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Integrated Zone Management of Cochin Coast Using Remote Sensing

Abhijith R, Ajay Balan

Department of Civil Eng., Viswajyothi College of Engineering and Technology, Vazhakulam, Kerala, India

ABSTRACT: The coastal areas are under great pressure more than ever. Due to the alarming rate of industrialization and commercialization causing increased number of user conflicts had led to a growth that which is not sustainable. In the present study the Integrated Coastal Zone Management Plan of Cochin coast in Kerala has been done. A Coastal Vulnerability Index has also been calculated factors like sea level rise, erosion, shoreline changes calculated for the study area to know the resistance of study area to various and is demarcated into four categories: Very Low, Low, High, and Very High. A Coastal Zone Information System (CZIS) has been designed and developed in GIS and in Microsoft Excel to prepare an effective Coastal Zone Management Plan (CZMP) hence making the data easily accessible in every format. The study will not only guide for development of various activities such as industries, tourism, setting up of harbor and jetties along the coast and also will help in proper utilization of coastal resources to avoid any adverse effect or damage to the entire coastal eco-system.

KEYWORDS: Integrated Coastal Zone Management, Coastal Zone Information System, Coastal Vulnerability Index, Erosion, Shoreline changes

I.INTRODUCTION

The coastal features are the unique and extremely important feature of the earth's surface. The resources of the oceans are the essential elements for the survival of the communities depending on it. As per UNCED, 1992 about more than half of the world's population lives within 60 km of the shoreline, and this could rise to three quarters by the year 2020. Hence there has been a sharp conflict of between the need for immediate consumption or use of coastal resources and the need to ensure the long-term supply of those resources. The need of a sustainable development plan for the safeguarding these resources in such a manner that its its beneficial both sociologically and economically and the righteous to answer to that question will always point towards an Integrated Coastal Zone Management Plan.

II.OBJECTIVES

The objectives of the present study are
1. Development of Coastal Vulnerability Index of Cochin Coast
2. Identification of vulnerable regions
3. Develop a dynamic Coastal Zone Information System (CZIS)for Cochin coast
4. Develop a Integrated Coastal Zone Management Plan (ICZMP) for Cochin Coast

III.STUDY AREA

The study area (fig 1) is the region along Cochin situated on the east coast of India between 10° 1'32.26"N, 76°12'42.02"E and 9°55'44.41"N, 76°17'1.33"E.The Cochin coast consists of four major islands namely WilingtonIsland,ValarpadamIsland,Vypin Island and Bolgatty Island. Our study area spans about 19.17km and the buffer zone considered (fig 2) is about 90km2. The study area features a tropical monsoon climate. The annual temperatures range is between 23 and 31 °C with the record high being 36.5 °C, and the all time low was 16.3 °C .From June to September, the south-west monsoon brings in heavy rains and from October to December, the study region receives lighter rain from the northeast monsoon. boundaries are the area of interest

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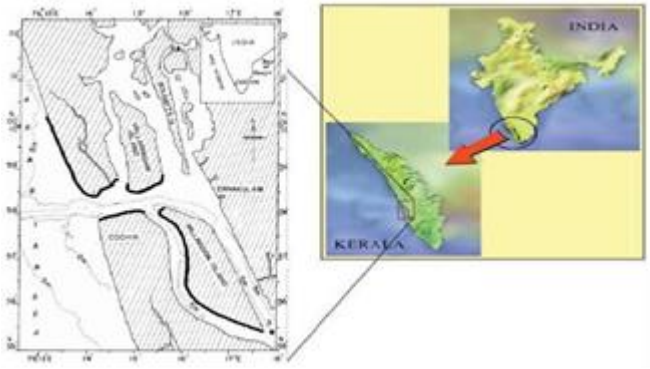

Fig-1: Loction of the study region, the demarcated

Fig-2 : Buffer zone

IV.METHODOLOGY

The methodology adopted in the present study while developing the Coastal Zone Information System through excel using the remote sensing and conventional data, analyzed in GIS environment. An Integrated Coastal Zone Management Plan (ICZMP) is then developed by analyzing the data. The database can be viewed, upgraded, or Seven physical–geological parameters including coastal slope, geomorphology, regional elevation, shoreline change, sea level rise, significant wave height and tidal range are considered for studying the index. The entire Cochin coast is segmented into about 2000 points and assigned vulnerability rankings from 1 to 4 representing very low, low, high and very high vulnerability, respectively modified.

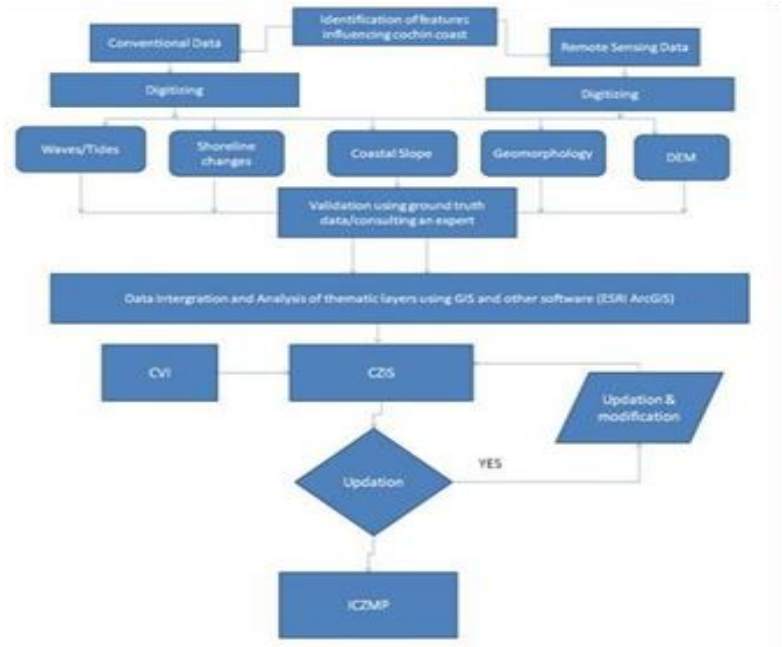

Fig-3: Flowchart showing the methodology.

V.DATA ANALYSIS

1. COASTAL SLOPE

The coastal slope (steepness or flatness of the coastal region) is defined as the ratio of the altitude change to the horizontal distance between any two points on the coast perpendicular to the shoreline. The susceptibility of the coast

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due to inundation by flooding and the associated land loss is a direct function of coastal slope (Thieler and Hammer-Klose, 2000). Thus, on a steep coast, the consequence of sea level rise would be insignificant, contrary to a gently sloping coast, where any rise in sea level would inundate large extents of land. From the analysis of the data (Williams, J. S. *et al* ,2013) for the study area the slope of the coast was found to be 1.2. Hence having a vulnerability ranking of 2

2.GEOMORPHOLOGY

Geomorphology is defined as the study of surface landforms, processes and landscape evolution of the Earth. The morphology of the coast is shaped by tectonic and structural features, the nature of the rock forming the coast, depositional and erosive activity. It plays a pertinent role in determining the response of the coast to sea level rise, as it expresses the relative erodibility and the degree of resistance of the different landforms and the materials that compose them (Thieler and Hammer-Klose, 1999). From the remote sensing data of the study region (Bhuvan-Indian-Geo Platform) and supported by the Ground Water Information Booklet OfErnakulam District, Kerala State the geomorphology of the region was found to be of coastal orgin (fig 3).

Table -1: Data used for the study.

DATA	SOURCE
Elevation	Google Earth Pro 7.3.0.3832 (32-bit)
Coastal Line Slope	Estimation of Indian coastal areas inundated into the sea due to sea-level rise during the 20th century, CURRENT SCIENCE, VOL. 104, NO. 5, 10 MARCH 2013
Geomorphology	Bhuvan-Indian-Geo Platform ISRO(http://bhuvan.nrsc.gov.in/gis/thematic/index.php), Ground Water Information Booklet Of Ernakulam District, Kerala State
Mean Sea Level	GLOSS(Global Sea Level Observing System)
Shore line change (end point method)	Long Time Shoreline Monitoring Of Cochin Estuarine System, South West Coast Of India Using Multi Temporal Data, International Journal of Scientific & Engineering Research, Volume 5, Issue 7, July-2014
Significant Wave Height	Wave transformation along open coasts and semi-enclosed regions
Tidal Variations	Naval Hydrographic Chart No.2004

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3.ELEVATION

Defined as the average elevation of a particular area above mean sea level, regional elevations play an important role in identifying and estimating the extent of land threatened by future climate change scenarios. Coastal regions having low elevations are considered highly vulnerable, whereas those having higher elevations are considered less susceptible. This is mainly because areas at higher elevations provide more resistance to inundation due to rising sea levels, tsunamis and storm surges.

4. SHORELINE CHANGE

Shoreline is the interface between land and water. Healthy beaches and shorelines are essential to the quality of life along the coast, and also provide buffers for storms and critical habitats for many species of plants and animals. Shoreline changes are a result of coastal processes, which are mainly controlled by wave characteristics, near-shore circulation, sediment characteristics and beach forms. The breaking waves and currents in the near-shore zone are responsible for the transport of shoreline sediments resulting in shoreline change. The shoreline change data of the study region was derived from the journal-Long Time Shoreline Monitoring Of Cochin Estuarine System, South West Coast Of India Using Multi Temporal Data and it was concluded that the study region had undergoes accretion at a rate of 3.4m/year (1970-2014). Hence as per the ranking it was considered as-Very Low.

5.SEA LEVEL CHANGES

Sea level change is one of the most important consequences of climate change. Mean sea level is the arithmetic mean of hourly water elevations observed over a specific 19 yrcycle.. The mean sea level data set of GLOSS was used as the primary source of information for sea level trend in the study area. The data recorded in Cochin station during the period from 1939 to 2013 was used for the present study. The seal level change of the study area was found to be 1.40mm/year, thus it had a ranking of 2 as per the criteria.

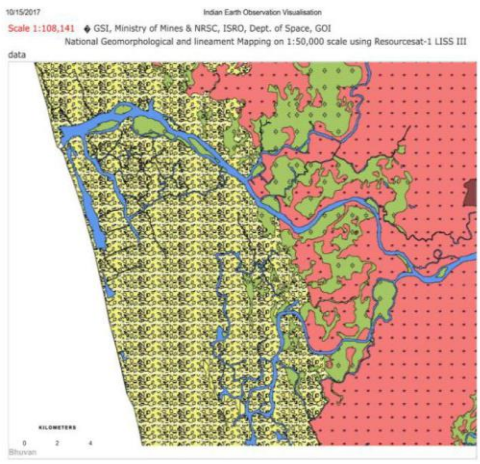

Fig-3: Geomorphology of the region

6.SIGNIFICANT WAVE HEIGHT

Significant wave height (SWH) is used as an alternative to wave energy and is important in studying the vulnerability of shorelines. It is the average height (trough to crest) of one-third of the waves in a wave spectrum for a given period of time.Wave energy is directly related to the square of wave height by the following formula:

$$E = 1/8\rho gH2$$

where E is energy density, H is wave height, ρ is water density and g is acceleration due to gravity. Increase in wave height causes an increase in wave energy, which subsequently results in increased erosion and inundation along the shore, causing loss of land. Hence, coastlines experiencing high wave heights are considered more vulnerable than those which are exposed to low wave height.

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7.TIDAL RANGE

Tidal range is defined as the vertical difference (in meters)between the high tide and the consecutive low tide. Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the moon and the sun and the rotation of the Earth. Cochin experiences semi dinural tides. The tidal levels as per Naval Hydrographic Chart No.2004 are as follows:

Table -3: Naval Hydrographic Chart No.2004

Highest high water level	+1.20m
Mean high water spring	+0.92m
Mean low water spring	+0.80m
Mean sea level	+0.582m
Mean high water neap	+0.60m
Mean low water neap	+0.30m
Lowest low water level	+0.20m

As per the ranking criteria analysis of the data the rank was assigned as 1.

8.COASTAL VULNERABILITY INDEX CALCULATION (CVI)

In order to assess the vulnerability of the shoreline considered under this study against the changing environmental conditions, an index called Coastal Vulnerability Index (CVI) has been adopted. The CVI in most of the vulnerability studies is expressed as the square root of the product of the ranking factors divided by the number of parameters considered. This method yields numerical data that cannot be equated directly with particular physical effects. In the present study the CVI of the study regin is calculated as

$CVI=\sqrt{(a*b*c*d*e*f*g)}/7$

Where,

a= coastal slope

b= geomorphology

c= elevation

d= shoreline change

e= sea level changes

f= significant wave height

g= tidal range

The data was analysed in the GIS environment and the coastal vulnerability map was obtained (fig 4).

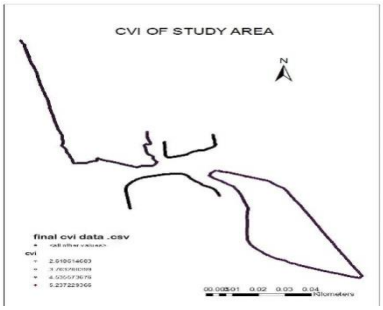

Fig-4: Costal vulnerability map

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VI. INTEGRATED COASTAL ZONE MANAGEMENT PLAN (ICZMP)

The major aim of the study was to develop an ICZM that aims to reduce or eliminate problems, assisted withthe coastalareas resulting in ethical and economic benefits. Ethical benefits include sustainable development, the promotion of social equity through consideration of the viewpoints of all stakeholders and protection of traditional uses of coastal resources. It could be theorized that economic benefits accrue from an integrated approach to management, which can have cost benefits when compared to management for separate sectors. Effective planning for the future also provides cost benefits.

The study region is a mixture of land uses like urban areas, ports and industries, settlements involved mainly in fisheries and tourism. To achieve economic prosperity without sacrificing ecological security it has been proposed for an area specific management plan to ensure overall development of the coastal area. Judicious utilization of resources would be fruitful based on carrying capacity based development plan.

1.IDENTIFICATION OF RESOURCES

Most of the coastal management issues originate from resource conflict. Hence it's necessary to identify the resources of the study area. For the study region the resource data was isolated to tourism and fisheries.

2.FISHERIES

Fisheries contribute about 1.07 % of the national GDP. Analysing the fish landing data of the state (CMFRI Marine Fish Landings2016) its noted that Oil sardine, the most favourite and common fish species of the state continued to show a decreasing trend in landings and this year recorded a mere 0.46 lakh tonnes which is the lowest in the past two decades. But the total marine fish production (5.23 lakh tonnes) in the state has increased by 0.40 lakh tonnes over the previous year. Scads belonging to the genus *Decapterus* were the most abundant resource in the state during 2016 with an estimate of 0.54 lakh tonnes. Pelagic finfish contributed 60%,Demersal fin fish 25%, Crustaceans 8% and Molluscs 7% of the total landings. The mechanized sector contributed 63% to the total landings followed by motorized (36%) and non-motorized sector (1%).

3.TOURISM

The study region attracts a huge crowd from various parts of the world. Kochi also known as Cochin backwaters are the group of islands on the Vembanad Lake. Most popular among them are Bolgatty, Vypeen, Gundu and Vallarpadam.Kochi is natural beauty visited by the tourists to relax in the serene backwaters. Analysing the tourism statistics of Kerala or the year 2015 about 39.5% of the tourism contribution originated from the Cochin coast. The data also shows an increase in the earnings from tourism (fig5).

Fig-5: Earnings from tourism (SOURCE: Kerala Tourism Statistics 2015)

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VII. CONCLUSIONS

After examining problems emerging in the coastal zone, the study adds voice to the growing lobby for integrated coastal zone management and examined the potential role of participatory management in achieving the aim of integrated CZM for Cochin coast.

- From the impact study of the environment its understood that the anthropogenic activities have put tremendous pressure on the fragile coastal environment. To protect the coastal community, from the various disturbances its necessary to implement various checks on vehicular pollution of boats and also encourage the use of LPG in homes.

- The authors have a suggestion to implement an Integration Hierarchy which would prevent the confusion and clash among the authorities and gives an idea about the chain of command The authorities should take note that commercial fishing encroachment along the coastal boundary is depriving small fishers' sustainable livelihood from fishing.

- Adequate control of sand mining activities must be ensured to prevent sedimentation of watercourses from spoil deposits and other disturbance on the land surface.

- The study understands the need of port, harbor and jetty development on the coastline as its required for the shipping industry, offshore oil and gas development, marine fisheries operations, naval and other military operations, but its should be sustainable.

- As the CVI indices of certain points were slightly high stress should be given for preventive measures ,construction of shelters and sustainable and integrated land use planning to minimize exposure to risks .

- Enhance the capacities as well as effectiveness of early warning systems of coastal disasters

VIII. ACKNOWLEDGEMENT

We would like to extend our sincere gratitude towards the scientists of KUFOS and CMFRI for evaluating our study and also giving us suggestions for improving the effectiveness of the study. We would like to thank the teaching and non teaching staffs of VJCET, Vazhakulam for supporting us. We personally like to wish our gratitude to our mentor Miss.Rose Mary Xavier , Assistant Professor, Department of Civil Engineering, V.J.C.E.T who gave us the much needed help and support during the conduct of the project. Without her our team would have been a lost kid in a crowd.

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