

Integrated Coastal Zone Management and Coastal Regulation Zone

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Prologue

The types of coastal change most threatening to human use and enjoyment of the coastal zone are erosion and deposition of sediment, deterioration in coastal ecosystems, and pollution of coastal land and waters. It is becoming increasingly apparent that successful management of these coastal problems must be integrated - that is, all aspects of multiple problems must be addressed, and the problems themselves must be seen in a wider context of other linked environments. Development of coastal protection, construction of flood protection structures e.g. dwelling mounds, dykes and dyke openings, and sustainable development of the coastal stretches and marine environment through sustainable engineering measures are of paramount importance to be addressed. Coastal zone management practices based on sound scientific principles taking into account the vulnerability of the coast to natural hazards, sustainable livelihood security for local communities, and conservation of ecologically and culturally significant coastal resources also play vital role for the management of coastal stretches.

Sustainable management of coastal and marine resources is essential to India's economic growth. India's coastal zone is endowed with a wide range of mangroves, coral reefs, sea grasses, salt marshes, sand dunes, estuaries, lagoons, and unique marine and terrestrial wildlife. India has a coastline of about 7,516km, of which about 5,400km belong to peninsular India and the remaining to the Andaman, Nicobar and Lakshadweep Island. With less than 0.25% of the world coastline, India houses 63 million people, approximately 11% of global population living in low elevation coastal areas. The coastal districts (73 out of a total of 593 districts) have a share of 17% of the national population, and nearly 250 million people live within 50km of the coastline. The coast also includes 77 cities, including some of the largest and most dense urban agglomerations - Mumbai, Kolkata, Chennai, Kochi and Visakhapatnam. This lecture discusses the vital points of *Integrated Coastal Zone Management (ICZM)* and *Coastal Regulation Zone (CRZ)* in Indian context.

Integrated Coastal Zone Management and important considerations

Definitions

Coastal Zone means the area from the territorial waters limit (12 nautical miles measured from the appropriate baseline) including its sea bed, the adjacent land area along the coast, and inland water bodies influenced by tidal action including its bed, upto the landward boundary of the local self government or local authority abutting the sea coast, provided that in case of

ecologically and culturally sensitive areas, the entire biological or physical boundary of the area may be included, as specified under the provisions of Environment Protection Act, 1986.

Integrated Coastal Zone Management (ICZM) means a process by which decisions are made for protection of coastal population and infrastructure, protection and conservation of coastal and marine areas and resources and sustainable development; *Integrated Coastal Zone Management Plan (ICZMP)* is the landuse plan or development plan prepared for implementation of the Integrated Coastal Zone Management. This concept was born in 1992 during the Earth Summit of Rio de Janeiro. The policy regarding ICZM is set out in the proceedings of the summit within Agenda 21, Chapter 17.

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.

Integrated coastal zone management (ICZM) is a process for the management of the coast using an integrated approach, regarding all aspects of the coastal zone, including geographical and political boundaries, in an attempt to achieve sustainability.

Coastal Regulation Zone

The increasing pressure on the coastal zone due to concentration of population, development of industries, discharge of waste effluents and municipal sewage and spurt in recreational activities, has adversely affected the coastal environment. The population of coastal districts is increasing through out the coastal areas in the world. In India, the population on coastal regions is Bleaching in 1998 likely to increase to from 15 per cent at present to almost 40 percent in next decade. In view of this, coastal stretches of bays, estuaries, backwaters, seas, creeks, which are influenced by tidal action up to 500 m from High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL has been declared as the Coastal Regulation Zone (CRZ). Further they are divided into four main broad domains as below:

CRZ- I areas are ecologically sensitive and most activity are restricted or prohibited in this zone.
CRZ- II is developed area and construction activities are permitted under certain condition.
CRZ- III is undeveloped area and limited activities are permitted. All islands are classified as CRZ- IV and no construction activities are permitted.

The critical issues in context of CZM are:

1) Coastal ecosystems and marine living resources

- ◆ Generation of reference or baseline data, conservation and restoration of vital and critical
- ◆ Habitats such as mangroves, coral reefs, sea-grass beds, etc.
- ◆ Reclamation of wetland for agricultural and industrial purposes
- ◆ Exploration and sustainable use of living resources

2) Shoreline protection

- ◆ Identification of vulnerable areas including eroded areas and developmental activities
- ◆ Planning and implementation of coastal protection work (erosion, flood protection, salt water intrusion, etc.)
- ◆ Impact of engineering structures and dams on coastal processes of erosion, deposition and sediment transport
- ◆ Suspended sediment dynamics
- ◆ Changes in bottom topography

3) Coastal water quality

- ◆ Non-point and point pollution
- ◆ Phytoplankton blooms

4) Coastal Hazards and Climate Change

- ◆ Cyclones, storm surges, sea-level rise and possible effects
- ◆ Emergency response plans for natural disasters such as cyclones, sea level rise, or anthropogenic activities such as oil spills.

5) Coastal development

- ◆ Site selection for industries, landfall points, aquaculture, recreational activities, etc.

Assessment of conditions in regulation zones, areas under construction setback-lines, mega cities, etc. (*Setback Line -a line demarcated along the coast, based on its vulnerability to sea-level rise, flooding and shore line changes*)

Objective and the problem

The objective of ICZM is protection and sustainable development of the coastal stretches and marine environment through sustainable coastal zone management practices based on sound scientific principles taking into account the vulnerability of the coast to natural hazards,

sustainable livelihood security for local communities, and conservation of ecologically and culturally significant coastal resources.

The abundant coastal and offshore marine ecosystems include 6,740 km² of mangroves, including part of the Sundarbans and the Bhitarkanika, which are among the largest mangroves in the world. There are major stocks of corals, fish, marine mammals, reptiles and turtles, sea grass meadows, and abundant sea weeds. Most of the oil and gas reserves in India lie in the coastal and shallow offshore areas. Thirty-five per cent of the coastal stretch is laden with substantial placer mineral and heavy metal deposits. Offshore wind, tidal, wave and future ocean thermal energy potential is huge. Tourism, cultural and archaeological sites, some with national and international significance dot the coasts. A very significant share of India's economic infrastructure, including maritime facilities, petroleum industries, and import based industries is located in the coastal zone, as are the 197 major or minor ports, 308 large-scale industrial units, and 77 coastal cities. Coastal fishing employs a million people full time, and the post harvest fisheries sector employs another 1.2 million people in 3,638 fishing villages and 2,251 fish landing centers.

Despite the ecological richness and the contribution to national economy, the coastal and marine areas are under stress. Rapid urban-industrialization, maritime transport, marine fishing, tourism, coastal and sea bed mining, offshore oil and natural gas production, aquaculture, and the recent setting up of special economic zones have led to a very significant increase in demand for infrastructure, resulting in exploitation of natural resources. About 34% of mangroves of India were destroyed in the last 40 years; 66% of the coral areas are threatened; marine fish stocks are declining; and aquarium fish, sea cucumbers are fast disappearing. Such depletion and degradation, unless arrested, will impact the livelihood, health and well being of the coastal population; affecting in turn prospects for sustained economic growth.

Threat of coastal hazards on economic and livelihood security is increasing. Indian coast is subject to severe weather events, including the cases of 2004 tsunami, several super-cyclones, and an average of nine cyclones per year, inflicting severe damage to lives and property. Resilience of the rural coastal communities to extreme weather variability had been low, mostly because of impoverishment.

In recent years accelerated erosion of coastal land is affecting coastal agriculture and built habitats, while return from traditional fishing is reducing due to environmental degradation and over-extraction. Climate change aggravates the risks to coastal communities and infrastructure. Studies already point out sea level rise, increase in the frequency and intensity of extreme weather events, mean climate variables, and changes in biophysical and human systems. A 1-meter sea level rise would flood nearly 6,000 km² in India, potentially triggering significant population movements among the 63 million people in low elevation areas, the low resilience

poorer communities among them being the most vulnerable. Climate change will also impact the large infrastructure investments in the ports, industries and other facilities.

Diverse stakes increasingly compete for coastal and marine resources. Rapid economic growth in recent years has propelled newer and larger investments in coastal zones, with more ports set up to act as gateways to the hinterland economy. Together with real estate growth in larger urban areas and unplanned tourism activities, these necessitate considerable increase in basic infrastructure to support the fast-growing rural, semi-urban and urban population in coastal zones. Further, the numerous unplanned but competitive economic activities have resulted in conflicts among stakeholders; misuse, abuse and overuse of resources; and degradation of ecosystems with some pockets of coastal landscapes entirely destroyed by commercial aquaculture. With coastal hazards such as cyclones striking with increasing regularity, the key issue in coastal zone and marine management is how to accommodate such needs in a sustainable manner.

Plethora of fragmented policies and incomplete institutional framework are unable to ensure balanced development. The management regime for coastal and marine areas of the country suffers from the lack of an integrated and coordinated decision-making system. This is reflected in a multiplicity of institutional, legal and economic planning frameworks, all narrow and sector driven. Consequently, sectoral activities and interventions in coastal and marine areas work in isolation from each other, at times with conflicting objectives and outputs. At the same time stakeholder interests are diverse and competitive, partly due to the lack of participatory planning and management process. Investments in large and small economic infrastructure - all critical components of national goals for growth and poverty reduction - take place without systematic analyses of long term effects. The overall policy and plan responses are further crippled by lack of knowledge on coastal resources, processes, impact analyses and management options.

The approach to managing India's coastal zone has been a purely regulatory one, as per the Coastal Regulation Zone (CRZ) Notification of 1991, promulgated under the Environment (Protection) Act of 1986. The 1991 notification prevents, restricts and controls development activities within a landward distance of up to 500m from the high tide line along the coasts. In the last decade, as the pressure of development has been growing, on one side there were large-scale reported violations of the provisions of the notification, and on the other demands from the various economic sectors to rationalize it.

Given the country and sector issues outlined above, the Govt of India has developed a vision for long term management of the coastal and marine areas, as articulated in the National Environment Policy, 2005 and has already initiated steps to operationalise one part of the agenda, which is to create a suitable policy environment for integrated management of coastal and marine areas. The second part is to develop and finance institutional arrangements, capacity

and adequate knowledge systems adequate for the country's long term needs. For initiating program for this second part, the India Integrated Coastal Zone Management project is formulated, with proposed assistance from the World Bank. The project will support capacity building for implementation of the integrated coastal zone management at the national level and in three pilot states. Once the initial demonstration is complete, the initiatives will be replicated for long-term gains and wider impacts, both at the national level and for the remaining nine coastal states and union territories. The replications will be supported by GOI own resources, and could be complemented by additional financing by other agencies. The lessons learnt from, and the quality of capacity created by this project will be crucial for designing and implementing future coastal zone conservation and management projects and program in India.

Integrated management of the coastal and marine areas in general and the project in particular will have long lasting benefits specially in protection of ecological, cultural and traditional rights and landscape is crucial to India's growth and promotes sustainable development. Balanced, sustainable and economic growth is also the fulcrum for poverty reduction. The project, and the reforms it supports, will also play a vital role in reducing vulnerabilities of coastal population to current variability and disasters, both of which are expected to be increase due to climate change effects.

India has envisaged three major components for the accomplishment of the goal.

Component One: National ICZM Capacity Building

The national component will include [i] mapping, delineation and demarcation of the hazard lines all along the mainland coast of India; [ii] mapping, delineation and demarcation, as required, of the Ecological Sensitive Areas (ESAs), also all along the mainland coast of India; [iii] capacity building of the MoEF as the secretariat for the NCZMA, and nation-wide training program for integrated coastal zone management; and [iv] setting up and operationalization of the new National Centre for Sustainable Coastal Zone Management.

Component Two: Piloting ICZM approaches in Gujarat

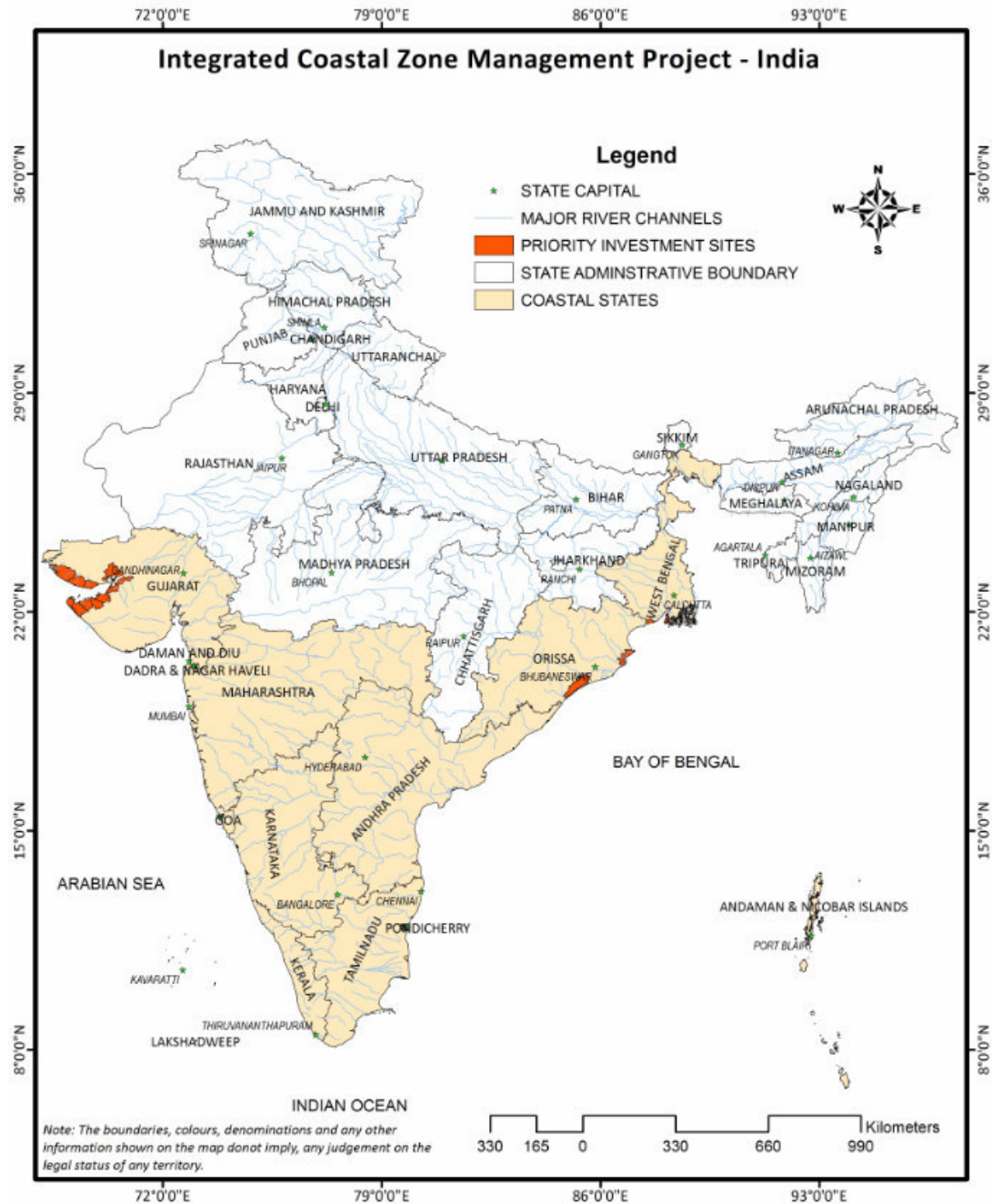
This component includes [i] capacity building of the state level agencies and institutions, including preparation of ICZM plan for the coastal sediment cell which includes the Gulf of Kachchh, and [ii] priority investments.

Component Three: Piloting ICZM approaches in Orissa

This component includes [i] capacity building of the state level agencies and institutions, including preparation of ICZM plan for the coastal sediment cells which include the stretches of Paradip-Dhamra and Gopalpur-Chilika, including a regional coastal process study, and [ii] priority investments.

Environmental and Social Management Plan

A detailed environmental and social management plan (ESMP) has been prepared along with the reporting responsibility and monitoring indicators for all project components. Each of the subcomponents or activity has been designed to maximize long-term benefits and institutional sustainability, and to avoid the avoidable impacts. The ESMP includes (i) monitoring to ensure that the avoided issues does not recur; (ii) mitigation and management plans, (ii) Monitoring & Evaluation including social audit and third-party audits, (iv) grievance redress process, (v) adequate budget, (vi) adequate staffing to oversee project implementation.



Categorization of the Coastal Zone

1. Coastal Management Zone - I (CMZ -I) shall consist of areas designated as Ecologically Sensitive Areas (ESA),

Indicative list of ecologically sensitive areas (ESA)

- i.) Mangroves
- ii.) Coral reefs
- iii.) Sand Beaches and Sand Dunes
- iv.) Mudflats
- v.) Marine wildlife protected areas under the Wildlife (Protection) Act, 1972
- vi.) Coastal freshwater bodies such as creeks, lakes etc
- vii.) Salt Marshes
- viii.) Turtle nesting grounds
- ix.) Horse shoe crabs habitats
- x.) Sea grass beds
- xi.) Sea weed beds
- xii.) Nesting grounds of birds

(ii) Coastal Management Zone - II (CMZ - II) shall consist of areas, other than CMZ - I and coastal waters, identified as “Areas of Particular Concern (APC)” such as economically important areas, high population density areas, and culturally and, or strategically important areas. The administrative boundaries of these “Areas of Particular Concern” would be boundaries of CMZ - II. The indicative lists of areas of particular concern are:

- i.) Coastal Municipalities/Corporations (the entire notified area)
- ii.) Coastal Panchayats with population density more than 400 persons per sq km (the entire notified area) as per the latest Census of India.
- iii.) Ports and Harbours
- iv.) Notified Tourism Areas
- v.) Mining sites
- vi.) Notified Industrial Estates
- vii.) Foreshore facilities for Special Economic Zones
- viii.) Heritage areas
- ix.) Notified Archaeological sites under the Protected Monuments Act.

- x.) Defence areas/installations
- xi.) Power Plants
- xii.) *Green field airports and expansion and modernization of existing airports

(iii) Coastal Management Zone -III shall consist of all other open areas including coastal waters and tidal influenced inland water bodies, that is, all areas excluding those classified as CMZ - I, II and IV.

The following activities, are permitted by the local or concerned authorities without CMZ clearance

- a) Boating, shipping and navigation.
- b) Fisheries including traditional fish processing, ice plants and ice crushing facilities.
- c) Mariculture including hatcheries and traditional aquaculture.
- d) Agriculture and horticulture.
- e) Public toilets and rain or cyclone shelters.
- f) Repair of existing buildings or infrastructure including reconstruction activities.

(iv) (a) Coastal Management Zone -IV (CMZ - IV) shall consist of island territories of Andaman and Nicobar, Lakshadweep, and other offshore islands.

In respect of the islands in coastal backwaters areas which are not included in CMZ -I or CMZ - II, such areas may be included in CMZ - IV at the option of the Local Authority; otherwise they would be included in CMZ - III. Once exercised, the option of the Local Authority would not be subject to change.

Guidelines for preparation of Integrated Management Plan for CMZ II areas

1. The entire notified Corporation, Municipality, Panchayat, revenue area, shall be the outer boundary of the APC.
2. ICZMPs shall be prepared for these areas indicating all present and future developments, conservation and preservation schemes.
3. The ICZMP shall address vulnerability to human life and property based on setback lines prepared by Ministry of Environment and Forests.
4. No constructions shall be permitted on the seaward side of any existing (as on 2008) approved building or a tarred or surfaced road in the area.
5. All the existing roads including the internal roads shall be strengthened, as these roads shall serve for the purpose of livelihood, communication, relief and evacuation measures particularly for fisher communities.

6. Adequate cyclone shelters shall be constructed taking into account the population of the area.
7. The new schools, market areas and other public facilities where large number of public congregate shall be located beyond the vulnerable area.
8. Along the seaward side sufficient bio shield with local vegetation, trees including mangroves shall be planted
9. The beaches shall be left free of any development.
10. Appropriate coastal protection structures be constructed where ever required on a scientific basis
11. New houses and settlements shall be planned on landward of the setback line.
12. Sand dunes, being natural speed breakers in the event of hazards, shall be maintained or regenerated by planting shrubs or through appropriate measures.
13. All the areas notified by the Ministry of Environment and Forests as CMZ I shall be clearly demarcated in the plan for their conservation.
14. The ICZMPs shall be approved by the proposed NISCM of the Ministry or any other authorized authorities as approved by the Ministry.
15. There shall be no regulation with regard to fishing and fishery related activities.
16. The enforcement and monitoring will be the responsibility of the concerned State or Union territory Coastal Zone Management Authorities.

Coastal Vulnerability

a) Exposure indicators

Population density in coastal areas - This is represented by the population density index derived from the ratio of coastal population to coastal land area. Population density indicates demand for a variety of resources and services, including land, fresh water and infrastructure.

Probability of natural disaster incidents - Natural disaster incidents that occurred in the past 100 years.

Percentage of vegetation cover - The ratio of forest cover to coastal lands.

Vegetation in coastal areas serves to protect human settlements and coastal environments from extreme storm activities, as well as protecting freshwater sources and reducing coastal erosion. Low forest cover contributes to low productivity due to soil degradation and sediment deposits in riverbeds, and also affects water quality.

Geographic exposure - The geographic exposure of a country is assessed using the percentage of flat land (less than 50m) and the proportion of the length of the coastline to the country's total

boundary. If a country has a longer coastline and the coastal lowlands are densely populated, people and ecosystems are more exposed to natural disasters than countries with shorter coastlines and fewer people in coastal lowlands.

b) Coping capacity indicator

The Human Development Index (HDI) developed by United Nations Development Programme (UNDP) appears to be the best available indicator for measuring coping capacities. It shows the combined effects of life expectancy at birth, education level and income level. People with high literacy rates, large incomes and longer life expectancies are generally better informed and have better access to modern infrastructure and communication.

The HDI considers three data dimensions: healthy life (defined by a country’s average life expectancy), knowledge (defined by its Gross Enrolment Ratio), and standard of living (defined by its Gross Domestic Product).

A country’s performance is measured by calculating the average of these three indices (UNDP, 2001). UNDP’s *Human Development Report* provides the latest HDI for each country, expressed as a value between 0 and 1. In this study, it is assumed that there is no difference between the HDI of a country’s coastal areas and its interior.

Computing vulnerability

A country’s coastal vulnerability is computed using the following equation:

$$\text{Vulnerability} = f ((PD) + (ND) + (1-FC) + (GE)) - (HD)]$$

Where, PD = population density

ND = high probability of natural disaster incidents

1-FC = low forest cover

GE = geographic exposure

HD = human development

Coastal Vulnerability Index (Gornitz et al, 1997)

The following six variables are used for calculating the CVI.

- i.) Coastal slope (CS)-
- ii.) Displacement (D)-
- iii.) Subsidence (S)-
- iv.) Geomorphology (G)-
- v.) Tidal Range (TR)-
- vi.) Wave Height (WH)-

$$\text{C.V. I} = \sqrt{\frac{(CS^3 S^3 D^3 G^3 TR^3 WH^3)}{6}}$$

Using quartiles (1-25%, 25-50%, 50-75% and 75 to 100%) the vulnerability of low medium, high and very high can be judged.

Some authors opine that, the CVI is expressed in the following way as given below:

Product mean:	$CVI_1 = \frac{(X_1 * X_2 * X_3 * X_4 * \dots * X_n)}{n}$,
Modified product mean:	$CVI_2 = \frac{[X_1 * X_2 * (X_3 + X_4) * X_5 * (X_6 + X_7)]}{n - 2}$,
Average sum of squares:	$CVI_3 = \frac{(X_1^2 * X_2^2 * X_3^2 * X_4^2 * \dots * X_n^2)}{n}$,
Modified product mean (2):	$CVI_4 = \frac{(X_1 * X_2 * X_3 * X_4 * \dots * X_n)}{5^{(n-4)}}$,
Square root of product mean:	$CVI_5 = [CVI_1]^{\frac{1}{2}}$, and
Sum of products:	$CVI_6 = 4x_1 + 4x_2 + 2(x_3 + x_4) + 4x_5 + 2(x_6 + x_7)$.
Where: n =variables present	x_1 =mean elevation
x_2 =local subsidence trend	x_3 =geology
x_4 =geomorphology	x_5 =mean shoreline displacement
x_6 =maximum wave height	x_7 =mean tidal range.

To express the standardized CVI for a country, it is calculated as below

$$CVI \text{ (standardized)} = (CVI - \text{min}) / (\text{max} - \text{min})$$

Conclusions

As a result of globalization, the varied and highly productive ecosystems on the coastal zone such as mangroves, coral reefs, sea grasses and sand dunes are under pressure on account of increased anthropogenic activity. It is necessary to protect these coastal ecosystems to ensure sustainable development. This requires information on habitats, landforms, coastal processes, water quality, and natural hazards on a repetitive basis. Also, it is imperative to assess the interaction between various activities conducted in the coastal zones need to be assessed. This would ensure judicious sustainable development of coastal zone without endangering the environment and ecology.

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