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THE EVOLUTION OF INTEGRATED COASTAL ZONE MANAGEMENT (ICZM) IN INDIA: AN OVERALL REVIEW

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ABSTRACT: Coastal water systems are increasingly threatened by anthropogenic pressures, making natural recovery processes difficult and accelerating environmental degradation. Consequently, the urgent and strategic management of coastal and marine resources has become imperative to promote sustainability. Since the mid-19th century, various global and regional efforts have aimed to improve coastal conditions, among which Integrated Coastal Zone Management (ICZM) has emerged as a comprehensive and holistic framework. While a considerable body of literature exists on ICZM, a systematic review that synthesizes its historical evolution, conceptual foundation, policy frameworks, implementation models, and challenges remains lacking. This paper addresses this gap by providing an integrated, interdisciplinary overview of ICZM - tracing its development, highlighting significant governance approaches, assessing environmental, institutional, socio-economic, political, and scientific challenges, and identifying future directions. Special emphasis is placed on the Indian context, offering insights into national strategies, institutional mechanisms, and the application of remote sensing and spatial tools in coastal management. The paper also examines the contribution of ICZM toward achieving key Sustainable Development Goals (SDGs), reinforcing its role as a critical pathway to sustainable coastal governance.

Keywords: Integrated Coastal Zone Management (ICZM), Coastal Management, Coastal Governance, Sustainable Development, Policy Frameworks, Environmental Planning.

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1. INTRODUCTION

A large area of coastal waters and occasionally a short stretch of coastal lowlands make up the coastal zone. The coast is a location where the exosphere, ocean, biosphere, and atmosphere interact (Fig. 1). These parts are constantly exchanging mass and energy, and as a result of these interactions, a unique ecology is formed. Because of these interactions, coastal regions show remarkable biological production and variety, which has led to their transformation into the hub of human activity. Fish, shellfish, and seaweed are produced in coastal areas, where the ports serve as trade and commercial hubs. Many biotas are also suppliers of home goods, including detergent, fertilizer, and medicines. Additionally, coastal wetlands store nutrients, trap pollutants, and aid in the defense of the shoreline against erosion and storms. Because of their beauty, the coastlines draw visitors and encourage tourism. These goods and services help sustain human existence, which has an effect on a nation's economy and, in turn, its socioeconomic circumstances. To guarantee that coastal ecosystems are in excellent condition and continue to supply a range of goods and services for present and future generations, the practice of sustainable management must be actively implemented.

Around 37% of the global population lives within 100 km of the coastline, in areas where the population density is twice the global average (Cosby *et al*., 2024). The coastal region has emerged as the primary location for a wide range of commercial activity. Many coastal developing countries rely heavily on limited coastal resources for economic growth. In many nations across the world, rapid urbanization and economic growth give rise to a variety of complicated resource-use disputes and environmental degradation issues in the coastal zone. In many coastal developing countries plagued by hunger, unemployment, poverty, and fast population expansion, the problems have gotten worse.

However, these negative effects are not readily apparent in coastal countries with a small and sparsely populated population, an abundant natural resource base, and a rural economy. As the population grows and market forces are anticipated to have a greater impact on resource exploitation and usage patterns, the situation will progressively alter.

Figure 1. Coastal Zone as an Earth System Interface.

The complicated management problems in the coastal zone cannot be solved by conventional sectoral management. These problems are frequently cross-sectoral in character, whereby the operation of one sector negatively influences the growth of another (Fallon and Chua, 1990; Scura *et al*., 1992). The problems with coastal management have escalated usage disputes, sparked social unrest, and undermined the stability of the national economy, making them a serious danger to environmental sustainability and economic sustainability. There is a clear need for an efficient alternative management structure. There is growing and urgent demand from policymakers and resource managers worldwide across both developed and developing nations for a comprehensive and actionable roadmap to guide sustainable coastal development.

1.1 Historical Evolution

With exceptional economic and ecological significance, coastal regions are among the most inhabited and productive places on earth. Natural, social, and cultural resources deteriorate as a result of increased competition for marine and coastal areas and mounting resource pressures. The effects of climate change are anticipated to expose the shoreline even more. In the past, coastal planning initiatives or development choices were made on a sector-by-sector basis with little connection between them.

This fragmented approach to planning and management leads to inefficient use of resources, conflicting land-use interests, and missed opportunities for more sustainable coastal development. One of the earliest policy frameworks for integrated coastal zone planning and management was the United States Coastal Zone Management Program (CZMP), which was created under the Coastal Zone Management Act (CZMA) of 1972 (Knecht, 1993). As a concept, ICZM has evolved over the past 40 years from nonintegrated sectorial to integrated methods (Sorensen, 1997; Cicin-Sain and Knecht, 1998; Salomons, 1999). The environment was initially the focus of ICZM, but subsequently economic, social, and ethical considerations were included (Turner, 2000). Under the support of the United States Agency for International Development (USAID), the Association of Southeast Asian Nations (ASEAN) started a regional initiative in 1986 to address the concerns of natural resource depletion and coastal environmental degradation.

Integrated Coastal Zone Management (ICZM) emerged as a globally recognized framework following the 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil. Agenda 21, particularly Chapter 17.1, emphasized the need for 'new approaches to marine and coastal area management and development at the national, sub-regional, regional, and global levels', approaches that are integrated in content, and precautionary and anticipatory in nature. This marked a significant shift towards holistic and forward-thinking strategies for sustainable coastal governance.

1.2 Significance or need of Coastal Management

Conflicts exist between the need to utilize coastal resources for human benefit and the preservation and conservation of those resources for long-term usage, which has reached an extremely critical stage in many nations (figure 2). The states of the coastal region and its resources have irreversibly degraded (World Bank, 1993). Over the last 25 to 30 years, there has been significant population pressure on our beaches due to tourism, excessive and unplanned housing, industrial facilities, the use of coastal regions as dumping places, unrestricted sand extraction, the construction of ports, piers, seawalls, etc. without regard for aesthetics or ecological considerations, filling for land reclamations, excavations built for coastal recreation, and even the building of roadways as a coastal solution for traffic problems (Oylum and Osman, 2016). Due to their higher natural variability, coastal ecosystems are often more robust than open ocean ecosystems, but because of their close proximity to populated areas, they are also typically exposed to larger concentrations of a wide range of anthropogenic stressors (Shackeroff *et al*., 2009). Furthermore, it is widespread and well acknowledged that numerous stresses, including fishing, pollution, warming oceans, and ocean acidification, have a negative impact on coastal ecosystems (Craig, 2003; Craig, 2010). According to Guichard and Peterson (2009), "the intrinsic complexity of coastal ecosystems and their relationship with human activities can explain the typical failure of management strategies centered on addressing single components of coastal ecosystems independently of others."

The objectives of ICZM are to maintain vital ecological processes, life support systems, and biological diversity in coastal and marine areas as well as to achieve sustainable development of coastal and marine areas, reduce vulnerability of coastal areas and their inhabitants to natural hazards, and achieve sustainable development of coastal and marine ecosystems (Cicin-Sain and Belfiore, 2005). The objective of ICZM is to interlink all the aspects of the coastal zone and design management plans with a holistic approach (figure 3).

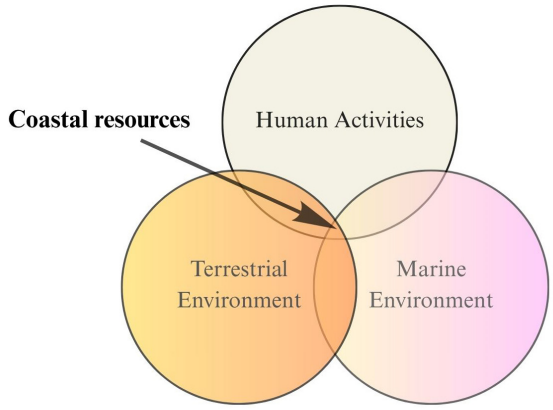

Figure 2. Conceptual Framework of the Coastal Resource System.

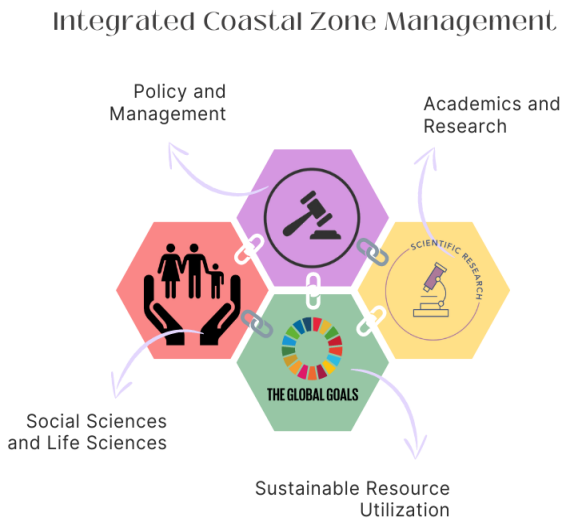

Figure 3. Interdisciplinary linkages supporting sustainable coastal resource management through policy, science, and society within the SDG framework.

The ocean is home to the biggest linked ecosystem in the world, which offers facilities and services vital to human survival. They control our environment and are anticipated to give communities all over the world a rising supply of energy, food, materials, leisure, and cultural services. As a result, environmental sustainability for the ocean is a common problem, necessitating the establishment of an appropriate global forum for the design of sustainable development goals backed by indices and ocean policies as well as the monitoring of their accomplishment. A specific Sustainable Development Goal (SDG) for the ocean and coasts that is developed and adhered to could spur greater international cooperation in order to achieve good environmental conditions for the ocean and coasts, secure blue wealth, ensure equitable access to ocean resources, and support the growth of resilient coastal communities. In addition to actively assisting in the achievement of 4 of the 17 SDGs, integrated coastal zone management is a powerful tool for ensuring a sustainable future. The integrated coastal zone management generally places the environment first, but occasionally it also emphasizes social and health considerations. Moreover, it also has influence on several other objectives of the SDGs besides those mentioned above.

2. COASTAL MANAGEMENT MODELS

Coastal management frameworks are broadly classified into two principal categories: the sustainability-oriented model and the conventional model. The sustainability model encompasses approaches such as ecosystem-based management (EBM), watershed-based management, and the establishment of protected marine areas (PMAs), all of which aim to maintain ecological integrity while supporting human needs. In contrast, the conventional model typically involves estuary-based management and integrated coastal zone management (ICZM), focusing more on administrative boundaries and sectoral planning rather than holistic ecosystem health (Kay and Alder, 2005; Cicin-Sain and Knecht, 1998).

2.1 Watershed management

Extending the scope of estuary-based management to encompass actual watershed-based management is a substantial change. The fact that circumstances in an inland watershed might differ from those in an estuary or coastal area makes in-land watersheds significant to those areas. Estuaries heavily rely on circumstances upriver and on the surrounding terrain that makes up their watershed (Costanza, 1998). It should be obvious that estuary-based management can only be increased in efficiency by extending management choices to the estuary's watershed.

2.2 Protected Areas

While climate change affects marine landscapes, a number of anthropogenic stressors are present in the background. Future projections indicate that the existing effects increasing warmth, acidification, oxygen depletion, and sea level rise will become more pronounced. Marine Protected Areas (MPAs) were created to

safeguard marine characteristics, typically with a goal of lowering fishing pressure and infrastructure installation. Since these MPAs are static in character and seldom take climate change into account, it is unclear how well they would be able to adapt as local adaptation strategies for conservation in response to climate change. When adaptive management practices and ecosystem-based techniques are applied, MPAs' resistance to climate change will be better supported (Hoppit *et al*., 2022).

2.3 Ecosystem management

Ecosystem-based management is a comprehensive management strategy that takes into account the entire ecosystem, including people. In order for an ecosystem to deliver the services that people desire and need, ecosystem-based management aims to keep it in a healthy, productive, and resilient state (Leslie, 2009). In contrast to existing approaches, which often concentrate on a particular species, sector, activity, or problem (McLeod *et al*., 2005; McLeod and Leslie, 2009), ecosystem-based management takes the cumulative consequences of several sectors into ecosystem-based management aims to keep it in a healthy, productive, and resilient state (Leslie, 2009). In contrast to existing approaches, which often concentrate on a particular species, sector, activity, or problem (McLeod *et al*., 2005; Leslie, 2009), ecosystem-based management takes the cumulative consequences of several sectors into account. MPAs are location-based marine management tools, roughly comparable to state and federal parks and wildlife refuges on land (Craig, 2003), both independently to safeguard specific ecosystems, such as kelp forests or coral reefs, or specific resources, such as fish species, and as a component of larger comprehensive maritime preservation plans, such as representative systems and EBM (Guichard and Peterson, 2009; Ruckelshaus, 2009; McLeod and Leslie, 2009). Any coastal or marine region that the appropriate government designates legally for some level of protection falls within the widest definition of an MPA.

2.4 Estuary

Estuaries are recognized as particularly important coastal ecosystems under estuary-based management, and efforts are made to avoid concentrating on the coastal zone, which is one of the main drawbacks of more extensive coastal zone management. Particularly, estuary-based management often develops in reaction to estuary deterioration brought on by upstream pollution, which motivates a watershed-based strategy for estuary management and restoration. Institutions created to control pollutants entering estuaries, however, can also develop into more thorough initiatives to conserve estuaries.

2.5 ICZM

Sorensen (1997), defined ICZM as "*the coordinated management and planning of coastal resources and habitats based on the physical, economic, and political linkages within and across dynamic coastal systems that collectively constitute the coastal zone.*" Effective ICZM necessitates the active coordination of stakeholders whose actions significantly influence the quantity and quality of coastal resources and ecosystems. According to Cicin-Sain and Knecht (1998), Coastal Zone Management (CZM) is defined as "*a dynamic and ongoing process for making informed decisions regarding the conservation, development, and protection of coastal and marine resources.*" This definition emphasizes the adaptive and continuous nature of CZM, highlighting its role in balancing ecological sustainability with socio-economic development objectives in coastal and marine environments.

The widely accepted and international definition of ICZM is given by the European Union, according to which ICZM is a dynamic, ongoing, and iterative process intended to advance sustainable management of coastal zones. The long-term goal of ICZM is to strike a balance between the benefits of economic growth and human uses of the coastal zone, the advantages of protecting, preserving, and restoring coastal zones, the advantages of minimizing the loss of human life and property, and the advantages of public access to and enjoyment of the coastal zone, all while staying within the bounds of natural dynamics and carrying capacity. The word 'integrated' in ICZM refers to both the integration of goals and the integration of the many tools used to achieve these goals. It entails integrating all pertinent policy domains, industry sectors, and administrative levels. It entails integrating the target territory's maritime and terrestrial components. ICZM is multidisciplinary by nature and integrated in both time and space. ICZM shouldn't merely be lumped in with 'environment', though despite the fact that ICZM refers to 'management', the ICZM process really encompasses the entire cycle of data gathering, planning, decision-making, management, and implementation monitoring. Thus, the term 'planning' is meant to refer to the creation of strategic policies as opposed to only land use planning or other sectoral planning in its broadest meaning. In order to assess the societal objectives in a particular coastal region at a particular time and to start taking the required steps to achieve these purposes, ICZM relies on the informed involvement and collaboration of all interested and affected parties (World Bank, 1993) (figure 4).

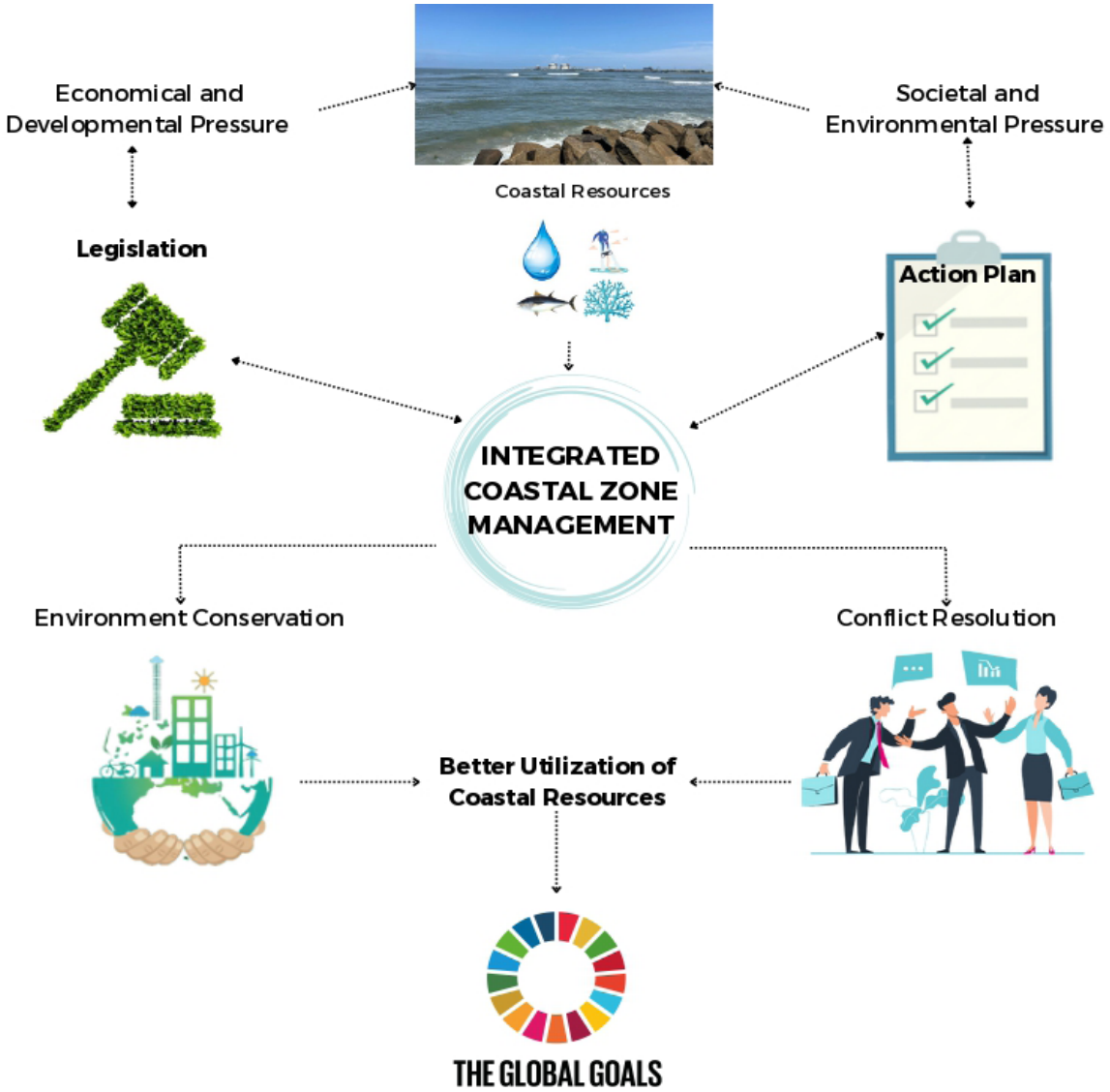

Figure 4. ICZM plan and guidelines.

3. ESSENTIAL ELEMENTS OF THE MANAGEMENT PROCESSES

3.1 Integrated Planning

Integrated resource management has gained widespread acceptance over the past 20 years as the key to attaining ecologically sustainable development. As a result, the Stockholm Declaration of the United Nations (1972), adopted one of its four guiding principles, which read in part: "*States should adopt an integrated and coordinated approach to their development planning so as to ensure that development is compatible with the need to protect and improve the human environment*". This principle laid the groundwork for future strategies, including the World Conservation Strategy (IUCN, 1980), which reinforced the concept of harmonizing development with environmental protection. Similarly, Principle 4 of the Rio Declaration on Environment and Development (UNCED, 1992) echoed this perspective, advocating for environmental protection to be an integral part of the development process. Lessons learned from prior planning for ICZM initiatives in Southeast Asia are included below.

In order to build the planning process, offer the framework for the management programme, and identify the important participating agencies, a multidisciplinary team should be formed during the first stages of programme creation. It's crucial to avoid focusing all of the resources under the control of one agency. The ASEAN/US Coastal Resources Management Projects (Chua, 1992) initially had a great deal of trouble keeping a comprehensive perspective on coastal concerns, especially in nations where a single line agency had been selected. The outcomes will be significantly impacted by this strategy. For instance, as the Fisheries Department is the primary coordinating and implementing agency for the ICZM initiatives for Lingayen Gulf and Segara Anakan, a greater focus is placed on fisheries. The planning team, according to (Scura *et al*., 1992) should consist of a core staff of six domains, including an expert in coastal management, a regional planner, a resource economist, ecology, a sociologist, and an environmental engineer. Depending on the available resources and how they will be used, specialists can be asked to join the planning team. Fisheries, aquaculture, coastal erosion, pollution, marine park administration, and environmental law are a few of the relevant fields (Scura, *et al*. 1992).

The model that has been suggested for Shanghai is a comprehensive coastal management model that uses a cross-sectoral approach and aims to take a number of difficulties into account. An ICZM plan should draw on Shanghai's current general development strategy (Shi *et al*., 2001), which has prioritized economic development while keeping environmental concerns in mind. Consequently, the following should be included in the ICZM plan: aims and goals, the legal system, institutional setting, a zonation system for coastal functions, management techniques and strategies, research in the sciences, training and education, system for monitoring and assessment, management of certain sensitive issues (such as biodiversity, aquaculture, nature reserves, and trash discharge regulation), particular action initiatives, funding strategy and the implementation framework. To guarantee that all needs are satisfied, the municipal government, local management organizations, economic sectors, scientific specialists, and locals should unquestionably be included in the planning process (Shi *et al*., 2001; Henocque, 2003). Figure 5 illustrates the decision-making framework employed in Integrated Coastal Zone Management (ICZM).

The collecting of information is crucial to the planning process. Unfortunately, a sizable portion of the information obtained could not be pertinent to the planning needs. On the other hand, crucial information for determining the management area's assimilative capability as well as for resource appraisal and regulation is typically overlooked. This is in part because they are hard to find, but more importantly because there isn't a multidisciplinary team to do effective programme design. It would be quite foolish to leave it up to the scientists to handle the initial phase of data collection and the subsequent design and planning of programmes. Clearly defining the sorts of data required for planning and programme design should occur early on. When implementing the strategic plans, research should only be done to offer definitive answers to the technical and management problems highlighted during the original phase.

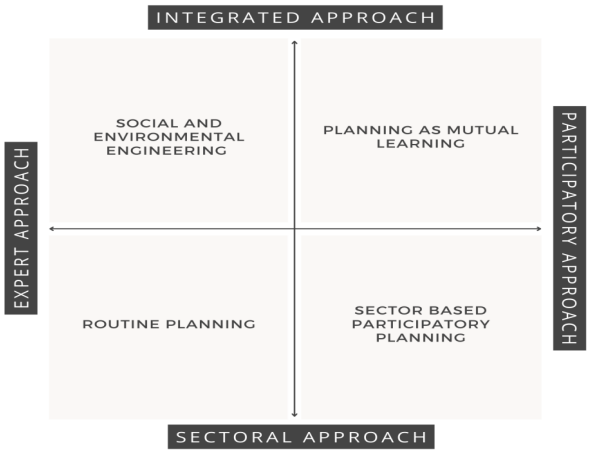

Figure 5. General framework of decision making (Welp, 2000).

Programs have frequently received revisions before the approval procedure was completed. Interests opposed to some aspects of the proposal may show up with novel and unexpected claims. Furthermore, a program's approval does not guarantee that it will receive sufficient funding (GESAMP, 1996). Scientists should examine original hypotheses before advising managers on whether the ICZM agenda needs to be revised or whether procedures need to be updated in order to take into account the most recent findings or to assimilate cutting-edge technological innovations that have practical applications (Forst, 2009). Appropriate consultation with the relevant resource management should be conducted and shall involve agencies of the federal and state governments, local government units, coastal communities, and other interested parties (Chua, 1993).

3.2 Implementation

Implementation involves employment of management practices that are eventually mutual and supportive. It requires a blend of sticks and carrots (OECD, 1993). Here, carrots refer to education, training, capital investments, participation in the formulation of policies, economic instruments (tradable permits, taxes, user charges), and decision-making procedures, while sticks refer to regulations (Sorensen, 1997). A lot of initiatives taken for ICZM did not move ahead of the planning phase. Programs developed for ICZM that do not involve concerned line agencies and government plans are commonly rejected by these organizations. If these planning and line agencies were involved before the start of ICZM programme development, it would have a tendency to become an integral part of the development plans of these agencies. Government funds and human resources play a major role in programme implementation, and these can be made useful only when policymakers are confident of the program's potential to create socio-economic benefits. Therefore, ICZM demands the implementation of programmes and projects. Implementation of these programmes and projects cannot happen all at once, and they are best implemented at the proposed time (Chua, 1993; Costanza, 2003).

The promotion and implementation of ICZM in the Mediterranean required a protocol to provide a framework to the Mediterranean states (21 in total) and the European Union, this came into force in March 2011. Acceptance of the protocol for implementation of ICZM policies and strategies in the Mediterranean countries provided a framework for managing the coast both in terms of information and boundaries. PEGASO stands for People for Ecosystem-Based Governance in Assessing Sustainable Ocean and Coast Development. It is a collaborative body of 25 Mediterranean and Black Sea institutions and organizations that assist the countries to follow the ICZM protocols in their respective areas. Its main objective is to utilize existing resources and develop a novel approach that can support policies for marine and coastal realms of the Mediterranean and accustom it to the requirements of the Black Sea (Santoro and Barbiere, 2013).

Spatial data infrastructure (SDI) is another asset for the implementation of ICZM and must include a government platform that connects scientists, administration, data providers, end-users, and other related official cartographic personnel (Strain *et al*. 2006). Initiatives that have the purpose of implementing data infrastructures on a large scale should be given importance. This can prove to be a major benefit for society, as technologies and the development of data sharing strategies are increasing. The necessity for a coordinated and effective management and administration plan for coastal zones is reinforced by the use of thematic SDIs, which can address coastal and marine infrastructures, land use changes, marine ecosystems, and biodiversity (Fowler, 2010). Because of its ability to combine existing but fragmented data and to improve users' access to source data, whether from the public, commercial, academic, government, or citizen sector, the deployment of adequate coastal and marine data and information infrastructures is becoming increasingly important (Strain *et al*., 2006; Binns, 2004). In addition, a robust and well-regulated framework needs to be established so that the governance mechanisms for the ICZM process are well in place (Malvárez *et al*., 2015).

However, even if these SDIs put forth endless efforts to validate the implementation and design, it is still difficult to have policy implementations that are fully integrated and operational (Cinnirella *et al*., 2012). The ICZM project was successfully implemented in Xiamen, in south eastern coast of China, in the mid 1990s. The ICZM of Xiamen has proven to have incorporated an ethical environmental management scheme. Success has also been duplicated in other countries, including southern coast of China. In 1994, Xiamen became one of the national demonstration sites for successful implementation of an ICZM programme and gained respect for achieving effective coastal and marine resources (Kazi *et al*., 2009; Hong and Xue, 2006).

This development leads to the establishment of cross-sectoral management. Implantation involved the planning and lively participation of stakeholders and scientists that eventually led to effective environmental protection and resource conservation. The implementation and management procedures of this ICZM also led to the prevention and mitigation of pollution of marine ecosystems, the protection of endangered species, lancelet (Branchiostoma), egret (*Egretta* spp.), Chinese white dolphin (*Sousa chinesis*) and mangroves, ocean use zoning, and the preservation of scenic spots (cultural sites, sandy beaches, and Maluan Bay on the east coast) (Peng *et al*., 2006). Most people agree that ICZM is a process that synchronizes a variety of policies and decision-making frameworks, enabling coordinated action to meet sustainable goals (Le Tissier and Hills, 2010). The rise in the number of projects at the European level that expressly include ICZM, such as those in Table 1, demonstrates the acknowledgement of its potential function.

Table 1. Different Projects addressing ICZM.

ICZM Measures	Year
Demonstration Programme	1996-1999
ICZM Strategies	1999
Communication on strategies	2000
ICZM recommendation	2002
Research into ICZM capacity requirements	2002
Evaluation of the extent of European Union ICZM implementation	2006
Green Paper of maritime policy	2006
Integrated Maritime Policy (Blue book)	2007
Maritime strategy framework directive	2008
ICZM protocol to the Barcelona Convention	2009
Review of the European Union ICZM recommendation	2011

European ICZM efforts over the past 15 years have primarily focused on investigating the needs for capacity building (Cicin-Sain *et al*., 2002), assessing the implementation of ICZM (Ballinger *et al*., 2006; Smith, 1997; Consult-Forschung and GmbH, 2006; European Commission, 1999) and developing policy frameworks, such as the ICZM strategy (European Commission, 1999), EU communication (European Commission, 2000), EU ICZM recommendation (European Parliament and Council, 2002), green paper (European Commission, 2006), blue book (European Commission, 2007), the marine strategy framework directive (Commission of the European Communities, 2008), ICZM protocol (Commission of the European Communities, 2009). According to the ICZM communication (2000), tool for implementing ICZM relates to the 8 principles that are listed in Table 2.

Table 2. Principles for ICZM (ICZM communication 2000)

Principle	Description of principle
1	Enable a holistic approach
2	Enable a participatory approach
3	Improve consideration of natural processes
4	Enable a locally specific approach
5	Support a long-term view
6	Involve relevant stakeholders
7	Introduce a combination of policy and technical instruments
8	Adaptive approaches

In Europe, the practical implementation of ICZM has been successful even with the support of a plethora of pan-European policy measures and legislative initiatives (Stojanovic *et al*., 2004). Some recurring challenges include the development of methods for implementing an interdisciplinary approach, such as overcoming problems associated with less interaction among policymakers, scientists, and practitioners (Fritz, 2010). It also includes uncertainty, data deficiency, indiscipline, difficult terminologies, and results from wide-ranging methodologies (Cooper, 2011; Olsen, 2002). The ICZM protocol for the Barcelona Convention is supposed to be the seventh protocol in the Framework. The existing set of protocols, including the Convention on Marine and Coastal Environments of the Mediterranean are complemented by this new reigning protocol and hold a significant place in the history of the Mediterranean Action Plan (MAP). This was signed in 2008 in Madrid and entered into force in 2011. The implementation of the ICZM programme along with the governance of the ecosystem put stress on the need to create initiatives on the basis of specific areas of interest (Olsen, 2002). In Greece, tourism turns out to be the main economic sector, especially in the Cyclades Islands. But the implementation of coastal policy in these regions is still fragile. There is no effective implementation of coastal environment management plans and no regulation of their respective planning systems. The sandy coast of North Lebanon, with a coastline of 100 km, has rocky terraces in order to protect the coast from erosion and storm surges. Despite the integration of national ICZM plans, it fails to incorporate an approach system to coherently use the plan for implementation of ICZM in the coastal zones. From the port side in the east to Alexandria in the west, the Nile delta area covers approximately 20,000 km2 and has a 240 km coastline. Because of water pollution, shoreline erosion, and urban sprawl, coastal resources are being degraded. This is negatively affecting the agricultural and allied sectors, especially fisheries and low-lying sectors. Due to a lack of institutional participation and coordination, many plans have not yet been implemented. Even though the national ICZM strategy was well explained in 2009, its approval is still pending (UNIVE, 2009).

3.3 Monitoring and evaluation

Monitoring and evaluation are important components of management processes, and these must be included in the planning and implementation phases of the ICZM programs (figure 6). The implementing agencies should actively monitor the progress made by the project along with the coordinating committee and evaluate the impact of the programme being implemented. The main purpose of these should be to measure the abilities of the ICZM program. They should see what can be done to achieve a good performance. They should have a tendency to seek opportunities for logistical and financial support in favour of the programme and make an assessment of the lessons learned from the impacts (Chua, 1993).

Monitoring on the coast gives a better understanding of the coastal zone and its environment, contributes to better decision-making on the coast by individuals (Williams, 1997), contributes to the well-being of the environment and its resources, and contributes to data sharing for the implementation and evaluation of management practices (Bayliss and Walker, 1996). When such monitoring practices are combined with evaluation, the scope of achieving benefits from work increases. These validate them and act as a feedback mechanism that shows the efficacy of plans and policies during their implementation. Monitoring and evaluation also deal with unexpected social, economic, and biophysical results that do occur as a result of management action (Scura *et al*., 1992). With respect to ICZM monitoring, it includes an intermittent surveillance that can discover the extent of conformity to an expected or unexpected norm (Hellawell, 1991). On the other hand, evaluation is the systematic use of social and scientific processes for assessing designs, concepts, value, and implementation of coastal zone plans and policy programmes (Rossi and Freeman, 1993). Evaluation should take into account the policies and programs' appropriate and effective procedures. It should aim to provide an appropriate data base that could be helpful for improving the program's performance. It should help with planning and improve decision-making. It should also provide better accountability for the policies and programmes of ICZM (Barrett, 1992; Sedgwick, 1993; Amies, 1994).

Coastal managers find it quite uneasy to evaluate the effective control of coastal programmes in terms of improving the condition and usefulness of the coast. The reason might be the low level of importance given to monitoring and evaluation procedures during and after implementation. This problem will continue until the present coastal monitoring systems are extended and integrated with a programme of evaluation. Monitoring and evaluation must, no doubt, be the focus of development and research so that coastal managers can see better management of coastal zones (Kay and Lester, 1997). Also, coastal managers within agencies should be provided a conceptual system or framework for proper management and decision-making that can be evaluated (Hildebrand and Norrena, 1992). Monitoring and evaluation clearly show whether the plan or programme is working or not. For better understanding, these should be isolated from other management activities and looked at separately in the planning and management system (Jacoby, 1994; CSIRO, 1994).

For adaptive management of the coastal zone, monitoring and evaluation is critical. These enable adjustment of management actions. However, the way in which monitoring and evaluation can support for adaptive management, is not often found considerable. To summarize, monitoring includes activities that estimates the effectiveness of actions and evaluation includes the interpretation of data (Jacobson, 2014).

Figure 6. Process flow of ICZM

4. ESSENTIAL ELEMENTS RELATED TO MANAGEMENT ISSUES

The ICZM development issues are related to a wide range of management problems and difficulties (Table 3). These issues can be due to environmental quality, resource utilization, institutional concerns and natural hazards (Chua, 1993).

Management issues are often linked with the quality of the environment and the utilization of resources. The historical, cultural, and archaeological resources need specific attention for protection. Institutional issues are linked to institutional power to implement programmes and influence legislation. Natural hazards such as tidal waves, storms, and typhoons can also cause issues with coastal management in the coastal zone. Sea level rise and sea temperature have a direct impact that can pose a set of new management issues and must be considered in the ICZM program. The identification of management issues requires a proper field survey and site inspection. These issues are frequently identified through consultative meetings with local government officials, communities, and members of other non-governmental organizations (NGOs) working in the field.

Table 3. Management issues identify in six of the pilot sites in ASEAN (Chua and Pauly, 1989).

Management Issues	Brunei Darussalam	Indonesia	Malaysia	Philippines	Singapore	Thailand
Resource utilization Sustainable fisheries development	Y	Y	Y	Y	N	Y
Sustainable aquaculture development	Y	N	Y	Y	Y	Y
Sustainable coastal forestry	Y	Y	Y	Y	N	Y
Land and water use conflicts	N	Y	Y	Y	Y	Y
Overfishing	Y	N	Y	Y	Y	Y
Open access	N	N	N	Y	N	N
Destructive fishing	N	N	N	Y	N	Y
Decreased tourism potential	N	N	N	Y	N	N
Destruction of habitats	Y	Y	Y	Y	N	Y
Undervaluation of resources and resource systems	Y	Y	Y	Y	Y	Y
Cultural/historical resources	N	N	Y	N	Y	N
Endangered wildlife	Y	Y	N	N	N	Y
Environmental quality Water quality	Y	Y	Y	Y	Y	Y
Siltation/sedimentation	Y	Y	Y	Y	N	Y
Solid/domestic waste	Y	Y	Y	Y	N	Y
Critical habitats	Y	Y	Y	Y	Y	Y
Oil spill	Y	N	Y	N	N	N
Coastal erosion	Y	Y	N	Y	N	Y
Pollution	Y	Y	Y	Y	Y	Y
Aesthetics	N	N	N	N	Y	Y
Floods	N	N	Y	Y	Y	N
Marine transportation	N	N	Y	N	Y	N
Dredging and filling	N	Y	N	N	Y	N
Coastal reclamation	N	N	N	N	Y	N
Waterfront development	N	N	N	N	Y	N
Agricultural waste	N	Y	Y	Y	N	Y
Conflicts in legislation	Y	Y	Y	Y	N	Y
Multi-sectoral integration/coordination	Y	Y	Y	Y	N	Y
Transnational cooperation	Y	N	Y	N	Y	N
Institutional capabilities	Y	Y	Y	Y	N	Y
Public awareness/involvement	Y	Y	Y	Y	N	Y
Legal framework	Y	Y	Y	Y	Y	Y
Ineffective law enforcement	N	Y	Y	Y	N	Y
Landownership	N	Y	N	N	N	N
Inadequate interdisciplinary planning capability	Y	Y	Y	Y	N	Y
Inter-sectoral conflicts	Y	Y	Y	Y	Y	Y
Lack of alternative livelihood	N	Y	N	Y	N	N
Equity	N	Y	N	Y	N	Y
Natural hazards red tide	N	N	N	Y	N	N
Flooding	N	N	Y	N	N	N
Typhoon/earthquake	N	N	N	Y	N	N

*("Y" for Yes and "N" for No)

Not every problem can be solved at once; in fact, it takes time. The ICZM assists in identifying priorities and characterizing management issues that must be addressed in order to implement long-term management strategies.

5. ESSENTIAL ELEMENTS RELATED TO MANAGEMENT ACTIONS

5.1 Institutional and organizational arrangements

A society creates institutional arrangements to divide finite resources among conflicting interests. Institutional arrangements are made up of laws, customs, and governing structures (stakeholders). A nation or sub-national entity has an institutional arrangement if it has set up a system to manage even one of its coastal resources (such as fisheries, beaches, sub-tidal lands, or port regions). The agreement could merely be on paper (such as laws that are ignored). The agreement does not have to be limited to the shore (as in a national fisheries law). The supporters of the ICM programme must be open and honest about the resources required at all phases of execution. Implementing institutional arrangements and regulations without the necessary funding would lead to countless expensive confrontations and gradually erode the initiative's credibility since it would be perceived as a hollow promise (Sorensen, 1997; Sorensen and McCreary, 1990).

For initiatives and programmes to be carried out, institutional and organizational frameworks are essential. Since ICZM is a government initiative, its execution must be legitimate. Without the support of the government, an ICZM initiative will frequently face significant challenges. The government must first transfer management responsibility to the affected local authorities or communities, even under the notion of "co-management" or "community management."

The government must nevertheless provide the essential oversight, technical support, and, in most cases, financial help. The management actions for an ICZM programme start with policy considerations. Regarding the promotion of sustainable development in inland, coastal, and marine regions, as well as the preservation of territorial use rights, biodiversity, coastal habitats, and environmental quality, government policies and regulations need to be developed or clarified. To solve organizational deficiencies, particularly with regard to law enforcement and the definition of roles and responsibilities, management measures are also necessary. The following are a few of the most frequent management actions that fall under this category: (a) defining and clarifying legal rights and obligations; (b) identifying organizational jurisdiction and responsibilities; (c) enhancing enforcement capacity; and (d) carrying out monitoring and evaluation. Since national, provincial, and local governments typically share jurisdiction over the coastal zone and ocean, it is generally recognized that ICM projects must operate from two perspectives: "top down" (involving the national government) and "bottom up" (involving the local community and provincial authorities) (Nayak, 2017).

5.2 Command and control

Many management practices fall into this category. To influence human behaviour in accordance with the aims of ICZM, both incentives and regulatory measures are required. Disincentives include high or new taxes, licenced fees, restricted seasons, and limiting access to certain resources, which are some of the strategies to encourage economic growth. Incentives include tax exemptions or reductions, government subsidies, and technical help to encourage environmental protection or forbid destructive or polluting behaviour (Chua, 1993).

Compulsory environmental licences, which are required for all types of potentially hazardous operations, significantly reduce the negative environmental effects. Other environmental laws have been passed to restrict the use of specific harmful substances, set emission caps, enforce specific technical requirements, hold producers accountable for the waste produced by their products, control land and coastal use planning, and prohibit the use of specific harmful substances. Another sort of legal document employed in CZM is a licensed for fishing or other coastal activity, which controls access. Protection zones, including national parks, conservation initiatives, etc., may be included in a simulation model that is built to provide the SAF-specified results. Legislations are the toughest sort of policy instrument, making them possibly the most foresighted instrument in a System Approach Framework (SAF) (Skorstad *et al*., 2020). The four types of command-and-control management actions that are most frequently used to reduce negative environmental effects are: (a) imposing new regulatory measures; (b) bolstering existing regulatory measures; (c) establishing and implementing standards, such as water quality and emission/discharge; and (d) offering incentives (Chua, 1993).

Direct public investment

This group of management practices entails a direct financial commitment from the government to raise public awareness, provide fundamental infrastructure, carry out research,

develop capabilities, or present opportunities that will result in the resolution of issues and problems related to coastal development. For instance, significant research funding is required to get a better knowledge of the elements that preserve the functional integrity of resource systems, the marine environment's capacity for assimilation, the societal costs of a poorly managed environment, waste management technology, etc. The managerial practices that most frequently fall under this category are (a) Public infrastructure, such as highways, embankments, and garbage collection and disposal systems or facilities, (b) Training and education, (c) Public awareness and information distribution, (d) Research and development and (e) Technical assistance (CRMP, 1992; NEDA, 1992).

6. COASTAL ZONE MANAGEMENT ACT (CZMA) AND POLICIES

In order to protect the marine and coastal environment for the current population as well as for future generations, ICZM is required, and ICZM regulations must be established. An ICZM policy is essential for preserving the biodiversity and productivity of coastal ecosystems, as well as improving the quality of life for human populations who rely on those ecosystems' resources (Bennett, 2001). A policy for ICZM also serves as a road map for future activities that must be undertaken to strike a balance between coastal development and conservation (Shi *et al*., 2001).

An ICZM policy offers definition and direction on resource utilization, enabling more coordinated decision-making. An ICZM policy provides a structure and procedure to connect various industries, fostering collaboration among users of coastal resources and their activities and choices. An ICZM policy has an impact on management by highlighting the relationships between users and the impact that each user has on one another, ensuring that logical decisions are made across sectors (Shi *et al*., 2001). The European Union has dealt with coastal zones through international accords governing its regional waters since the 1970s. Since 1996, the European Commission has been trying to find and promote solutions to the degradation of Europe's coastal zones and to improve the overall situation. The EU has only lately started to address issues, especially those connected to the condition of coastlines and the coast as a regional entity (EEA, 2006). The EU Demonstration Programme on Integrated Coastal Zone Management (ICZM), which was run by the Commission from 1996 to 1999, was built around a number of 35 demonstration projects and six topic studies (Reis, 2014). The objectives of this initiative were to: (1) disseminate technical knowledge on sustainable coastal zone management and (2) promote a robust discussion among the many parties engaged in the design, administration, or utilization of European coastal zones. The goal of the programme was to reach agreement on the steps that must be taken in order to promote ICZM in Europe.

In India, in order to prevent all development activities 500m or more from the High Tide Line, the initial policy framework for the protection of India's coastal zone was created in 1981. This was followed by the resolution of the Environmental Protection Act (1986) and a draught notification on the Coastal Regulation Zone (CRZ) in 1986. In 1991, CRZ notification was subsequently issued. In the meanwhile, in 1998, National and State Coastal Zone Management Authorities were established (Joseph and Balchand, 2000).

7. COASTAL ZONE MANAGEMENT IN INDIA

About 7500 km of the Indian coast are made up of diverse ecosystems and landforms. In India, a programme for integrated coastal zone management has been launched, and institutional frameworks at the national and state levels have been established to support it. The National Center for Sustainable Coastal Management (NCSCM), a Center of Excellence for Coastal Management, is built with cutting-edge research facilities as part of building knowledge and a planning basis. With seven significant coastal research subject areas, NCSCM is already supporting coastal management. Piloting ICZM approaches have been put into practice in some of the states of the country. Some of the planned activities for this component have also been completed, such as the completion of livelihood projects in 169 coastal villages and the enhancement of the Gujarat Pollution Control Board's capacity to monitor coastal and marine pollution. For the Odisha Pollution Control Board, 14 cyclone shelters were built, and the community helped with their operation and maintenance (World Bank, 2017).

The Indian government created an ICZM plan as a case study of the Andaman Islands that addresses, among other things, the creation of databases and knowledge bases, the use of framework methodologies, conflict detection, risk assessment, alternatives, cost-benefit analyses, strategic plans, action plans, and suggestions for institutional reforms (Devaraj and Arumugam, 2011). In order to encourage research on topics

linked to coastal processes, eco-systems, shoreline erosion, pollution, hazards, and coastal vulnerability, the Ministry of Earth Sciences launched the Integrated Coastal and Marine Area Management (ICMAM) programme in 1998. Incorporating environmental and social issues into all sectoral development operations by using techniques like geographic information systems (GIS), remote sensing, mathematical modeling, and environmental impact assessments (EIA) in coastal regions, this idea promotes sustainable management of the coastal zone and rational resource exploitation (NCCR, 2019).

India has a highly successful remote sensing programme, and during the past 40 years, changes in coastal ecosystems, landforms, shorelines, and other factors have been noted using the Indian Remote Sensing Satellite (IRS) series of satellites. The categorization and geometric accuracy of items, as well as the classification system for coastal ecosystems, are standardized. Coral reef characteristics and mangrove community details were created. Using satellite data, the high and low tide lines were precisely drawn over the whole coastline. The coastline database for the whole nation was generated once all of these data were grouped in a GIS (Gupta, 2001; Nayak, 2017).

On coastal ecosystems, the effects of several threats, including cyclones, tsunamis, and sea level fluctuations, were reported. Using elevation data acquired from satellite data, coastal multi-hazard vulnerability maps for the coastline of India were created based on topography, shoreline changes, and tides (Mahendra *et al*., 2011; Mahendra *et al*., 2010). The data on sea surface temperature and ocean colour were used to create prospective fishing advisories, which are sent out to fishermen every day. To pinpoint coastal control zones, marine protected areas, sensitive zones, etc., the coastal database was efficiently used. For the benefit of society, a number of services were developed for the tsunami, fishing, and coral reef bleaching. In order to foresee impending threats and expected changes in the coastal zone and take appropriate action, models for the coastal zone are designed. To comprehend the effects of anthropogenic activities and the changing climate on the coastal zone, socio-economic data must be integrated with the knowledge database of the coastal zone (Nayak *et al*., 1989; SAC, 2011).

A Society for Integrated Coastal Management (SICOM) was founded by the Ministry of Environment, Forests, and Climate Change with the goal of promoting the implementation of ICZM activities in India. SICOM stands for lively, marine, and resilient coastal and marine environments. In order to improve the protection, conservation, rehabilitation, management, and policy design of the coast, the SICOM developed and operationalized the National Centre for Sustainable Coastal Management (NCSCM) at Anna University in Chennai. The whole coast has also been cell mapped and ESA mapped as part of project phase 1 (ICZM, 2018), while phase 2 is focused on capacity development and implementing ICZM Plans, managing coastal pollution, and conserving coastal and marine natural resources (Telave and Chandankar, 2021).

8. CHALLENGES TO ICZM

8.1 Environmental challenges

Climate change is an important challenge for coastal management in terms of identifying future baselines and coastal setbacks. A coastal setback is simply a buffer zone just behind the shoreline. The European legal framework lacks particular provisions for accounting for coastal setbacks (Sanò, 2010). Along with coastal climate change, failures in management to protect coastal ecosystems and high development pressures resulting in environmental degradation tend to exacerbate conflicts over access to the integrated use of the coastal zone (Ahmed, 2010). In Algeria, a Mediterranean country, the growing population and their environmentally unfriendly activities present a challenge with respect to the implementation, monitoring, and evaluation of ICZM programs. This can heavily impact the coastal and marine environments of Algeria (Khelil *et al*., 2019). Other challenges, like natural disasters such as tsunamis and floods, could hinder the management activities.

8.2 Institutional challenges

Institutional setup, from planning to implementation and monitoring, is one of the key challenges imposed on ICZM. It requires political will, financial support, human resources, and cooperation among different stakeholders. When the institutional set-up is there, the legal and administrative framework can be formed just like in Mediterranean countries, and its heterogeneity in morphological aspects creates the implementation of the new ICZM provisions protocol. This may eventually result in the manifestation of prohibited buffer zone construction, approximately 100m from the coast. As a result, it proves to be a significant challenge for an early initiative to succeed (Sanò, 2010). In the North Adriatic case, it is interesting to note that international coordination and cooperation are put forward with the challenge of contributing to the management of biological resources and quality water in the coastal zone. It is challenging even for the Black Sea countries to adopt

an overarching legal framework for ICZM, just to adhere to a more coherent spatial scale for the management of coastal zones (Olsen, 2002). In Algeria, in total, 7 parameters have been evaluated in order to assess the institutional capacities for implementing the foundations of ICZM. These are the legal framework, financial resources, capacity building, participation, and awareness. The challenge is to create various legal and institutional reinforcements, like the creation of agencies dedicated to coastal management and the enactment of a coastal law with respect to ICZM (Kheli *et al*., 2019).

8.3 Socio-economic challenges

The coastal managers also face the most important challenge of designing an uncertain, complex socio-economic governance strategy involving the problem of fundamental scale definition. Hence, there is a challenging need to frame ICZM initiatives with strong regional and national strategies and a management framework (Olsen, 2002). The deteriorating environmental condition creates a highly acute situation and hinders social and economic development. This forces poverty, hunger, and disease, leading to a vicious cycle of environmental conflicts and the challenge of creating balance between short-term gains and long-term integrated resource management, prefigured as ICZM (Ahmed, 2010). Whereas economic sustainability in terms of public health risk requires a more complex understanding and determination of the role of environmental resources and conditions (Bowen and Riley, 2003). For example, the mainland of Ecuador and the Galapagos Islands face challenges in the face of constant changes in tourism and economic realities. Although Ecuador receives support for training for ICZM and has a few international financing heads for ICZM, it is obvious that this will not guarantee right management. This is due to changes in administrative, political, and, most importantly, economic factors. These have had a high impact on tourism and the dynamics of the economy in these coastal areas (Bowen and Riley, 2003).

8.4 Political challenges

Identifying the political issues seen along the coast and understanding their potential solutions continue to be the most difficult challenges for coastal managers and practitioners dealing with management. Not only this, but problems like lack of political and financial support in the medium and long terms, the difficulties faced by coastal managers in translating the principle of integration into daily management practices, and the unknown surety of the sustainability of ICZM initiatives and efforts the wide breach between science and political decision-making processes and the "dictatorship" of sectoral approaches can also represent important challenges. ICZM is a well-recognized principle for achieving sustainable development in coastal areas, but the theoretical framework for addressing the complexity of coastal governance is not an alternative; the main problem is translating the ICZM principle into daily management practices (Olsen, 2002).

8.5 Scientific challenges

Some scientific challenges include difficulties finding and collecting outcome data within the coastal management zone. The criteria for success are often unloaded by the fact that coastal legislation or programme plans are not always evident (Knecht *et al*., 1996). Countries need proper integration of scientific knowledge into coastal policies and ICZM programs. Even developed countries like Italy still face challenges regarding the proper coordination of science and policy, and there seems to be zero coordination between regional authorities and localities with national authorities (Cantasano, 2017).

To summarize, the multi-scale nature of coastal governance, the difficulties in promoting integration, the burdensome relationship between science and decision-making, the dictatorship of sectoral approaches, and the complexity in understanding the relationship between statutory frameworks and voluntary agreements have been identified as the primary factors impeding wider adoption of ICZM in the cases studied (Olsen, 2002).

9. FUTURE PERSPECTIVES

Over the past few decades, numerous local, regional, and national ICZM policies, programmes, initiatives, and activities have emerged. In ICZM, sharing experiences and learning from examples of effective practices are crucial. In light of this, the European Commission maintains the 'OurCoast' online database, which contains over 350 case studies on important subjects such as planning and land management tools, institutional coordination mechanisms, and information and communication. Despite all of its efforts, ICZM still has flaws, such as an inadequate political and legal standing or the absence of a standardized and relevant methodology for practitioners and policymakers. ICZM must be politically credible, legitimate, and consistent in its results, together with instructions on how to attain them. ICZM agreements have recently been created and approved for global and extensive regional marine regimes. For instance, the "Protocol on Integrated Coastal Zone Management in the Mediterranean," the first transnational, legally binding ICZM pact (21 nations in Europe, Africa, and Asia), came into effect in 2011. The European Union is

a party to the ratification, which is enforceable across all member states. Officially, it outlines the coastal zone, presents a vision of sustainable development, and responds to new ICZM needs. Coherence of governance and acts, legitimacy, and a hierarchy of tactics and plans. It is outcome-focused, offers step-by-step instructions for the process, is interactive, and can be expanded. If it can serve as a model for regional seas throughout the world, that will be evident in the future.

The integration of ICZM with maritime spatial planning, maritime policy, and marine environment protection, the integration of land and marine spatial planning, as well as the further development and implementation of tools such as systems approach frameworks (SAF) for coastal zones, are some of the significant issues that will need to be overcome in the future. To enhance the effectiveness of Integrated Coastal Zone Management (ICZM), several strategic steps can be considered, including: (1) determine and manage the consequences and implications that are caused by changes in the marine environment and how they relate to land and communities along the coast, (2) enable coastal communities to realize their legitimate ambitions in their adjacent coastal waters by ensuring complete synergy between the spatial planning and management of the marine and terrestrial environments, (3) establish a political agenda that is equitable and takes development, society, and the environment into consideration and (4) decision-making in coastal waters should be held to the same standards of consistency, openness, and democratic accountability as decisions made on land through long-term and, when necessary, legally formed partnerships for coastal and inshore waters, regional communities and stakeholders.

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