mapping Handbook. Department of the Interior, U.S. Geological Survey and U.S. Department of Commerce, National Ocean Service and Office of Coastal Zone Management, U.S. GPO, Washington, D.C. Encyclopedia of Coastal Science. Schwartz. M. (editor) - 2005, Springer, Netherlands, 1211p

Fairbridge, R. W. 1968. Encyclopedia of Geomorphology. Encyclopedia of Earth Sciences Series, Vol. III. Dowden, Hutchinson & Ross.Inc. Stroudsburg, Pennsylvania.Chapman, 1977

Gerlech, S. A. 1973. Grzimek's Encyclopedia Of Ecology. Edited by B. Grzimek, J. Illies, W. Klausewitz. Van Nostrand Reinhold Company. New York.

Glossary of Geology (5th ed.), edited by Klaus K.E. Neuendorf, James P. Mehl Jr. & Julia A. Jackson, 2005. American Geological Institute, Alexandria (VA), USA. Hardcover, xii 779 pages

IOM Glossary. Coastal Zone Management and Coastal Shelterbelt Vulnerability. Published by ENVIS Centre for Coastal Coastal Zone Management and Coastal Shelterbelt, Institute for Ocean Management, Anna University, Chennai

King, C. A. M. 1972. Beaches and Coasts. II ed. 1972. University of Nottingham. Published by Edward Arnold (Publishers) Ltd. London. Davies, 1972

Ladd, H. S., 1977. Types of coral reefs and their distribution. In Jones, O. A., and Endean, R. (eds.), Biology and Geology of Coral Reefs, Vol. 4, Geology 2, pp. 1–19.

Maxwell, W. 1968. Atlas of the Great Barrier Reef. Amsterdam, 258pp.

Nayak, S. and Sahai, B. 1985. Coastal morphology: a case study in the Gulf of Khambhat (Cambay). Inter. J. Remote Sens., 6(3 & 4): 559-568

Nayak, S., Pandeya, A., Gupta, M. C., Trivedi, C. R., Prasad, K. N. and Kadri, S. A. 1989. Application of satellite data for monitoring degradation of tidal wetlands of the Gulf of Kachchh, Western India. Acta Astronautica, 20: 171-178.

NRCS, USDA. Part 629 – Glossary of Landform and Geologic Terms. www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052234.doc

Rumsey, I.A.P., 1971, Relationship of fractures in unconsolidated superficial deposits to those in the underlying bedrock: Modern Geology, v. 3, p. 25–41

CED, 1987. "Our Common Future". World Commission for Environment and Development.

Annex 2: Image Interpretation key for CZMP mapping (modified after Nayak, et al., 1991)

Category	Tone	Shape	Texture	Location	Association	Remarks
Agricultural Land	Red	Regular	Smooth	-	Plains	Rectangular pattern of fields are seen in some cases.
Forest						
Natural	Red	Irregular	Rough	-	Hilly terrain	-
Manmade	Dark brownish red/ dark brown	Linear	Smooth	Adjacent to beach, on dunes	Sandy area/dunes	-
Wetlands						
Mudflat						
Sub-tidal Mudflat	Brown/ Black	Irregular	Smooth	Along lowest water line	Low energy coasts	Usually clayey and silty. Vegetation may be present.
Inter tidal Mudflat	Persian green	Irregular	Smooth	In inter-tidal areas	Low energy coasts and quite depositional Areas, where tidal Influence is not too strong.	Made up of fine grained soft mud in inter-tidal zone. Acts as a suitable habitat for mangroves/marsh vegetation & a variety of flora and fauna
High tidal Mudflat	Bluish green	Irregular	Smooth	Near high tide line	-	Does not get inundated by daily tides. Inundated only during monsoon and highest of high tide.
High tidal Mudflat (With Salt Encrustation)	Pale blue to white	Irregular	Rough to smooth	Near high tide line	-	Have crenulated boundary

Category	Tone	Shape	Texture	Location	Association	Remarks
Mudflat with Vegetation	Bluish green / Brown with red tinge/ spots	Irregular	Rough	-	-	-
Sand						
Beach/Sand Patch	White	Linear/ Crescent	Smooth	Adjacent to coast on land-water boundary	Open coast	Made up of fine sand particles, broken molluscan shell, etc.
Spit	White	Linear may be curved at end	Smooth	Part of beach extending in sea	Open coast	Narrow embankment of land consisting of sand/gravel having one end attached to the mainland and other terminating in open water
Sand Bar/ Barrier Island	Whitish	Linear and Narrow	Smooth	Running Parallel to the beach	In shallow epicontinental or shelf water. Found singly or together and internally terminated.	Linear deposite of sand/gravel
Shoal	Brown	Irregular	Smooth	Near the coast or offshore within estuary, delta, gulf, etc.	-	Either submerged ridge, bank or bar producing shoal. Consisting of sand, mud, gravel etc.
Rocks						
Rocky coast	Dark Brown	Narrow strip	Rough	Adjacent to coast	Pocket beach and cliffs	Beach, mudflats are normally absent
Rock exposure	Dark Brown	Irregular	Rough			
Coral Reef						
Coral reef	Greenish, Greenish Blue		Smooth	Near Low Water line	Lagoon in some cases	Can be fringing, atoll, platform or patch reefs

Category	Tone	Shape	Texture	Location	Association	Remarks
Reef Flat	Green, Bluish Green, Reddish Green	Irregular	Smooth	Inward to Algal Ridge	Occurrence of live coral colonies	Exposed during low tides, scattered coral colonies, may be covered with a layer of mud or sand
Sandy Patch / Beach	White. Light Pink if vegetated	Irregular	Smooth	On Reef Flat	Reef flat	Sand depositions
Coral Lagoon	Cyan/ bright blue/ deep blue depending on the depth and substrate	Irregular but mostly circular or elliptical	Smooth	Landward from the reef flat or algal ridge and seaward from the beach	Atoll	A coral reef lagoon is an enclosed body surrounded by reef and island and may have one or more openings into the sea
Coralline Shelf	Blue	Irregular	Smooth	Surrounding Windward Reef Front/ extending southwards or connecting two reefs	Coral Reef	Coralline shelf is the shelf area discernible from satellite data when the waters are clear. It may be 50 m or more in depth and may be with corals
Mangrove	Bright red, if dense, pale red if sparse	Irregular	Rough to Smooth	In the inter tidal area	Low energy coasts or quiet depositional area. Warm waters.	Grows on substrate of mud/ mudsand composition where the percentage of mud is more. Evergreen.
Marsh vegetation	Dark brown if dense, brown if sparse	Irregular	Smooth	In the inter tidal/ supra tidal area	Low energy coasts or quite depositional area. Cold waters	Usually occur in temperate countries. Certain salt-tolerant species occur within mangroves or after the mangrove belt. Evergreen.

Category	Tone	Shape	Texture	Location	Association	Remarks
Algae	Pink if dense	Irregular	Smooth	Inter-tidal/ Supra-tidal area	On reefs,rocks and mudflat	Distinct on reef edge, reef flats & rocky coast
Seagrass	Dark Green, Blackish Green, Bluish Green	Irregular	Smooth	In lagoonal waters shore-ward/reef-flat	Sand/sandy mud in low energy environment	They occur as beds/meadows in the lagoonal areas or may inhabit shallow pools in the reef flat.
Water Bodies						
Estuary	Dark blue	Funnel	Smooth	Connection with Sea and land	Rivers draining into Sea	Semienclosed body. Part of the lower river course that is affected by mixing of salt-water and fresh water
Creek	Blue	Meandering	Smooth	Inter-tidal/ Supra-tidal area near high-tide mark	Mudflat	Intricate network of narrow inlets of sea water in tidal flats
Lagoon	Deep blue	Varying Oval, linear etc	Smooth	Offshore / near / Parallel to coast	In between coral reefs lying parallel to coast and separated from open sea by bar/barrier island/Spits, in some area	Lagoons situated in between reef have sandy beach on one end. Opening of the lagoon into sea may be more than one.
Bay	Dark blue	Semicircular	Smooth	On the coast	-	-
Barren Land						
Mining area/ dumps	Light to dark green	Irregular	Rough	Bad land	Ponds	Iron ore, stone quarries

Category	Tone	Shape	Texture	Location	Association	Remarks
Rock outcrops / gullied land	Green blue yellow brownish	Irregular	Very coarse to coarse & medium	Steep hillrocks,hill slope/crest plateau and eroded plains	Barren and exposed rock, stony waste, lateritic out crops, mined areas, and quarried sites	These are exposures of different rock types which occur as massive boulders etc in hill forest, plateau, plains etc. These are barren and devoid of soil cover and vegetation.
Shoreland						
Saline Area						
Coastal Dune	Red/ white	Linear	Smooth	Behind the beach on land ward side,	Develops in any environment in which loose particles of sand are exposed to sand action. Plantation in some cases.	Detected easily when vegetation is present on it, otherwise the signature of dune gets mixed up with beach. Casurina plantations may be present.
Reclaimed mudflat	Bluish white	Irregular	Rough	Above High Water Line	Presence of Earthern Bund	Crops are grown on it.
Built Up Land						
Habitation	Dark bluish green in the core & bluish on the periphery	Irregular	Coarse &	Plains, plateaus on hill slopes	Network of road and rail etc.	Built up land can be big or small size settlement industrial structures bldg. or any other artifact physical spread or sprawl along with density of transport network are useful surrogates to classify it as urban or rural land transformation can be noticed around built up land.

Category	Tone	Shape	Texture	Location	Association	Remarks
Habitation with veg.	Dark bluish green in the core & bluish on the periphery and reddish spots	Irregular	Coarse &Moltted	Plains, Plateau, Hill slopes	Same as above	Under regulative order.
Open vacant land	Yellowish greyish	Rectangular	Smooth		Within built up area	-
Transportation						
Roads	Dark grey	Straight with bends	Smooth		Interspersed with pink tone	It has a linear pattern.
Railways	Light grey	Straight	Smooth	-	-	-
Harbour	Light cyan	Irregular	-	On the coast	Breakwater, Berths, Quays etc.	-
Waterways	Dark	Linear		-	Reservoirs and Large Water bodies	-
Airport	Light blue	Long straight strips	-	Outskirts of city	Runways	
Other Features						
Aquaculture ponds	Dark black	Rectangular/ square	Smooth	Near high tide limit	Mudflat, Creek	-

Category	Tone	Shape	Texture	Location	Association	Remarks
Reclaimed area	Dark bluish green in the core and bluish on the periphery	Irregular	Coarse & mottled	-	Bunds, embankments	Reclaimed for agriculture, industrial, residential use
Salt Pan	Dark Blue/ light blue/ white	Rectangular/ square	Smooth	Near high tide limit	On the land. Tidal influx is not daily.	Dry salt pan appears white. Shallow depressions in which water collects and evaporates leaving salt deposit.
Embankment		Linear			Across the creeks, near HTL	Constructed to stop salinity ingress, reclamation, etc.
Ponds/lakes	Light blue to dark blue	Regular to irregular	Smooth to mottled	Tanks and lake in lowlands/plains, reservoirs, etc	Amidst cultivated lowlands	These are impounded water bodies on low lands,plains across river/streams
Rivers/streams	Blue/ White	Irregular sinuous	Smooth to medium	Natural rivers /streams (perennial & ephemeral)	Drainage pattern on hill slopes,floodplains,uplandsetc	These are water courses in the channels of different dimensions and lengths.
High water line	White	Linear	Smooth	Located up to the highest sea water influx on land during high tide	Supratidal area	Total discontinuity between wetland and terrestrial system
Low water line	Blue	Linear	Smooth	Located up to level to which water recedes during low tide	Subtidal area	Total discontinuity between wetland and marine waters.

Annex 3: Classification accuracy estimation (modified after Nayak, et al., 1988)

The geographical location of points to be sampled on the ground is commonly determined by any of the following three ways: (i) random sampling, (ii) stratified random sampling and (iii) stratified systematic unaligned sampling. We have followed the random sampling method. In random sampling, the location of the sample point on the ground is chosen using a random number table to select random coordinates for sampling. These coordinates may be geographic (latitude and longitude) or any arbitrary coordinate system, so long as all the areas on ground have an equal probability of being selected.

The classification accuracy is tested on a sample basis assuming a binomial distribution for the probability of success/failure of sample tests. Sample size is decided using look-up tables prepared (Tables 5, 6 and 7), using a binomial probability distribution model (Arnoff, 1982). Each segment was chosen of size 50 x 50 m (2 x 2 mm on 1:25,000 scale). This ensures that there is only one predominant class in each segment to satisfy binomial condition. This segment should be large enough to be easily locatable the ground.

Initially, 300 points are to be selected by pseudo-random sampling and plotted on the final wetland map (the points falling in the sea as well as far inland are to be rejected). The selected points are to be transferred on 1:25,000 scale topographical maps to evaluate approachability of these sites/locations. To reach these areas, approach the nearest village. Cultural features, tomb, water well, and so on are to be used to confirm the position. Wherever no such cultural features are available the topographic/geomorphic information such as creeks, rock outcrops and islands are to be used to reach the sample sites. Before visiting the area, the tidal conditions are to be checked, as the points falling in the intertidal area can be approached only during low tide.

Confusion matrix is then drawn and the accuracy is estimated (Table 5). The confusion matrix scores each observation according to the class in which it has been mapped and the true class as observed on the ground. A sample result for the Maharashtra coast is given in Tables 6 and Table 7

Table 5: Confusion error matrix of coastal wetland/land use mapping (Maharashtra coast)

S. No	Category in Map	Verified on ground										Total omission/ Commission	Error
		1	2	3	4	5	6	7	8	9	10		
1	Mudflat	6										6	
2	Beach		4									4	
3	Mangrove			6	1							7	1
4	Other vegetation				3							3	
5	Dune					3						3	
6	Mining area/ Dumps						2					2	
7	Habitation							4				4	
8	Habitation with vegetation								3			3	
9	Reclaimed mudflat									2		2	
10	Salt pans										2	2	
Total		6	4	6	4	3	2	4	3	2	2	36	1

No. of points checked = 36
No. of failures = 1
Classification accuracy = 89 % at 90 % confidence level.

Table 6: Classification accuracy levels for the confidence level of 90%

Sample	No. of allowed Failures										
Size	0	1	2	3	4	5	6	7	8	9	10
15	85	76	68	61	54	47	40	34	28	23	17
20	89	82	76	70	64	59	53	48	43	38	34
25	91	85	80	75	71	66	62	57	53	49	45
30	93	88	83	79	75	71	68	64	60	57	53
35	94	89	86	82	78	75	72	69	66	62	59
40	94	91	87	84	81	78	75	72	70	67	64
45	95	92	89	86	83	80	78	75	73	70	68
50	95	92	90	87	85	82	80	78	75	73	71

Table 7: Confidence levels for classification accuracy of 85%

Sample	No. of allowed Failures										
Size	0	1	2	3	4	5	6	7	8	9	10
15	91	68	40	18	6	2					
20	96	82	60	35	17	7	2	1			
25	98	91	75	53	32	14	7	3	1		
30	99	95	85	68	48	29	15	30	1		
35	100	98	91	79	62	43	27	14	7	3	1
40	100	99	95	87	74	57	39	24	14	7	3
45	100	99	97	92	83	69	52	36	23	13	7
50	100	100	99	95	89	78	64	48	33	21	12

N = Sample size
X = No. of allowed failures

Annex 4: Standard symbols, colours and patterns to be used for mapping

Sr. No.	Class type	Symbol	Layer 1							Layer 2										
			Type	Color	Red	Green	Blue	Angle	Scale	Type	Colour	R	G	B	Width/size	Angle	Scale	Separation	Width/size	Colour
1	Sub tidal mudflat		Simple Fill Symbol	Gray 60%	104	104	104			Marker Fill Symbol	Solar Yellow, Asterisk 3	255	255	0	18	0		12		
2	Inter tidal mudflat		Simple Fill Symbol	Gray 50%	130	130	130			Line Fill Symbol	Big Sky Blue, Dashed	0	197	255						
3	High tidal mud flat		Simple Fill Symbol	Gray 60%	104	104	104													
4	High tidal mud flat with salt encrustation		Simple Fill Symbol	Gray 60%	104	104	104			Marker Fill Symbol	Raw Umber, Esri caves, Subaqueous coralloid	168	112	0	Gray 20%	204		204	204	
5	Beach/Patch		ESRI Picture Fill Symbol	Foreground: Poinsettia red	230	0	0													
				Background: Topaz Sand	255	235	175													
6	Spit		ESRI Picture Fill Symbol	Foreground: Gray 50%	130	130	130													
				Background: Yucca Yellow	255	235	175													
7	Bar/barrier/island		Simple Fill Symbol	Topaz Sand	255	235	175			Marker Fill Symbol	Cretan blue	0	112	255	18	45		12		
											Yucca Yellow, Esri caves1, Unicode:163	255	255	190	18	45		12		
8	Shoals		Simple Fill Symbol	Topaz Sand	255	235	175			Marker Fill Symbol	Gray 40%, Esri caves3, Unicode:88	156	156	156	18	0		12		
										Marker Fill Symbol	Circle	115	115	0	2					
9	Beach ridge		Simple Fill Symbol	Tecate Dust	215	194	158			Character Marker Symbol	Cherrywood Brown, Esri dimensioning, unicode:75	115	38	0						
10	Swale		Simple Fill Symbol	Tecate Dust	215	194	158			Marker Fill Symbol	Fir green, Esri caves2, Unicode:72	38	115	0	18	0		12		
11	Rocky coast		ESRI Picture Fill Symbol	Foreground: Gray 50%	130	130	130													
				Background: Burnt Umber	156	76	0													
12	Rock exposure		ESRI Picture Fill Symbol	Foreground: Gray 30%	178	178	178			Marker Fill Symbol	Peridot Green, Esri caves1, Grass	170	255	0	18	0		12		
				Background: Burnt Umber	156	76	0													
13	Mangrove Dense		Simple Fill Symbol	Fir Green	38	115	0													
14	Mangrove Sparse		Simple Fill Symbol	Medium Apple	85	255	0													
15	Mangrove degraded		Simple Fill Symbol	Fir Green	38	115	0			Marker Fill Symbol	Gray 40%, Square2	156	156	156	18	0		20		
											white, Square2	255	255	255	18	0		20		
16	Marsh Vegetation Dense		Simple Fill Symbol		140	137	70			Marker Fill Symbol	Fir Green, Grass	139	90	43	18	0		8		
17	Marsh Vegetation Sparse		Simple Fill Symbol		140	137	70			Marker Fill Symbol	Simple Diamond1	139	90	43						
18	Algae Dense		Simple Fill Symbol		255	223	255			Marker Fill Symbol/ESRI CAVES 1/Unicode:63	Leaf Green	56	168	0	22	0		10		

19	Algae Sparse		colour	colour	255	223	255				black, dashed				1	0	4			
20	Seagrass Dense		Simple Fill Symbol		218	252	221			Marker Fill Symbol/ESRI CAVES 1/Unicode:195	Peridot Green	104	104	104	30	0		12		
21	Seagrass Sparse		Simple Fill Symbol		218	252	221			Marker Fill Symbol/ESRI CAVES 3/Unicode:49		139	90	43	18	0		30		
22	Scrub Sparse		Picture fill Symbol	Foreground: Lime Dust	215	215	158													
				Background: Cordavan Brown	137	68	68													
23	Fringing Reef		Simple fill Symbol	Tourmaline Green	0	255	197			Marker	Dark Amethyst				20	0		12	1	Beryl Green
24	Platform Reef		Simple fill Symbol	Tourmaline Green	0	255	197			Marker	Anemone Violet				30	0		20	1	Light Apple
25	Patch Reef		Picture fill Symbol	Foreground: Medium Azul	122	142	245													
				Background: Tourmaline Green	0	255	197													
26	Atoll Reef		Simple fill Symbol	Tourmaline Green	0	255	197			Marker	Anemone Violet				30	0		50		
27	Reef Edge																			
28	Algal Ridge																			
29	Reef flat		Simple fill Symbol	Tourmaline Green	0	255	197			Line fill Symbol	Sahara sand	255	235	190	3	0		6		
30	Sand cay		Simple fill Symbol	Sahara Sand	255	235	190			Marker	Fir Green	38	115	0	18	0		12		
31	Coral Lagoon		Simple fill Symbol	Tourmaline Green	0	255	197			Line fill Symbol	Black				1	135/45		5		
32	Coral Pinnacle		Simple fill Symbol	Tourmaline Green	0	255	197			Marker/Square 1	Black	0	0	0	5	0		12		
33	Coralline Shelf		Simple fill Symbol	Tourmaline Green	0	255	197			Marker/ESRI Caves2/Unicode214 &215	Black & Fuchsia Pink				18					
34	Coral Head		Simple fill Symbol	Tourmaline Green	0	255	197			Simple Circle Marker Symbol	Arctic White	255	255	255	5				1	Black
35	Coral knoll		Simple fill Symbol	Rose Quartz	255	190	190													
36	Pond/lake		Simple fill Symbol		0	0	200													
37	Lagoon		Picture Fill Symbol	Foreground: Arctic White	255	255	255													
				Background: Apatite Blue	115	223	255													
38	Oxbow lake/meanders		Simple fill Symbol		0	0	200			Line Fill Symbol/ESRI Dimensioning/Unicode 75	Arctic White	255	255	255	10	0		12		
39	Reservoir/Tank		Simple fill Symbol		0	0	200			Line Fill Symbol	Arctic White	255	255	255	1	90		5		
40	Waterlogged		Picture Fill Symbol	Interbedded sandstone and Silt stone Foreground:	0	0	255													
41	Mining area/dump		colour		168	112	0			Line	Yellow, continuous				1	0	4			
42	Rock outcrop		colour		168	112	0			Marker	Triangle, black				9	0	7			
43	Brick Kiln		Simple fill symbol		191	158	61			Marker fill symbol	Square-2,Arctic white	255	255	255	5	0		8		
44	Sandy area		Picture Fill Symbol	Foreground: Mars red	255	0	0													
				Background: Yucca Yellow	255	255	190													
45	Saline area		Line fill symbol	beryl green	155	255	223								0.5	135		4		
			Line fill symbol	beryl green	155	255	223								0.5	45		4		

46	Dune with vegetation		Simple fill symbol	Mango	255	211	127			Marker fill symbol	Fir green	38	115	0	20	0		14		
47	Dune without vegetation		Simple fill symbol	Mango	255	211	127													
48	Habitation		Simple fill symbol	Mars red	255	0	0													
49	Habitation with vegetation		Simple fill symbol	Mars red	255	0	0			Marker fill symbol	Tree1,Tarragon green	112	168	0	6	0		10		
50	Open/vacant land		Simple fill symbol	Mars red	255	0	0			Marker fill symbol	Solid square1,Sahara sand	255	235	190						
51	Industrial area		Simple fill symbol	Poinsettia red	230	0	0			Line fill symbol	Arctic White	255	255	255	1	0		5		
										Line fill symbol	Gray 10%	225	225	225	1	90		5		
52	Waste dumping		Picture Fill Symbol	Mars red	255	0	0			Marker fill symbol	Black	0	0	0	2	0		7		
										Simple fill symbol	Gray 10%	225	225	225						
53	Agriculture land		Simple fill symbol	Solar Yellow	255	255	0			Marker fill symbol	Environmental, wetland, Fir green	38	115	0						
54	Forest/Plantation		Picture fill symbol	Foreground: Tree,Tarragon green	112	168	0	8	0.5	Picture fill symbol	Foreground: Tree,Fir green	38	115	0		0	X: 0.40, Y:0.5 0			
				Background: Nil							Background:	190	190	190						
55	Aquaculture Pond		colour	0	0	0	200			Line	White, continuous	1	45	4						
56	Saltpans		Simple fill symbol	Arctic White	255	255	255			Line fill symbol	Gray 70%	78	78	78	0.5	0		5		
										Line fill symbol	Gray 70%	78	78	78	0.5	90		5.4		
57	Seawall/Embankment		colour	0	0	0	0			Line	black, continuous	1	90	4						
58	Palaeomeander		colour	211	255	190				Marker	Diamond, black				15	0	12			
59	Palaeochannel		colour	211	255	190				Line	continuous, black				1.5	90	5			
60	Reclaimed Mudflat		colour	211	255	190				Marker	Triangle, black				12	0	9			
61	Rolling Plain		colour	211	255	190				Marker	Air, black				18	0	12			
62	Strand Plain		colour	211	255	190				Line	continuous, black				1.5	45	5			
63	Deltaic Plain		colour	211	255	190				Marker	Circle, black				3	0	5			
64	Flood Plain/Flood Prone		colour	211	255	190				Line	continuous, black				1	0	5			
65	Terrace		Simple fill symbol		204	179	128													
66	Jetty		Simple fill symbol	Peony pink	230	0	169													
67	Airport		Simple fill symbol	Gray 30%	178	178	178			Line fill symbol	Arctic White	255	255	155						
68	Man made forest		Simple fill symbol		152	230	0			Marker fill symbol	Montane grassland, Tree, oval	115	0	76	40	0		x:30 , y: 40		
69	Estuary		Simple fill symbol		0	77	168			Marker fill symbol	Vertebrate Skeleton,	255	255	255	3	0		6		
70	Creek		Simple fill symbol		0	77	168			Marker fill symbol	Esri Geology, Unicode:74									
71	Bay		Simple fill symbol		0	77	168			Marker fill symbol	Cauliflower aa lava	255	255	255	30	0		30		

72	River/stream		Simple fill symbol		0	169	230													
73	Canal		Apatite blue		115	223	255													
74	Cliff		Character Marker Symbol	Esri caves 1, Unicode:217, Cocoa Brown	137	90	68			Character Marker Symbol	Esri caves 1, Unicode:217, Cheerywood Brown	115	38	0						
				Esri caves 1, Unicode:108, Black	0	0	0				Esri caves 1, Unicode:108, Black	0	0	0						
75	Road		colour		255	0	0													
76	Rail		Line fill symbol	Single Nautical Dashed																
77	Reef Edge		colour	205	205	102														
78	Algal Ridge		colour	76	115	0														
79	High Tide Line		colour	255	0	197				Line	magenta, continous				2					
80	Low Tide Line		colour	0	112	255				Line	blue, dashed				2					
81	Mud with vegetation		Simple fill symbol		158	112	15			Marker fill symbol	tree1	150	205	96						
82	Sand with vegetation		Picture fill symbol	Foreground: Black	0	0	0			Marker fill symbol	Tree broad spreading, Fir green	38	115	0	16	0		16		
				Background: Mango	255	211	127													

Annex 5: Standardization of Methodology for Demarcation of HTL/LTL - Minutes of the Meeting 1 & 2.

Minutes of the 1st Meeting on Standardization of Methodology for Demarcation of HTL/LTL held at Ministry of Earth Sciences, New Delhi on 1st July 2014

1. **Introduction:** In its 27th meeting held in the Ministry of Environment, Forests and Climate Change, New Delhi, on 25.06.2013, the National Coastal Zone Management Authority (NCZMA) constituted a committee under the chairmanship of Dr. Shailesh R Nayak, Secretary, MoES with seven authorized agencies as members and Director, NCSCM as Member Convener to standardize the methodology for demarcation of HTL/LTL so as to make the demarcation procedure uniform. The following is the ToR for the Committee.
    i. Review / Evolve uniform guidelines / methodology for demarcation of HTL/LTL.
    ii. Suggest the format of the report on HTL / LTL demarcation including map of 1: 4,000 scale with Co-ordinates, land features etc.
    iii. Prescribe the Time schedule for demarcation of HTL/LTL.
    iv. Prescribe cost for demarcation of HTL/LTL.

Accordingly, the first meeting of the Committee was held at Prithvi Bhawan, Ministry of Earth Sciences, New Delhi on 01/07/2014, under the Chairmanship of Dr. Shailesh R Nayak, Secretary, MoES. Representatives of the following authorized agencies for demarcation of HTL/LTL attended the meeting.

i. Space Application Centre (SAC), Ahmedabad
ii. National Centre for Earth Science Studies (NCESS), Thiruvananthapuram
iii. Institute for Remote Sensing (IRS), Anna University, Chennai
iv. Institute of Environmental Studies and Wetland Management (IESWM) Kolkata
v. National Hydrographic Office (NHO), Dehradun
vi. National Institute of Oceanography (NIO), Panjim, Goa
vii. National Institute of Ocean Technology (NIOT), Chennai
viii. National Centre for Sustainable Coastal Management (NCSCM), MoEFC, Chennai

The List of members and invitee who attended the meeting is given in Annex A.

2. **Opening Remarks by Chairman:** Dr. Shailesh R Nayak, Secretary, MoES Chairman in his opening remarks stated that the methodology for demarcation of HTL/LTL and for preparation of regional level and local level CRZ maps should be based on scientific principles and should be repeatable and verifiable. He emphasized that all the records used and generated in various projects should be maintained for future verification by independent agencies and that the accuracy of the results should invariably be specified in the final reports. He also said that the definition of each parameter should

be understood and agreed upon by all agencies involved and that the period of input data such as Satellite imageries etc, chosen for the work should be in synchronization with the task. He stressed the need for discussions in order to arrive at unanimity and standardization of definitions and classification systems used for landuse, geomorphology and various other parameters.

3. **Remarks by Member Convenor:** In his remarks, Prof. R. Ramesh, Director NCSCM and Member Convenor of the Committee welcomed Chairman and proposed to the Chair to guide the Committee through the process of standardization of methodologies. He mentioned that NCSCM is also now authorized by MoEF&CC, Government of India for demarcation of HTL/ LTL. NCSCM would coordinate between the various agencies and the MoEFC in developing a comprehensive standardized Manual for demarcation of HTL/ LTL. This manual would be used by the current authorized agencies and various other agencies who will be involved in future for demarcation of HTL/ LTL. Prof. R. Ramesh also explained in detail the various aspects of the ToR of the Committee.

4. **Group Discussions:** The presentations made by the various agencies are given in Annex B. The members brought out the following points for discussions during their presentation.

4.1. Issues related to CRZ mapping:

a) Definitions and Classification system:

- Definition, location and distribution of sand dunes and mud flats have to be provided by appropriate authorities.
- Defining and identifying 'biologically active mudflats'.
- Distinction between Khar land, Filtration pond & paddy fields.

b) Satellite data – Multi-Resolution, Different time period etc:

- Inaccessible areas like Andaman & Nicobar, Reserved Forest, Defense areas and endangered areas cannot be done by the present methodology.
- In some cases of densely populated built-up areas even 1: 4000 scale map is not interpretable accurately, to suit individual site needs.

c) Ecologically important areas such as mangroves etc:

- Some of the ecologically sensitive areas such as turtle nesting sites have to be provided by the authorized agencies.
- Categorization for any mangrove plantation/ sapling areas.
- Information on 'Turtle nesting grounds' and Horse shoe crab habitats, biologically active mud flats & salt marshes is necessary.

d) Boundaries of CRZ with respect to features – Classification of CRZ I, II, III, IV & V:

- There are no guidelines available for fixing the mouth of the Creek / Bay / backwaters and it leads to confusion.
- In case of Kerala and Maharashtra, it is observed that low lying areas

are protected by bunds constructed prior to 1991. However, due to damage of bunds, salt water intrusion occurs in low lying areas causing mangroves to grow. In the same way Holding ponds meant for storm water management also suffer incursion of sea water because of damage to the bunds.

- Change of shoreline by natural and manmade sources has to be critically addressed.
- Within a legally designated urban body, there can be patches of dense built-up area, vacant plots/area, sparse or undeveloped area. Will such different land use plots be marked as different CRZ categories such as CRZ-II or CRZ -III? What will be the threshold of "Substantially built up" quantitatively? Dichotomy in interpreting ratio of built up to that of total plots > 50% = CRZ- II due to scale factor.
- In case different CRZ categories may be delineated, what may be the minimum area acceptable for a separate CRZ categories within an urban body or if there are other basis for classification??
- For a built-up unit lying partly within a designated urban body what will be the basis of CRZ zonation?
- Boundary between the sea and creek, estuary, backwater, bay, river.
- Salt pans : any distinction between those with natural tidal flow & artificially pumped ?

e) Tidal levels and their transfer, width of water bodies:

- Tide levels are currently available only for major / selected minor ports. Because of this the high and low tide levels are interpolated which affect the accuracy.
- Guideline does not stipulate the frequency of HTL / LTL sampling during field verification.
- Storm surges during extreme events are not considered as HTL.
- Width of the water body: whether it is the distance between the HTL at the bank to the HTL on the opposite bank or the width between the LTL at the bank to the LTL on the opposite side.

f) Period related issues – 1991 or 2011 etc:

- Guideline does not stipulate the conditions for mangrove mapping. Whether mangrove map will be as on 1991 or 2011 or present day?
- 50 m buffers for mangroves on the landward side which has got road as in 1991 to be drawn or not to be drawn?

g) Geo-referencing, Benchmark, etc:

- Geo-referencing of village maps is done using Satellite imagery/GCP due to non-availability of village bi-junction / tri-junction pillars.
- The resolution of previous data (1:25,000) and present data (1:4000, 1:25,000) are different, making it difficult to superimpose and compare.
- Non-availability of Bench marks along the coast and inland creeks causes hardship in transferring high tide levels. Hence geomorphology and ground evidences are only used to mark HTL.

h) Measurement of Salinity:

- Salinity level is dynamic even across the day due to changing rainfall conditions and mixing of domestic and industrial waste disposal. Salinity sampling for all the creeks at the same time is not possible.
- In Kerala fresh water dilutes the Salinity level which makes it difficult to estimate the Tidal influence.
- Treating / lining structural changes in the storm water drainage channels draining into the creeks bring about serious changes in Salinity levels.

5. Standardization of Methodology:

- **Definitions & Classification system:** Standard definitions of all important parameters/ terms (e.g. Bay, estuary, creeks etc) will have to be provided as definitions and as Glossary in the Manual, for the benefit of all authorised agencies.
- **Coastal Information System:**
  - » Database should be prepared first, irrespective of scale and checked for accuracy and final maps should be prepared in the required scales.
  - » Satellite images should also be a part of the database in all projects and images from Bhuvan is also recommended for use.
- **Field Surveys – Determining Upper Limit of Tidal Influenced Water Bodies:** Standardized methodology will be provided in the Manual for measurement of salinity, from sampling to Analysis, in order to maintain methodological consistencies among all authorised agencies.
- **CRZ Survey Report Format:** The Manual prepared by SAC / International symbols and legends available in IHO publication may be used for consistency.
- **Accuracy Assessment:**
  - » For estimation of Total horizontal and vertical uncertainties, Special Publication #44, 5th edition of the IHO Publication may be referred.
  - » Quality check of all output should be done and accuracy numbers should invariably be mentioned as part of final reports.
- **Identifying geo-morphological features:**
  - » All natural salt pans should be taken as Inter-tidal zone, except artificially pumped salt pans, such as those in Tuticorin District, Tamil Nadu.
  - » Bunds constructed across tidally influenced water bodies such as rivers, creeks etc before the year 1991 should be taken as the HTL and bunds constructed after 1991 should not be taken as the HTL. HTL as in the years 1991 and 2011 should be surveyed and changes in HTL with respect to 1991 and 2011, if any, should be indicated with justifications.
  - » Ecological sites / turtle breeding sites, sand dunes and mud flats, etc are being mapped by NCSCM under the ICZM project and will be provided to the authorised agencies.
  - » Width of rivers and water bodies should be taken from HTL to HTL (and not LTL to LTL which refers to CRZ in water bodies).

- **<u>Cost factors for preparing 1:25,000 & 1:4000 scale HTL/ LTL maps:</u>** Cost of HTL/ LTL mapping should be based on the layout/ size of maps. Follow the standardised pattern of SoI for charging for various maps (e.g. 7 ½′ x 7 ½′ for 1: 25,000 maps). Exact costs need to be worked out collectively.

6. Decisions taken:

i. The next meeting will be tentatively either on 1st of August 2014 or around 11th of August 2014.

ii. A Sub- Committee consisting of Dr. M. Baba, Dr. Anjali Bhuguna, Dr. A.S. Rajawat, SAC, along with a team from NCSCM will prepare the first draft of the Manual by 15th July 2014 and submit to the Chairman.

iii. Member Convenor can also request the representatives from authorized agencies to contribute to the manual as deemed necessary for specific aspects.

iv. This draft Manual will be finalized in the next meeting of the full Committee in August 2014.

7. The meeting ended thanking the Chairman.

Annex A

List of Members & Invitees who attended the first meeting on Standardization of Methodology for Demarcation of HTL/LTL held on 1st July 2014 at 11:00 am in the Conference room 114, Prithvi Bhawan, MoES, New Delhi

Chairman: Dr. Shailesh R Nayak, Secretary, Ministry of Earth Sciences, New Delhi.
Member Convenor: Prof. R. Ramesh, Director National Centre for Sustainable Coastal Management, MoEF&CC, Government of India, Anna University Campus, Chennai.

Members / Representatives of Authorized Agencies:

i. Dr. A S Rajawat Head, Geosciences Division, SAC, Ahmedabad.
ii. Dr. K V Thomas, Head Marine Sciences Division, NCESS Trivandrum.
iii. Dr. S S Ramakrishnan, Director IRS, Anna University, Chennai.
iv. Dr. M A Atmanand, Director, NIOT, Chennai.
v. Dr. Debajyoti Bhowmik IESWM, Kolkata.
vi. Dr. A K Chaubey, NIO, Goa.
vii. Cdr Anirban Banerjee, NHO, , New Delhi

Invitees:

i. Dr. M. Baba, Former Director, NCESS, Thiruvananthapuram.
ii. Dr. Anjali Bhaguna, Environment Consultant, Ahmedabad.
iii. Dr. A.B. Harapanahalli, National Project Director, SICOM, MoEFC, New Delhi.
iv. Dr. A. Senthil Vel, Additional Project Director, SICOM, MoEFC, New Delhi.
v. Dr. Purvaja Ramachandran, Scientist-G, NCSCM, MoEFC, Chennai.
vi. Mr. M. Dharma Raj, Senior Consultant, NCSCM, Chennai.
vii. Dr. R. Vidhya, Professor, IRS, Chennai.
viii. Dr. K. Srinivasaraju, Professor, IRS, Chennai.
ix. Dr. Alak Haldar, IESWM, Kolkata.

Annex B

Presentation by Authorized agencies:

1. **Presentation by SAC Ahmedabad:** In his presentation, Dr. A S Rajawat Head, Geosciences Division, SAC, Ahmedabad highlighted the following aspects concerning the methodology being followed by SAC.
   - SAC had undertaken Pilot studies to determine the methodology for mapping the hazard Line, which is the union / most landward of flood and erosion lines
   - Satellite imagery selected at Low tide time (using Tide tables) is used for demarcation of LTL
   - Season of satellite data is from December to February
   - LISS IV merged with Cartosat data is used
   - IKONOS data is used for 1: 4000 scale mapping in grids of 2′ 30″ X 2′ 30″
   - Band 4 of LISS IV in which land-water boundary is distinct is used, especially for LTL
   - SAC LULC classification which is specific to the coastal areas is used
   - On-screen interpretation is done using interpretation keys
2. **Presentation by National Centre for Earth Science Studies (NCESS), Thiruvananthapuram:** Dr. K V Thomas, Head, Marine Sciences Division, NCESS Thiruvananthapuram, detailed the following points regarding the methodology being followed by NCESS.

   i. HTL is normally defined as the water level at which the highest tide intersects with the vertical plane. But according to the functional definition given by MoEF, HTL is "*the line on the land up to which the highest waterline reaches during the spring tide",* which gives the combined effect of spring tide, wave set up and seasonal shoreline oscillations. LTL may be defined as the conventional LLWL.

   ii. Different approaches to demarcate HTL:

   a. Tide level Projection;

   b. Using Morphological Signatures

   - Field method; *b.* Satellite data.

   iii. NCESS follows the method which uses Morphological signatures. The HTL is identified using morphological indicators such as landward (monsoonal) berm crest, seawalls/ revetments/ embankments, permanent vegetation line, tidal flats, mudflats, rocks, headlands and cliffs. Position of HTL is fixed with respect to identified reference points (GCPs) on the land, at intervals of about 1 km alongshore which is dependent on coastal morphology. In the cases of estuaries, creeks, backwaters, etc, the upstream limit of tidal influence is determined based on whether salinity is 5 ppt or more. Salinity measurements and indictors like tidal barrages, presence of mangroves, tidal flats and reversal of flow are also used to identify the limit of tidal influence.

   iv. Cadastral/ Revenue maps are geo-referenced with WGS 84 datum and UTM projection using GPS measured GCPs' at identified plot junctions, survey stones and other ground features identifiable both on the map

and ground. Signature of the nearest HTL is identified and observed using GPS with reference to GCP and transferred to the map in GIS platform. Information from Satellite images are used to verify the data collected and also to supplement the data wherever the area is not approachable. With the availability of precision GPS and high resolution Satellite data like Quick bird, IKONOS, Cartosat and Resource Sat (P6) it is now possible to get an accuracy of less than 1 m for the demarcation of HTL / LTL.

v. LTL Delineation: Information on LTL from Hydrographic charts and Satellite imagery is used. Seaward limit of beach / tidal flat during fair weather season when the beaches / intertidal zone will have the maximum width is identified from imagery.

vi. CRZ Map in 1: 25,000 scale: For policy decisions, CRZ maps in 1: 25,000 scale are sufficient. These are prepared with SoI Toposheet as base map. HTL and other morphological features are extracted from imageries supported with maximum ground truthing. In areas having canopy cover like coconut, field mapping is more relied upon for 1:25000 CRZ map.

3. **Presentation by NIOT, Chennai:** In his presentation, Dr. M.A. Atmanand, Director, NIOT, Chennai discussed the following points on the methodology followed at NIOT.

   i. Steps involved:

      a. Tracing the contour corresponding to the High Tide Level on the ground.

      b. Integrating the contour of HTL onto the chart containing cadastral data and project details.

   ii. Tracing the contour of HTL on the ground:

      - Nearest SoI/other Bench mark (MSL) is identified.
      - Using this BM another TBM is established at the site close to the beach.
      - The tidal characteristics at the site are ascertained from the largest scale NHO charts.
      - MSL ~ CD indicates the amplitude of the tide at the site (e.g. Chennai 1.2 m).
      - Taking TBM as the reference, beach profiling is done at 50 m interval, from lowest possible level to HTL + 2 m, using RTK GPS.
      - A contour chart is prepared for the coverage area in which contours corresponding to HTL / LTL are marked.

   iii. Integrating the HTL contours and the Cadastral details:

      - Cadastral map is geo-coded using prominent features such as road junctions or known structures as control points.
      - HTL contour is superimposed on the map.
      - From NHO chart 0 depth contour is digitized and added in the Cadastral map.

4. **Presentation by Institute for Remote Sensing (IRS), Anna University, Chennai:** In his presentation, Dr. S S Ramakrishnan, Director IRS brought out the following points regarding the methodology being followed by IRS.

    i. Methodology:

    - Collection of Cadastral & ward maps, Geo-referencing & Digitization.
    - Extraction of HHT and LLT from SoI Tide tables for ports and interpolation for places between the ports.
    - Mapping Coastal Geomorphology from Satellite Imagery.
    - Transfer of levels from the SoI GTS bench marks to the base point network.
    - Simulation of HHTL and LLTL on the ground using DGPS at 250 m intervals.
    - This has helped to identify the distance along the coastal zone and creeks, rivers and canals up to which the Tidal waters would have inundated during HHT.
    - Validation of HTL & LTL with the help of indicators like permanent vegetation, geomorphic features like dunes, berms, cliffs available on the ground as well as in the Satellite data.
    - Processing of surveyed information in ArcGIS.
    - Quality assessment.

5. **Presentation by Institute of Environmental Studies and Wetland Management (IESWM), Kolkata: <u>Tide line(HTL / LTL) Mapping Approach Methodology – IESWM, Kolkata:</u>** In his presentation, Dr. Debajyoti Bhowmik explained the following regarding the methodology being followed by IESWM.

    For tide line mapping, the approach of IESWM involves preparing digital data base in GIS platform and preparing pre-field map based on satellite image interpretation. Necessary Ground Truth Verification and validation are conducted during field work and accordingly updation is carried out as post-processing in the RS&GIS laboratory for analysis, cartographic layout and report generation.

    Delineation of Tide lines during field normally involve assessment of combination of indicators including but not limited to soils, vegetation, hydrology and other physical indicators.

    - **Step 1:** Collection of Data (Cadastral Map, Topographic map, Satellite Image, other relevant information).
    - **Step 2:** Geo rectification of Cadastral Maps and Satellite imagery (WGS-84 & UTM projection), Digital Image Processing (DIP)
    - **Step 3:** Preparation of field map based on Image Interpretation and existing data.
    - **Step 4:** Field Survey and random LU/LC ground verification around the 7km radius from the AOI.
    - **Step 5:** Delineation of High Tide Line using GPS and ground verified indicators (scum line, wrack line, soil, vegetation, etc).

- **Step 6:** Low Tide Line is primarily delineated based on satellite image interpretation based on digital image processing where land-water boundary is extracted. Cloud free satellite data of low tide time based on tide table are indented for procurement if available.
- **Step 7**: Mapping of ecologically sensitive areas if present such as mangroves, sand dunes, and turtle breeding sites, archaeological sites, marsh/salt flats and other features are delineated or validated using GPS and pre-field map during filed work.
- **Step 8:** Superimposition of HTL, LTL, ecologically sensitive areas if any, buffer lines (50m, 100m, 200m, 500m etc.) along the coast and tidal influenced water bodies are transferred onto cadastral maps at 1:4000.
- **Step 9:** Classification of CRZ as per Notification using colour codes and symbols developed by the institute for CRZ Mapping.
- **Step 10:** Generation of CRZ Maps including LULC at 1:25000 Scale incorporating 7 km radius from the AOI. HTL and LTL at this scale are solely based on satellite image interpretation.

6. **Presentation by National Hydrographic Office (NHO), New Delhi:** 6. **National Hydrographic Office (NHO), Dehradun:** In his presentation, Cdr Anirban Banerjee, NHO, **Dehradun** brought out the following points regarding the methodology being followed by NHO.

    1. HTL is delineated by following methods
        i. Walking over
        ii. Flotsam and debris – considered indicative of HTL
        iii. Delineation by helicopter where walking over is not feasible
        iv. Remote sensing data (satellite imageries) is utilised in inaccessible areas and planning purposes only.
    2. LTL is Delineated by following methods
        i. Soundings using shallow draft boat
        ii. Spot soundings using sounding poles from shore to seaward.
    3. The entire length of the coastline and foreshore is to be walked, mapped and graphically depicted. The accuracy/confidence levels are to be described in accordance with International Hydrographic Organisation (IHO) Special Publication, SP-44.
    4. The whole foreshore is to be walked at low water as far as possible during spring tides in order to demarcate the HTL as well as detect inter tidal features not otherwise detected whilst sounding.
    5. The standardisation of all symbols globally being utilised for the depiction of features are accepted in accordance with United Kingdom Hydrographic Office (UKHO) publication INT 5020.

7. **Presentation by National Institute of Oceanography (NIO), Goa:** In his presentation, Dr. A. K. Chaubey brought out the following points regarding the methodology being followed by NIO.

    1. Demarcation of HTL:
        - Survey is carried out using DGPS & Total Station
        - Base and reference stations are established by DGPS observations
        - Criteria indicated by MoEF (2011) for demarcation of HTL are followed
        - Total Station observations are made to obtain geographical position of identified HTL and extent of morphological feature
    2. Demarcation of LTL:
        - Bathymetry survey following standard procedure.
        - Spot sounding by Levelling staff and DGPS / Total Station.
        - Carrying out measurements during lowest low tide on particular day of Survey using Total station.
        - Beach profiling at an appropriate interval.

Minutes of the 2nd Meeting on Standardization of Methodology for Demarcation of HTL/LTL held at National Centre for Sustainable Coastal Management (NCSCM), Chennai on 9th October 2014

The Second Meeting of the Committee on Standardization of the methodology for demarcation of HTL/LTL was held at NCSCM, MoEF&CC, Chennai on 9th October 2014 under the Chairmanship of Dr. Shailesh R Nayak, Secretary, MoES, Government of India, New Delhi. This meeting is in continuation of the 1st meeting held at Prithvi Bhawan, MoES, Government of India, New Delhi on 1st July 2014 and subsequent three meetings of the expert Sub-Committee held in NCSCM, Chennai. Representatives of the following authorized agencies for demarcation of HTL/LTL attended the meeting.

i. Space Application Centre (SAC), Ahmedabad
ii. Institute for Remote Sensing (IRS), Anna University, Chennai
iii. Institute of Environmental Studies and Wetland Management (IESWM) Kolkata
iv. National Hydrographic Office (NHO), Dehradun
v. National Centre for Sustainable Coastal Management (NCSCM), MOEF&CC, Chennai

NCESS had sent its comments for the consideration of the Committee. Dr. A. Senthil Vel, Additional Project Director, SICOM, MoEF&CC, New Delhi; Dr. M. Baba and Dr. Anjali Bahuguna attended the meeting as special invitee experts. The list of members and invitees who attended the meeting is given in Annex C.

2. **Introduction by the Member Convenor:** In his opening remarks, Prof. R. Ramesh, Director NCSCM and Member Convenor of the Committee welcomed the Chairman, other members and invitees and highlighted the significant suggestions made by MoEF&CCin the meeting held in New Delhi on 29/9/2014 and subsequently during the sub-committee meeting under the Chairmanship of Dr. Shailesh Nayak on 8th October 2014 at NCSCM, Chennai.
3. **Remarks by Chairman:** Dr. Shailesh R Nayak, Secretary, MoES and Chairman in his remarks stated that there should be uniformity in the demarcation of HTL and in the methods followed by different agencies in preparing the CZMPs. The Chairman indicated that HTL will be mapped by NCSCM while CZMP maps will be prepared by the authorized agencies using 2011 satellite data using the classification system and other details provided in the HTL manual being finalized.
4. ***Presentation by the Member Convenor***: Prof. R. Ramesh then made a presentation to the Committee on the following decisions taken in the expert Sub-Committee meeting held in NCSCM Chennai on 8/10/2014 Chaired by Dr. Shailesh R Nayak, Secretary, MoES, Government of India, New Delhi.

4.1 ***Objectives***:The main objectives as specified in the ToRs for the Committee and the various sub-tasks under each ToR as given below were explained by Prof. R. Ramesh.

ii. Review/ evolve uniform guidelines/ methodology for demarcation of HTL/LTL

a. Standardize the methodology for demarcating HTL, LTL and mapping of CRZs;

b. Standardize the classification system and definitions for inventorying the different features such as tidal wetlands and coastal landforms;

c. Use of satellite imagery (2011) for 1:25,000 and 1:4,000 Scale

d. Development of coastal database with

i. Information derived from aerial photographs

ii. Satellite imagery

iii. HTL/ LTL and CRZ categories as in 1991 Notification and 2011 Notification

iv. CZM Plans

v. ICRZ and IIMP

vi. Hazard line

vii. Cadastral information

viii. Ecologically Sensitive Areas (ESA) and Critically Vulnerable Coastal Areas (CVCA)

ix. Administrative Boundaries

iii. Suggest the format of the report on HTL/LTL demarcation including map of 1:4000 scale with coordinates, land features

a. Achieve uniformity in output with respect to their content, format, legend, colour scheme, etc.

b. Suggest the format of the 'Report on HTL/LTLDemarcation' including map of 1:4000 scale with co-ordinates, land features, etc.

iv. Prescribe the time schedule for demarcation of HTL/LTL

v. Prescribe the cost for demarcation of HTL/LTL

4.2 ***Procedure of delineation of HTL / LTL using Aerial Photographs / ortho images of SoI***: Prof. R. Ramesh explained the availability of 2011-2012 aerial photography data covering the entire mainland coast from Gujarat to West Bengal, organised into eight blocks at Survey of India campus funded by MoEF&CC under the ICZM project. He explained the method that would be adopted in delineating the HTL using the SoI orthoimages and LTL using the LAT data and High resolution DEM.

4.3 ***Cost*:** Prof. R. Ramesh explained the cost table showing the cost worked out for 1: 25,000 or 1: 4,000 scale CZMP maps, as given below. The cost is based on the various tasks / components that are involved in preparation of 1: 25,000 or 1: 4000 CZMP maps and are only indicative.

S. No	Tasks involved in producing one 1: 25,000 scale (7 ½' x 7 ½' - 196 sq. km) / 1: 4,000 scale (1 ½'x 1 ½' - 2.7 km X 2.7 km or 7 sq. km approx.) CZMP maps	No. of Scenes/ Sheets/ Mandays etc.	Unit cost [permanday/ sheet/scene etc.] (`)
1	Cost of HR Satellite Image	**1 Scene**	12000
2	Image pre-processing, GCP collection from base map, Geo-referencing & image rectification.	1manday	4000
3	Merging of Cartosat and LISS IV and mosaicing [PAN-sharpening & mosaic generation]	1 manday	4000
4	Image interpretation and preparation of Coastal GIS / Database	10 mandays	4000
5	Geo-referencing cadastral maps, Base map preparation, Digitization& transfer of village boundaries, survey numbers etc., from the cadastral base map.	2 Mandays	4,000
6	Ground Truth Collection (Random points) excluding travel costs	5 mandays	10000
7	Total		
8	Overheads	@10%	
9	Institutional cost	@10%	
10	Total cost		
11	Service Tax	@12.36 %	
Fees to be charged on state Government for production of one 1: 25,000 scale (7 ½'x 7 ½'- 196 sq. km) or 1:4,000 scale (1 ½'x 1 ½'- 2.7 km X 2.7 km or 7 sq. km approx.) CZMP maps		**Total cost + 12.36 % Service Tax**	

Decisions

5.1. HTL Demarcation will be carried out by NCSCM using aerial photographs at SoI. Wherever there are gaps in aerial photographs or if aerial photos are not of good quality; high resolution remote sensing data from Indian satellites of the same period will be utilized for this purpose. NCSCM will provide the data with 'HTL coordinates'. The curvilienarity and spacing would be at 1m interval along the entire coast of India. For tidally influenced water bodies the upper limit will be as demarcated in the CZMPs approved based on the 1991 Notification/ SoI Toposheet. The HTL line already demarcated by the States through the authorized agencies may be validated based on the above.

5.2. Issues related to CZMP mapping:

a. Definitions and classification system: It was agreed that in addition to glossary, definition of terms appearing in the main text will be included in the main section of the manual. The classification system for uniformity in

geomorphological features was discussed and it was agreed to provide details in the CZMP up to Level III.

b. CZMP preparation: CZMP will continue to be prepared by the state Government through the authorized agencies. The HTL / LTL from 2011 ortho-photos delineated by NCSCM will be provided to the States/ authorized agencies as X-Y coordinates with curvilinearity and spacing of 1m. A shapefile containing HTL and LTL along with their coordinates will be provided by NCSCM to the authorized agencies for the preparation of CZMPs at a cost to be decided by MoEF&CC.

c. The HTL/ LTL coordinates shall be provided to the authorized agencies/ State Governments at a cost that would be decided by MoEF&CC.

d. The authorized agencies will follow the HTL/ CZMP manual being finalized by the Committee.

5.3. Satellite Data:

a. Cartosat & LISS IV data of 2011 will be used to prepare the coastal database from which the CZMP on 1: 25,000 and 1: 4,000 scales will be produced by the authorized agencies.

b. In areas where there are gaps in the 2011 ortho-images of SoI (e.g. Vishakhapatnam, Lakshadweep, Andaman &Nicobar Islands) satellite images of 2011 will be used by NCSCM to delineate the HTL.

5.4. Ecologically Sensitive Areas:

It was decided that as part of the ESA mapping, locations of turtle nesting sites will be provided to NCSCM by the concerned coastal State Governments

5.5. Geo-referencing, Benchmarks etc:

a. In addition to HTL, NCSCM will also provide shape files with certain important features such as road junctions, bund junctions etc, mapped from the SoI ortho-images, uniformly distributed in each 1:25,000 HTL map to the authorized agencies, so as to enable uniform geo-referencing of their satellite images and cadastral maps.

5.6. Measurement of Salinity:

a. NCSCM will use ortho-images /satellite images to fix the upper limit of HTL in tidal influenced water bodies or use the upper limit already fixed using salinity measurements or other suitable methods from the existing approved CZMPs/ SoI Toposheets

5.7. Information on fishing hamlets / ice factories / fishing harbour etc., required as per CZMP would be depicted as attributes by the authorized agencies.

5. **Standardization of methodology:**

   a. **Definitions/classification system and glossary:** Standard definitions of all important parameters/ terms (e.g. bay, estuary, creeks etc.) will be provided in the Manual.

   b. **Coastal Information System:**

   - Database will be prepared first, irrespective of scale and checked for accuracy. Final maps will be prepared in the required scales using this database.
   - Satellite images should also be a part of the database in all projects and images from Bhuvan are also recommended for use.
   - Any relevant information pertaining to CZMP should be added to the data base, e.g. Hazard line as and when it is completed by SoI.

   c. **Accuracy Assessment:** The following will be the accuracy thresholds:

S.No.	Map Scale	Planimetric/ Positional Accuracy	Thematic/ Classification accuracy
1.	1: 25,000	• Accuracy for HTL and LTL demarcation: 1m and 2m respectively	90 % classification accuracy at 90 % confidence interval
2.	1: 4,000		90 % classification accuracy at 90 % confidence interval
3.	1: 1,000		NA

Accuracy for CZMP using satellite imagery: 5m

   d. **Identifying geo-morphological features**:

- Bunds constructed across tidally influenced water bodies such as estuaries, creeks, backwaters etc. before the year 1991 should be taken as the tidal limit of HTL and bunds constructed after 1991 should not be taken as the tidal limit of HTL. Changes in HTL with respect to 1991 and 2011, if any, should be indicated with justifications.
- ESAs, geo-morphologically important zones, archaeological and heritage sites are being mapped by NCSCM and will be provided to the authorized agencies as part of CZMP mapping at a cost to be decided by MoEF&CC

   e. **Cost factors for preparing 1:25,000 or 1:4000 scale CZMPs:** Cost of HTL/ LTL mapping should be based on the layout/size of maps. The cost estimate for preparing 1: 25,000 or 1: 4,000 scale maps have been worked out and an approximate cost as provided in Section 4.3 plus actual travel costs and taxes as applicable has been recommended. This cost is only indicative and is based on the broad guidelines given in para 4.3 above and will be subject to revision depending on the wage/ tax structure and other factors to be considered from time to time.

6. The draft Manual will be finalized and submitted to the Chairman by 29/10/2014 for final submission to MoEF & CC by end of December 2014.
7. The meeting ended thanking the Chair.

Annex C

List of Members & Invitees who attended the second meeting on Standardization of Methodology for Demarcation of HTL/LTL held on 9th October 2014at 10:30 am, Koodal Hall, NCSCM, Chennai

Chairman: Dr. Shailesh R Nayak, Secretary, Ministry of Earth Sciences, New Delhi.

Member Convenor: Prof. R. Ramesh, Director National Centre for Sustainable Coastal Management, MOEF&CC, Government of India, Anna University Campus, Chennai.

Members / Representatives of Authorized Agencies other than NCSCM:

1. Dr. A S Rajawat Head, Geosciences Division, SAC, Ahmedabad
2. Dr. S S Ramakrishnan, Director IRS, Anna University, Chennai
3. Dr. Debajyoti Bhowmik IESWM, Kolkata
4. Cdr Prachit Mangrulkar, NHO, Dehradun

Invitees:

1. Dr. M. Baba, Former Director, NCESS, Thiruvananthapuram
2. Dr. Anjali Bhaguna, Environment Consultant, Ahmedabad
3. Dr. A. Senthil Vel, Additional Project Director, SICOM, MOEF&CC, New Delhi
4. Dr. Purvaja Ramachandran, Division Chair &Scientist-G, NCSCM, MoEF&CC, Chennai
5. Dr. B R Subramanian, Senior Consultant, NCSCM, Chennai
6. Mr. M. Dharma Raj, Senior Consultant, NCSCM, Chennai
7. Dr. D. Thirumalaivasan, Professor, IRS, Chennai
8. Dr. R. Vidhya, Professor, IRS, Chennai
9. Dr. K. Srinivasaraju, Professor, IRS, Chennai
10. Dr. Alak Haldar, IESWM, Kolkata
11. Dr. Ramachandra Bhatta, Division Chair & Scientist 'G', NCSCM, MoEF&CC, Chennai
12. Dr. P. Krishnan, Scientist NCSCM, MOEF&CC, Chennai
13. Dr. Badarees K O Scientist NCSCM, MOEF&CC, Chennai
14. Mr. S. K. Sinha, Director, Survey of India, Chennai

Composition of the Committee

It is informed by the Ministry in its letter No. J-17011/18/1996-IA.III dated 11th April 2014 that the National Coastal Zone Management Authority in its meeting held on 25th June 2013 decided to constitute a committee under the Chairmanship of Dr. Shailesh Nayak, Secretary, MoES with seven authorized agencies as members and Director, NCSCM as Member Convener to standardize the methodology for demarcation of HTL/LTL so as to make the demarcation procedure uniform.

Terms of Reference of the Committee

i. Review/evolve uniform guidelines/methodology for demarcation of HTL/LTL

ii. Suggest the format of the report on HTL/LTL demarcation, including map of 1:4000 scale with coordinates, land features etc.

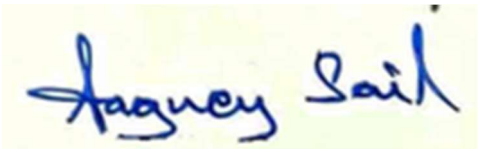
iii. Prescribe the time schedule for demarcation of HTL/LTL

iv. Prescribe cost for demarcation of HTL/LTL

Sittings of the Committee

The committee in accordance with the ToR had the following meetings:

- 1st July 2014 at MoES, New Delhi- meeting of the committee to examine the issues presented by various authorized agencies
- 9th October 2014 at NCSCM, Chennai – meeting of the committee to draft the report
- A series of discussions were held through emails and personal communications with the members/ experts, at various times during the course of preparation of this manual
- The Minutes of the meeting is given in the Annex 5
- The report will be submitted in the second week of February, 2015



Gmail

754

Aagney Sail <aagneysail@gmail.com>

O.A. No. 42/2023(WZ) - Rejoinder to GCZMA REply - NEXT DATE 16.02.2026

1 message

Aagney Sail <aagneysail@gmail.com> Sun, Feb 15, 2026 at 10:53 PM
To: Supriya Dangare <dangaresupriya@gmail.com>, gczma gczma <goacoastalzone@gmail.com>, Shivshankar Swaminathan <shivshankar.swaminathan@yutilaw.com>, Shankar Swaminathan <shankar@chambers.net.in>, Pushkal Mishra <pushkalm6@gmail.com>, Jatin Ramaiya <jatin.ramaiya@gmail.com>, hr@ncscm.res.in, director@ncscm.res.in, purvaja@ncscm.res.in, pearlsgoa@goa.com

To,
1. Goa Coastal Zone Management Authority (GCZMA).
2. MoEF&CC.
3. NCSCM.
4. Water REsources Department (WRD), Govt. of Goa.
5. Sevana Z. Jacques.

Please find attached the Rejoinder to GCZMA Reply in O.A. no. 42/2023(WZ).

Best

Adv. Aagney Sail,
Counsel for Original Applicants.
Mobile: +91.9810076618

OA42-23 Rejoinder FINAL.pdf