

Integrated coastal planning for sustainable development of coastal communities – A Literature Review

¹Nithya Parthiban, ²Kartiki Pataskar

¹M. Plan student, ²Assistant Professor
Hindustan Institute of Technology and Science, SPADE
Chennai, India

Abstract- Integrated coastal planning is the concept that was established in 1992 to manage the coastline effectively for urban uses. The strategy was developed for land use planning for the long-term development of the coastal zone. This study aims to analyze existing methodologies used for coastal planning, and identify the various relevant parameters that can be integrated with coastal area planning for sustainable coastal community development. The primary focus of the study is to establish a relationship between physical and ecological issues that affect the coastal development. The study summarizes various journal papers and articles in the domain of integrated coastal planning for establishing relation between development and sustainability.

Key words: Coastal area planning, coastal community, coastal development, Coastal zone, Sustainable coastal community, Integrated coastal planning.

I. INTRODUCTION

The extensive coastline resources are essential elements for coastal towns for their survival. As stated by Rachel Carson "Everything comes from the sea and everything returns to the sea, the ocean covers 70% of the Earth's surface, which has a significant impact on weather, climate, and heat distribution". It supports a wide variety of organisms and habitats, and is essential for the Earth's ecology. A large portion of life depends on the ocean for nourishment and survival. Given the limited resources available to the oceans, the consequence is that it is necessary to reduce the impact that the growing number of coastal communities have on marine environments. And hence the need to reconsider coastal planning for development is apparent. Over 80% of marine pollution in India is caused by land-based sources, including untreated sewage, industrial effluents, and solid waste discharge into rivers and coastal areas. According to the Central Pollution Control Board (CPCB), about 80% of coastal areas in India are heavily polluted. The Ministry of Earth Sciences estimates that about 45% of India's coastline is eroding at an average rate of 1.7 meters per year. Integrated coastal planning is essential for managing Indian coast sustainably. The distinctive ecology of the area must be conserved by integrating economic growth with social and environmental concerns.

II. MATERIALS AND METHODS

"To what extents have integrated coastal planning strategies been effective in promoting sustainable coastal development?" is the research question that leads this literature review. The literature review was conducted with following research questions:

- What are various parameters to be considered for spatial planning of a coast?
- What are different analysis techniques/ tools that can be used for studying the coastal resources?

SEARCH STRATEGY:

To find relevant papers on integrated coastal planning, a comprehensive literature review was carried out. Three significant academic databases were searched: Scopus, Web of Science, and Google Scholar. The keywords searched for included word combinations like "integrated coastal planning," "coastal management," "coastal governance," and "sustainable coastal development." To ensure a focus on current literature, the search was confined to research papers written in English and released between January 2000 and September 2021.

SELECTION CRITERIA:

A systematic approach was used for selecting the articles. The works that were included are peer-reviewed articles, conference papers, book chapters and reports. Works that mainly concentrated on specific elements, such as fisheries management or coastal engineering, were pruned in order to maintain an individual emphasis on integrated coastal planning. The geographic scope included both studies of a global scale and particular coastal locations with various planning contexts.

DATA ANALYSIS:

Recurring themes, patterns, and trends in the literature were found using a thematic analysis approach. To find common planning approaches and strategies used in different coastal locations, the retrieved data were meticulously reviewed. The study additionally looked at the extent and type of stakeholder involvement, including the functions of government organizations, regional communities, non-governmental organizations (NGOs) and industrial players. To give a comprehensive review of integrated coastal planning practices and their results, the findings were combined.

III. A LITERATURE REVIEW –
COASTAL LAND SUITABILITY ANALYSIS

Coastal Regulation Zone, 2019 (CRZ) guidelines are currently used in India for coastal management. These guidelines are difficult to implement and do not take into account variations in shoreline physical properties. An alternative to this approach is quantitative land classification of coastal areas based on geospatial information and multi-criteria decision-making techniques. In this work two approaches are carried out in three case locations in coastal areas of the Mumbai region that are i) predominantly urban, ii) rural and iii) undeveloped areas. The study applied the two approaches of CRZ and Coastal Area Index (CAI) to the three case locations of the coastal lands in Mumbai region. The results of the two approaches were compared and contrasted to show the drawbacks in the present CRZ classification 17 .This study determines that unscientific planning practices can lead to the degradation of coastal ecosystems. CAI is a significant approach to achieve a balance in environment quality and urban development along the coastal area. The outcome of CAI for land use classification in coastal zone has generated a futuristic scenario with improved resilience and restoration of the coastal system. The actual outcome of CAI can be profoundly useful for land-use planning decisions.

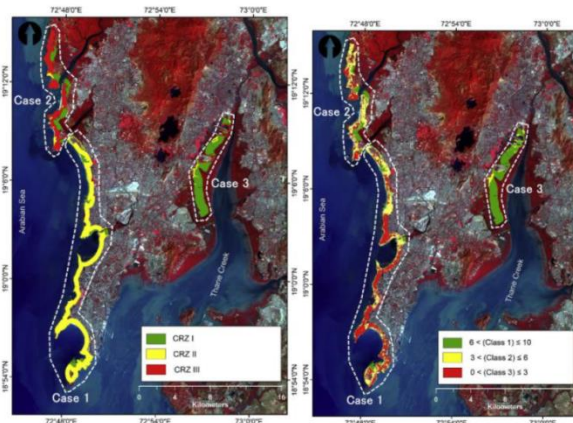


Fig. 1 Case location for CAI, Mumbai

The second case is of coastal area of Thiruvavarur district where integrated approach of Geographic Information System (GIS) and Analytical Hierarchy Process AHP was carried out to identify the suitable site for aquaculture. Given its abundant coastal region and 47.2 km of shoreline, the Thiruvavarur district has tremendous fishing potential. As per the coastal aquaculture authority (CAA) recommendation this study focuses on selecting a suitable site for aquaculture. This study found that the environmental productive site locations significantly differed from the socioeconomically suitable area, demonstrating that an integrated approach of GIS and AHP was the most effective way to identify the suitable site for aquaculture. Thematic maps were generated using IRS P6 LISS IV satellite images and geological data from the Geological Survey were overlaid in GIS. Conceptually overlaid layers show that aquaculture can be practiced in 2160 sq.km of Thiruvavarur district 8.

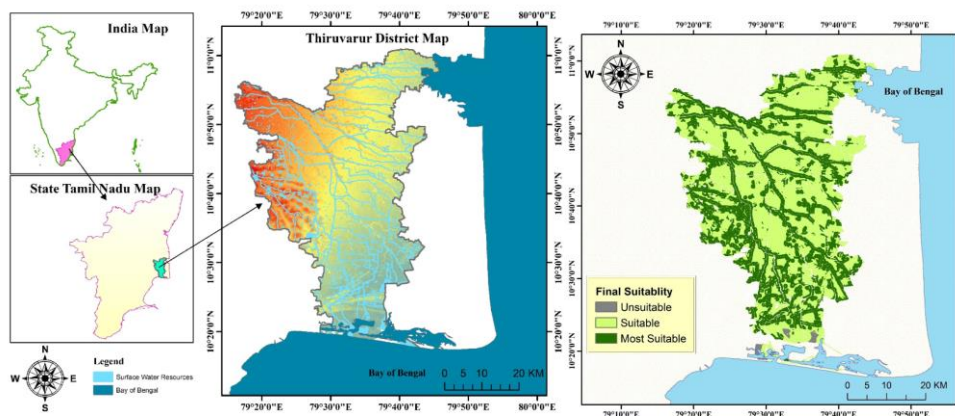


Fig. 2 Aquaculture suitability map in Thiruvavarur District

The study on New York coastal city to minimize the risk of sea level rise to coastal population and infrastructure adopted the land suitability model. This involves the classic overlay method developed by Ian McHarg by incorporating sea level rise projections for the 2020s and 2050s into a GIS-based land use suitability analysis of New York City. The results suggest that Eastern Staten Island and the southern shore of Brooklyn and Queens are especially unsuitable for future development without major adaptation measures. The study also recommends for improving this analysis through improved hydrological connectivity measures in modeling sea level rise, and better methods of accounting for policies influencing the manner of development in flood zones. Adaption of policies that influence the style and rate of development in flood zones would improve the coherence and internal consistency of future suitability analyses for informing urban decisions.

INTEGRATED COASTAL ZONE MANAGEMENT (ICZM) POLICIES AND FRAMEWORK

It is a method of managing coastal regions that seeks to balance numerous environmental, social, and economic objectives while ensuring the long-term growth of coastal zones. ICZM considers the interconnection and fragility of coastal systems, taking into consideration both land and water. Scientific information is required for proper implementation, and it is built around five key management elements to ensure integration, coordination, processes, issues and management, and interaction between government officials, environmentalists, economic planners and the general public 10. The study on Shanghai, Republic of China offers an ICZM framework to address the current demands and management challenges of the coastal zone. It focuses on cross-sectoral management, strategic environmental evaluation, intense scientific research, and public participation. The findings indicate that local management approach innovation will hopefully assist to the goal of sustainable development in the coastal zone of China's most developed area, where wetland areas are also of global importance.22

In the coastal area of the Kuala Langat District, Selangor, Malaysia, an integrated plan was created using a systematic approach to identify optimal land use the suitability for future sustainable development. The application of the multi criteria evaluation (MCE), particularly the Analytic Network Process (ANP), resulted in the integration of opinion from experts on social, economic, and environmental criteria within the planning framework and provided an effective spatial strategy for coastal land use development. The planning process could possibly have improved effective through integration of multiple groups of important stakeholders and taking into consideration allocation and predicted modeling challenges. 2.

Peru's approach to managing its coasts is complex, with minimal environmental countermeasures and focused on the coast. This has led to significant territorial imbalances and low urban quality of life. To address this, Peru is collaborating with various international organizations to advance the planning of its National Policy in Integrated Coastal Zone Management and its associated National Programme. Key assessments in this process involve the decision of regional and local organizations to national initiatives. To address all of the aforementioned, it is necessary to assess and analyze the outcomes of national public policy in an independent way 6 .

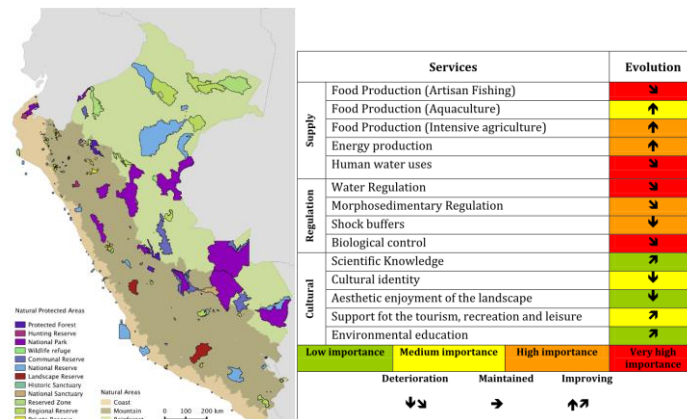


Fig. 3 Marine Protected Area approach in Peru 6

INTEGRATING SOCIO-ECONOMIC AND ENVIRONMENTAL ASPECTS IN COASTAL PLANNING

The study in Semarang City, Indonesia used in-depth interviews, field observations, and survey mapping to calculate the resilience score of the environmental and socioeconomic situations. It was found that social and physical capital had strong potential to assist community resilience, but human resource and financial capital had a more limited capacity. The presence of the mangrove forest increased the natural capital's capability, and a medium to high score on the socioeconomic index indicates that there are many options for the local community to improve its standard of living 7.

A GIS-based coastal vulnerability index for wave-induced erosion was studied in Northern Ireland to see how socioeconomic factors may be included. The development of a socio-economic sub-index, together with sub-indices for coastal pressure and coastal characteristics, resulted in a potential contribution of one-third to the total index score. A random scale of 1 to 5, with 5 being the most vulnerable, was used to rank the variables. The combined score was evaluated against data collection and outdoor research, and the results revealed that the socioeconomic index was underrepresented. To examine the issues involved in the creation of such indices, it was effective to incorporate a socio-economic sub-index in an overall index to measure vulnerability to wave-induced erosion for Northern Ireland 18.

Marine Spatial Planning (MSP) is an executive approach aimed at achieving marine conservation and preventing over exploitation of marine resources. The study mapped all of the important hot spots for biodiversity along the coast of Odisha, such as turtle congregation sites, turtle migration routes, coral reefs, sea grass beds, mangrove swamps, mega fauna, marine protected areas, and fishing zones. The MSP framework prepared for Odisha demonstrated an approach that can reduce possible conflicts between marine and environmental processes, increase utilization of Odisha's marine space through compatible activities and biotechnology research on marine products, and develop untapped marine resources with sufficient area for further exploration. A well-documented framework on marine planning at central level is required to ensure shared responsibility of end users of maritime resources, product and service with a common goal of understanding the maritime future for the country 1.

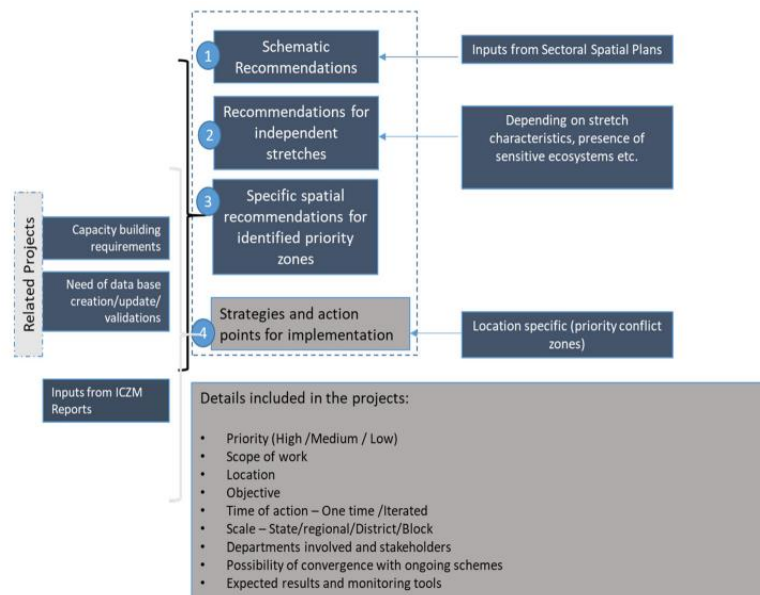


Fig. 4 Marine Spatial Planning Framework 1

INTEGRATED COASTAL Zone Management Toolkit

The initial objective was to establish marine protected areas as part of the coastal management study for the Belize Barrier Reef. However, MPA initiatives did not take into consideration land-based activities, therefore the focus shifted towards an interdisciplinary approach with Integrated Coastal Management (ICM). While the MPA strategy has not progressed with the trend of more community engagement, the ICM process resulted to greater engagement and discussion in decision-making for issues which includes coastal resource management. In the next ten years, strengthening the connections between MPA and ICM programmes, encouraging community involvement in management, expanding ICM to include watershed governance and ocean governance, and ensuring sustainable funding for both initiatives will be the greatest challenges 9.

The analysis provided by ecosystem-based management (EBM) highlights the significance of ecosystem services (ES) as the fundamental elements maintaining the environment, social and economic integrity, as well as human well-being. The majority of Brazilian coastal zone management programmes lack the essential ecosystem-based evidence for effective EBM. Additionally, they frequently fail to achieve in integrating information based on ecosystems into the management framework. This study proposes a roadmap model to produce the ecosystem-based information and its application for coastal policies. This involves the identification of (1) dominant ecosystems and ecosystem services; (2) benefits for human well-being; (3) stakeholders affected; (4) main pressure, human or natural produced; (5) main impacts, (6) managerial responses. The results show the possible way to define ecosystems that take into account ecological, economic and social elements in an integrated framework.20 .

By including potential escape routes and green areas in coastal communities; the initiative seeks to establish a network of green infrastructure. The three regions of South Korea's Haeundae District are divided into neighborhood units, with the northern region featuring environmentally friendly neighborhoods, the middle region featuring advanced industrial districts, and the southern region featuring a coastline tourism district. This study looks at the district's Green Infrastructure Network GIN, which connects living-zone-based green networks to urban open areas including parks for emergency preparation, greenways, and gardens 16.

Ecosystem services are positive aspects obtained from ecosystems for people. Ecological economics is an interdisciplinary science that aims to provide an accessible framework for the communication of data from various fields. The ecosystem services approach is an integrated and iterative process that aims to enhance decision-making about a specific issue. Depending on every instance, different measuring units (biophysical, monetary, or non-monetary) are used. It acknowledges the significance of the context in which the environmental assessment is placed as well as the need for services by understanding the importance of knowing how the coastal environment works so that we can maximize the most of it while threatening ensuring the delivery of these positive benefits to people.2

Coastal Sustainability

The GoI (Government of India) initiative of CRZ refers to the Coastal Regulation Zone in India. The Coastal Regulation Zone is a framework of regulations and guidelines established by the Ministry of Environment, Forest and Climate Change (MoEFCC) in India to manage and protect the coastal areas of the country. The CRZ regulations aim to balance the need for development activities in the coastal areas while ensuring the conservation and sustainable use of coastal resources and protecting coastal ecosystems. To preserve coastal ecosystems, the Government of India has declared areas between high and low tide lines (HTL, LTL) and 500 m from HTL as the Coastal Regulation Zone (CRZ). Geospatial information technology can contribute greatly to develop such models, and the sustainable management also depends on the nature of the social system, comprising political economic and industrial infrastructure and its linkages, with the knowledge about coastal systems as well as local communities 19.

Mangrove forests abound along rivers and along coastlines in the tropics and subtropics where land and water meet. In addition to providing a variety of goods and services, they additionally provide forestry, fishing, and non-timber forest products. Mangrove conservation efforts support several of the Sustainable Development Goals (SDGs) of the United Nations, including Goals 13 and 15: "Sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss." Goal 13 calls for "immediate measures to combat climate change and its impacts." Goal 14 proclaims for "conserve and sustainably use the oceans, seas, and marine resources for sustainable development 5."

IV. CONCLUSION

Rapid urban industrialization, maritime transport, marine fishing, tourism, coastal and sea bed mining, offshore oil and natural gas production, aquaculture, and the recent establishment of special economic zones have led to a significant increase in demand for infrastructure, resulting in the over-exploitation of marine resources. Integrated coastal planning is the strategy of preparing land use plan for the sustainable development of Coastal Zones. Integrating various context specific parameters as part of ICZM framework can improve the coastal resilience. Sustainable coastal management means managing the wider coastal zone in terms of people and their environment livelihood, social and cultural well-being, safety from coastal hazards, and minimizing environmental impacts. Inter-sectoral coordination and consultation play a crucial role in the development of ICZM plans. By involving multiple stakeholders, including government agencies, local communities, industry representatives, and environmental organizations, political will can be enhanced, and the quality of life for coastal communities can be improved. This collaborative approach helps ensure that the decisions made regarding coastal development are well-informed, inclusive, and sustainable in the long term.

REFERENCES:

- Anuja Shukla , Falguni, Ivica Trumbic(2021) Relevance of Marine spatial planning in coastal zone management planning : Opportunities and challenges in Indian context – Case study of Odisha , J. Earth Syst. Sci. (2021) 130:97 Indian Academy of Sciences, <https://doi.org/10.1007/s12040-021-01574-6>
- Carla I. Elliff, et al(2015) , The ecosystem service approach and its application as a tool for integrated coastal management, Brazilian Journal of Nature Conservation, <http://dx.doi.org/10.1016/j.ncon.2015.10.001>
- Devaraj Asir Ramesh, Arumugam Senthil Vel(2011) Methodology of integrated coastal zone management plan preparation, Journal of Environmental Protection, 2011, 2, 750-76012
- GIS Coupled multiple criteria decision making approach for classifying urban coastal areas in India, Habitat International 0964-5691 <https://doi.org/10.1016/j.ocecoaman.2019.104929>.
- Jeffrey Chow (2018), Mangrove management for climate change adaptation and sustainable development in coastal zones, JOURNAL OF SUSTAINABLE FORESTRY2018, VOL. 37, NO. 2, 139–156, <https://doi.org/10.1080/10549811.2017.1339615>
- Juan M. Barragán, et al(2018) Policy progress on ICZM in Peru, Ocean and Coastal Management, <https://doi.org/10.1016/j.ocecoaman.2018.03.003>
- Judi Lowea, , Johann Friedrich C. Tejadab , Mark G. Meekanc(2019), Linking livelihoods to improve biodiversity conservation through sustainable integrated coastal management and community based dive tourism : Oslob Whale Sharks, Marine Policy 108 (2019) 103630
- K. Shunmugapriya, et al (2021) Integration of multi criteria decision analysis and GIS for evaluating the site suitability for aquaculture in southern coastal region, India, Marine Pollution Bulletin , <https://doi.org/10.1016/j.marpolbul.2021.112907>
- Lisa P sousa, Fatima L. Alves(2020) A model to integrate ecosystem services into spatial planning , Ocean and coastal management 195(2020) 105280 Devaraj Asir Rmaesh , Arumugam Senthil Vel(2011)
- M.C Pathak, Ranjay Sinha, R.Nigam and K.L Kornala (2017) Concepts, Approaches and application of integrated coastal zone management in planning and management of Indian coast, Marine geoscience in India
- M.Miharja and Arsallia (2017) Integrated coastal zone planning based on environment carrying capacity analysis, IOP Conf. Series: Earth and Environmental Science 79 (2017) 012008, <https://doi.org/10.1088/1755-1315/79/1/012008>
- Maria, Steohanie, Andre Frainer, Priscila, Jon Lopez, Samiya selim and Natasha (2021)The missing layers: Integrating sociocultural values into marine spatial planning, Frontiers in Marine Science volume 8 Article 633198
- Marisa Berry, et al (2021) Integrating sea level rise into development suitability analysis, Computers, Environment and Urban Systems, <http://dx.doi.org/10.1016/j.compenvurbsys.2014.12.004>
- Methodology of integrated coastal zone management plan preparation – Case study of Andaman Islands ,India , Journal of Environmental Protection, 2011, 2, 750-760
- Nana Kariada Tri Martuti, Rudhi Pribadi , Nur Kusuma Dewi , Wahid Akhsin Budi Nur Sidiq , Dhita Pracisca Mutiari (2022), Analysis of environmental, socio-economic, and stakeholder partnership for integrated coastal management in Semarang city,Indonesia, Journal of Integrated Coastal Zone Management (2022) 22(1): 9-22
- Planning a Green Infrastructure Network to Integrate Potential Evacuation Routes and the Urban Green Space in a Coastal City: The Case Study of Haeundae District, Busan, South Korea (2020), Science of the total environment <https://doi.org/10.1016/j.scitotenv.2020.143179>
- Ravinder Dhiman, Pradip Kalbar, Arun B.Inamdar. (2019). spatial planning of coastal urban areas in India: Current practice versus quantitative approach Ocean and coastal management - 0964-5691,

- 18.S. McLaughlin,et al(2002) , Socio-economic data in coastal vulnerability indices: constraints and opportunities, Journal of Coastal Research, Special Issue 36, 2002, <https://doi.org/10.2112/1551-5036-36.sp1.487>
- 19.Satyendra Kumar and CR Suthar (2022) Linkages of sustainable development goals with integrated coastal zone management project in India: An approach to enhance efficacy-pp. (S153-S162)
- 20.Shawky Mansour,et al(2019) Geospatial based multi-criteria analysis for ecotourism land suitability using GIS & AHP: a case study of Masirah Island, Oman, Journal of Ecotourism, <https://doi.org/10.1080/14724049.2019.1663202>
- 21.Vincenzo Maccarrone,et al(2014) , The ICZM Balanced Scorecard: A tool for putting integrated coastal zone management into action, Marine Policy , <http://dx.doi.org/10.1016/j.marpol.2013.09.024>
- 22.X.Q. Wu, M. Gao,et al(2012) Framework and practice of integrated coastal zone management in Shandong Province, China , Ocean & Coastal Management , <http://dx.doi.org/10.1016/j.ocecoaman.2012.07.030>