


Integrated coastal resources management of Saint Martin's Island, Bangladesh

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Received: 28 November 2016 / Revised: 9 July 2017 / Accepted: 13 September 2017 / Published online: 18 September 2017
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Abstract Coastal ecosystems support enormous natural resources which are major sources of livelihoods and income generation for a major part of the global population. With this growing dependency coupled with the continued destruction (from both global climate change and human interventions), coastal resources are facing unprecedented threats of deterioration thus limiting the valuable ecosystem services that support all sorts of human welfare. Taking Saint Martin's Island as a case study, this paper investigates the potential vulnerabilities which persist as negative forces in managing the available coastal resources in an integrated as well as sustainable way. In addition, this paper suggests a people oriented coastal resource management framework incorporating all aspects of vulnerabilities.

Keywords Ecosystem · Coastal resources · Coral · Participatory framework

Introduction

Coastal zones support dynamic interactions of land, water and atmosphere that are constantly altered by both natural

processes as well as human activities (Beatley et al. 2002). Coastal zones occur through a gradual transitional region, usually comprising a narrow strip of coastal lowlands and a vast area of coastal waters (comprised of backshore, foreshore, inshore and offshore) and refer to a spatial zone between the sea and the land; and which is the area between the landward limit of marine influence and the seaward limit of terrestrial influence (Alder and Kay 2005; Haslett 2008; Thia-Eng 1993). The zone encompasses only twenty percent of the Earth's surface; hosts a significant portion of the entire human population, *i.e.*, approximately fifty percent of the human population live within two hundred kilometres of the coast, harbours most of the Earth's complex, diverse and productive (from both the biological and economic viewpoint) ecological systems (Farhan and Lim 2013; Rockloff and Lockie 2004; Thia-Eng 1993). In recent years coastal areas are being acknowledged with greater importance owing to increasing human population, rapid urbanization and accelerated developmental activities, which are putting tremendous pressures on fragile coastal ecosystems (Kenchington and Day 2011; Ramesh and Vel 2011). Therefore, there is a growing trend of complex resource-use conflicts and environmental degradation problems in the coastal zone (Thia-Eng 1993).

Coastal zones are an ever-dynamic natural system and thus their management is a growing challenge for global communities. The area is popularly called a zone with multiple vulnerabilities and multiple opportunities. The vulnerabilities are associated with both climate change induced natural disasters like storm surge, cyclones and tsunamis and human-induced pressures (burden of high human population, urbanization and accelerated developmental activities), which collectively pose tremendous pressure on the fragile coastal environment (Ramesh and Vel 2011). Vulnerabilities may arise from unavoidable conflicts among different competing resource user-groups. Coastal populations are almost constant as migration

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is limited (Jentoft and Buanes 2005). The people, their lives and livelihoods are under continuous threat of sudden shock. There is a history of catastrophic natural disasters and in terms of risk value, living in the coastal zone is extremely risky. Despite having such life-threatening risks, people continue to live in the coastal zones, because coastal ecosystems are highly productive with high biological diversity, rich fishery resources and significant seabed minerals (Alquezar and Boyd 2007; Yamindago 2015).

Coasts also support a diverse array of related industries (e.g., fisheries and aquaculture, tourism, shipping, oil and gas industries), which provide enormous economic productivity and employment opportunities. All such coastal resources are now subject to unsustainable human interventions through diverse human activities including both traditional, such as coastal fisheries, aquaculture, forestry and agriculture, and modern for instance marine transport, industry and tourism (Banica et al. 2003). Coastal ecosystems provide critical services for over two billion people worldwide who live within one hundred kilometres of the coast; these precious services, however, are subject to continuous degradation, making the poor poorer, more vulnerable and more marginalized and reducing their ability and incentive to contribute to preserving the ecosystem services that sustain them (Brown et al. 2008; Newton et al. 2007).

The main concept of sustainable development is to meet present needs without compromising the needs of future generations (Brundtland 1987). To ensure the ability to meet the needs of the future, a development plan should be developed in such a way that considers the upcoming good, bad or worst scenarios. Integrated Coastal Zone Management (ICZM) is a holistic and multidisciplinary approach covering the full cycle of information collection, planning design, management and implementation (Banica et al. 2003; Yamindago 2015). Ideally the ICZM process is fully iterative and dynamic; that is, the management cycle has to be resumed all the time as coasts change and need other measures to be taken. Integrated Coastal Zone Management (ICZM) is a dynamic, multidisciplinary and interactive strategy that promotes sustainable management within coastal areas. ICZM is a process for the effective management of the coast using an integrated approach to achieve sustainability, regarding all aspects of the coastal zone, including geographical and political boundaries. This management strategy encompasses all the components of the coastal system including natural resources, thus establishing a balance between cultural, economic, environmental, recreational and social aspirations of the zone. Integrated Coastal Resource Management (ICRM) is basically a sub-section that merges within the process of Integrated Coastal Zone Management (ICZM). Since coastal ecosystems are so complex, it aims to facilitate a dynamic balance between both marine and terrestrial ecosystems. Due to the growing collective impacts of illegal human interventions and global climate

change, coastal ecosystems require the integration of management approaches covering all available natural resources, which is needed for the efficient allocation of coastal resources and to minimize the potential of environmental degradation reducing future sustainability. Therefore, ICZM and ICRM are almost complementary terms as both concepts deal with the management of all resources associated with coasts.

Methodology

A variety of methods from people-oriented participatory approaches to ecosystem approaches were applied in this study. Two field studies were performed in two different seasons (tourism season and non-tourism season). An in-depth assessment of the present and historical dependency of local stakeholders on the valuable natural resources (both terrestrial and marine) were performed using participatory approaches: a semi-structured questionnaire survey, key informants interview (KII), focus group discussions (FGDs) with livelihood groups (e.g., fishermen, farmers, resource collectors, businessmen, hotel/motel owners, local NGO/CBO representatives and local government officials, educated and elderly people [Fig. 1(a–d)].

The information gathered by the above approaches was further validated through interactive participatory rural appraisal (PRA) sessions comprising cross-sectoral livelihood groups. The fundamental ecosystem approach was finally applied in this study to perceive the iterative and dynamic nature of the coastal marine environment around the study area. The inter-dependency of cross-sectoral stakeholders and their historical dependency on the marine-terrestrial resource base were studied to realize the exact scenario of Saint Martin's resource utilization and regeneration processes over the years. Relevant necessary information was collected from the Ministry of Environment and Forests (MoEF), Department of Environment (DoE) and the Forest Department (FD) of Bangladesh. Various published books, journal articles and some other national and international organizations like IUCN, Bangladesh POUSH and CARDMA were supportive in disseminating relevant information.

Study area

Saint Martin's Island is a small island (area only 8 km²) in the northeastern part of the Bay of Bengal, about nine (9) km south of the tip of the Cox's Bazar-Teknaf peninsula, and forming the southernmost part of Bangladesh (Fig. 2). There is a small adjoining island that is separated at high tide, called "Chhera-dia" Island. It is about 8 km west of the northwest coast of Myanmar, at the mouth of the Naf River. The local names for the island are "Narical Gingira", also spelled

Fig. 1 (a, b, c & d): FGDs and KIIs to know the socio-economic status, dependency on natural resources, threats, rate and reasons of resource exploitation (photo copyright: Shahriar Rahman)



“Narikel Jinjira/Jinjera”, which means “Coconut Island” in Bengali, and “Daruchini Dip”. Saint Martin’s is the only coral island in Bangladesh.

This island is rich in diverse natural resources, both marine and terrestrial. In terms of habitat classifications, the physiographic features are plain land, intertidal zone, sandy shore (beach and dunes), rocky shores or platforms, mangrove forest, algal bed, coral zone, fishing ground and wetlands (lagoons); while the land use patterns include agricultural land (producing rice, watermelon, ground nut, maize, seasonal vegetables as well as coconut, betel leaf and nut), human settlement, coconut, screw-pine or umbrella (locally called “Keya”) and mangrove forest (Hossain et al. 2007). The island is home to a rich stock of marine resources include coral reefs, seaweeds, algal biodiversity, fisheries, turtles, molluscs, etc. The socio-economic status of the islanders is historically and largely associated with local natural resources. The primary livelihood activities are fishing, agriculture, seaweed collection, coral harvesting, coconut selling, mollusc shell collection and associated businesses.

Natural resources and major threats to Saint Martin’s Island

Saint Martin’s is a resource rich island endowed with vast terrestrial as well as marine natural resources having a global biodiversity outlook. Terrestrial ecosystems are found on the dry land of this island, whereas the marine ecosystems mostly take place under shallow water marine habitats including rocky and sandy inter-tidal habitats, offshore lagoons, rocky sub-tidal habitats, coral aggregations, sea grass beds, soft coral habitats and offshore soft-bottom habitats (Thompson and

Islam 2010). This location is a unique example of the co-occurrence of corals, algae, seaweeds, grasses and mangroves, such co-occurrence being quite rare elsewhere in the world (Table 1).

The natural resources of this island are primarily experiencing an increasing over-exploitation by means of unsustainable utilization and unrestricted coastal development. Since all the coastal resources provide invaluable support to humans, it is urgent to maintain a balance so that, as a minimum, resources should be extracted to allow the resources to continue to support human needs [Fig. 3(a–d)].

For the present case, there is mounting pressure on the resource base as a result of the growing demand from a growing population, the lack of suitable alternative livelihood sources other than natural resources, deterioration of the resource base due to global climate change impacts, absence of strict legal tools for monitoring and awareness building, lack of proper management works incorporating indigenous knowledge and the local peoples’ view in decision-making processes, the illiteracy of the islanders and weakness in scientific as well as technical knowledge among the islanders mostly due to the inappropriate policy of the management authority in excluding them. All these threats and vulnerabilities have been working together thus risking erasing the prospects of natural resources derived ecosystem services (Table 2).

Why integrated coastal resources management for Saint Martin’s Island

Being a small isolated coastal island, Saint Martin’s is a unique biodiversity hotspot in Bangladesh with international

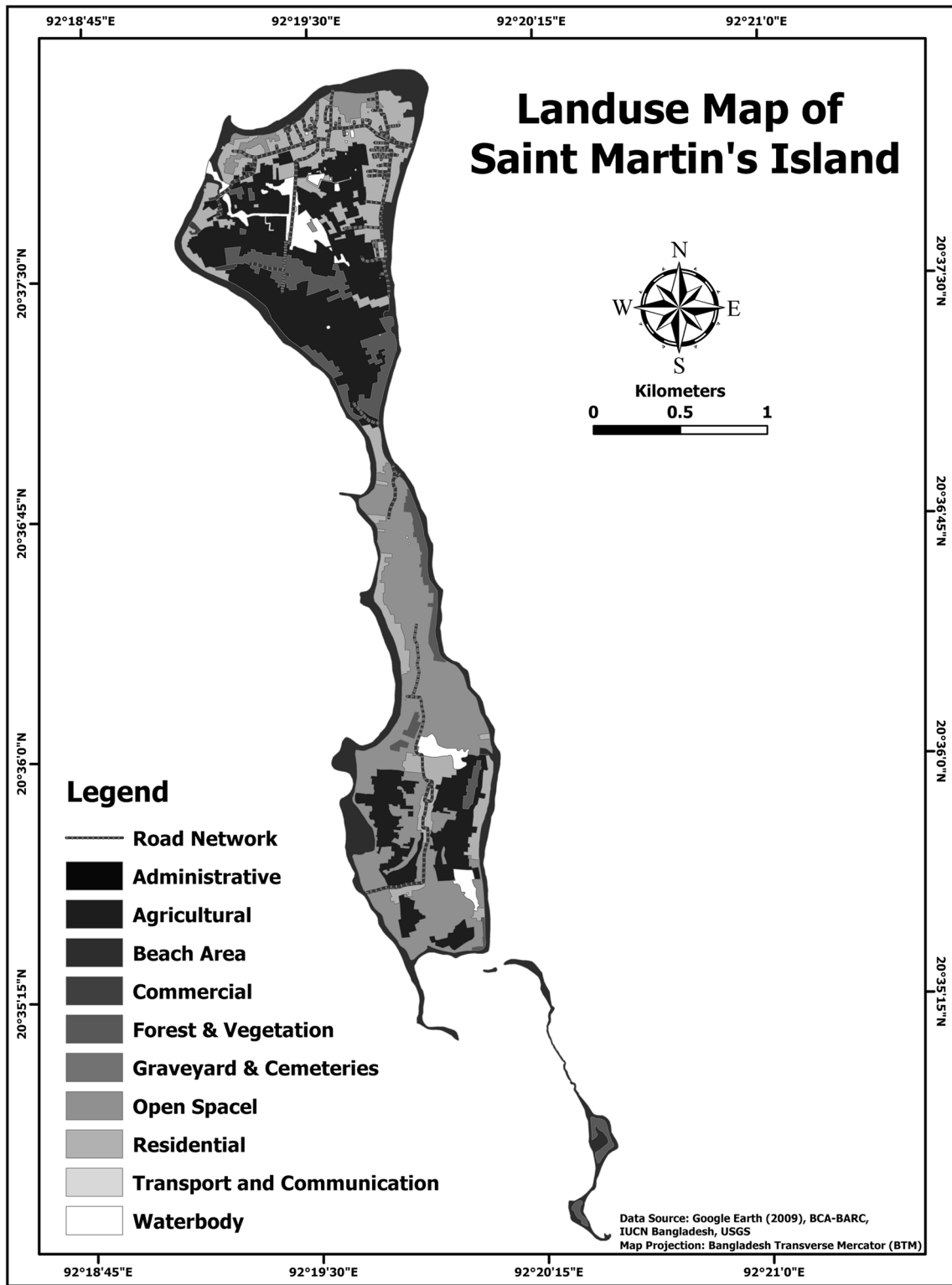


Fig. 2 Land use map of the Saint Martin’s Island, Bangladesh

focus. The island fosters tremendous marine and terrestrial natural resources. The co-occurrence of corals, algae, seaweeds, mangroves and grasses makes the island a rich resource site forming a unique ecological setting (Thompson

and Islam 2010). Being the only place in Bangladesh that supports a favourable environment for growing precious coral resources, the islands have a very high ecological significance (Tomascik 1997). Due to its panoramic landscapes, vast lands

Table 1 Natural resources of Saint Martin's Island

Faunal Resources		Floral Resources	
Species	Total Number of Species	Species	Total Number of Species
Corals	166	Herbs	150
Mollusks	187	Climbers	32
Crabs	12	Shrubs	25
Fishes	234	Trees	53
Reptiles	27	Marine Algae	154
Birds	120		
Mammals	19		

(Feeroz 2009; Thompson and Islam 2010; Tomascik 1997)

of sand dunes, mangrove formations, crystal-clear sea-water and natural treasures of coral colonies, the island is one of the most exciting growing tourist spots of Bangladesh (Tomascik 1997; Upal 2015). A generalized summary of natural resources has been listed in Table 1. Recent floral surveys recorded 260 plant species including 150 herbs, 32 climbing plants, 25 shrubs and 53 trees, belonging to 58 families. Aquatic vegetation has been less well studied, but recent surveys identified 151 species of benthic and drifted algae including a number of marine red algae, 18 species of bryophytes and 157 species of angiosperms (Rashid and Khan 2001).

Saint Martin's island is a resource rich island which bears multiple marine and terrestrial resources. As it is separated from the mainland, the pattern of living and livelihood options are quite different from any other coastal parts of Bangladesh. The people are involved mainly in fishing, farming, business, boating, coral and seaweed collection and tourism-related activities. It is a

growing tourist attraction and the total population has increased dramatically. While this situation has proven to be lucrative for the islanders, it is causing the natural beauty of the island to deteriorate. These entire livelihood activities are closely natural resource oriented so inherently the people are living on natural resources.

Stakeholders (both primary and secondary) from the local community are the key persons who were proposed to be in central part (focal point) in the conservation programme. The stakeholders' capacity building and consensus building through moral education and training is the basis of the conservation programme. Here, their capacity building is considered as important because the ultimate target is to make multiple alternative livelihood options and also to increase the efficacy of the options. If there is confusion in understanding, for example, our focus is to improve a livelihood strategy (option) then this generally requires an increase in the capability or empowerment of the person pursuing it – the 'primary stakeholder'. This in turn requires a change in the relationship between this person and other stakeholders, and in the benefits derived from it. Therefore, the benefit sharing will be the main point of concern to achieve success in such a community-based programme, and thus, should bring transparency (Fig. 4).

In recent years, several studies have found that natural resources were degrading and as a result scientists have predicted that in the near future the community will suffer from a livelihood crisis. Already some negative impacts have emerged. The incidence of poverty and migration rate are rising. People are becoming increasingly dependent on natural resources and as a result the rate of over-exploitation is gaining momentum. Therefore, to bring a

Fig. 3 (a, b, c & d): Photos of common forms of human activities: **a.** illegal resource extraction, **b.** unplanned tourism, **c & d.** unsustainable fishing methods [the fishing nets that gets attached with precious natural resources (seaweeds, corals, crabs)] (photo copyright: Md Touhiduzaman)



Table 2 Major threats to coastal natural resources of Saint Martin's Island

Broad Category	Sub-category	tbcolw250ptRemarks
Natural/ Climate Change Induced Threats	High Loads of Sedimentation	Accumulation of sediment on coral tissue is known to reduce the metabolic and tissue growth rates of coral, increasing the probability of bleaching and coral death.
	Cyclones and Storm Surges	Saint Martin's is heavily impacted by monsoons and frequent cyclones and heavy sedimentation from the Ganges, Brahmaputra and Meghna rivers (Rajasuriya and Karunarathna 2000). The most vulnerable areas for sea level rises are the atolls and low-lying coastal regions, whereas the coral reefs themselves will be only minimally affected provided they still contain healthy coral populations. There has been coastal erosion, and saline intrusion into fresh groundwater along the western and southern coasts of Sri Lanka and possible increases in cyclone activities in the Bay of Bengal (Bangladesh and India) will cause greater erosion and loss of economic activities.
	Ocean Warming and Subsequent Coral Bleaching	Coral reefs are threatened by a variety of environmental changes. Higher water temperatures and increased ultraviolet radiation, which are associated with climate change, are sources of widespread coral bleaching. Global warming is a matter of major concern for coral reefs of this island as elsewhere. The most noticeable damage caused by high sea temperature is coral bleaching. In coral bleaching, the coral turns colourless and ugly. Coral reefs have already suffered major mortalities because of high-temperature events. Coral is also dependent on a species of algae that lives symbiotically in its body and produces additional food by photosynthesis. When the sea temperature rises above 28°C, the coral expels the algae and consequently it starves.
Anthropogenic Threats	Illegal Resource Extraction	Commercial coral collection began in the 1960s and is now the professional activity of many families. Of 332 family heads engaged in natural resource exploitation in 2000, almost one-fifth were coral collectors (Islam 2002). Coral is collected between October and April when the sea is calm, water is clear and the tides are favourable. The NCSIP-1 survey between 1995-1997 found that at least 11 small non-mechanized boats were being used up to depths of 5 metres, while others that did not have boats walked out up to depths of about 2 metres. A hammer and chisel is used to break the coral. <i>Acropora</i> , <i>Favia</i> and <i>Goniastrea</i> spp. were the main types collected with <i>Acropora</i> spp. the most highly sought after. The estimated weight of coral harvested ranged from 40-100 kg/day/boat or about 20-40 kg/day/person. Tomascik (1997) estimated that 24% of the existing coral population is removed annually. Most is smuggled to Cox's Bazar to supply the curio businesses there.
	Unregulated Tourism and Environmental Pollution	In the tourist season (Nov.-Feb.), an average of 3,000 people visit this island daily, which is beyond the holding capacity of this small marine island (Behera and Haider 2012). A huge amount of crude oil and other non-biodegradable wastes are released in the sea water adjacent to the island from ferry services and boat engines used for carrying tourists to and from the island. In addition, huge amounts of untreated commercial and domestic wastes, which include sewage (only 5% of the local people have sanitary latrine facilities) from the local people and tourists, are discharged into the adjacent coastal water. Thus, the quality of coastal water is degrading gradually. Coral, algae, different species of shells and star fish are collected by the tourists regularly. Local people also collect stone and rock daily for lime making and construction works, which is a threat to the existence of the island.
	Unsustainable Fishing and Boating	Fishing is one of the major activities of the inhabitants, with about 600 professional fishermen and 170 fishing boats recorded on the island in 2000-01 (Islam 2002). The main fishing season is September to April, during which each boat averages a total catch of about 11 metric tonnes. The main fishing gears are drift, fixed and plain gill nets and the seine net. The fish are caught offshore as well as from coral beds. Fishing in inshore waters over boulder reefs is done with rock-weighted gill nets which has an adverse impact on coral. Most of the fish are sun-dried locally by the five large fish drying farms on the island and by individual households, and then supplied to merchants in Cox's Bazar and Chittagong. The type and amount of chemicals used during fish processing and the impact of their use on the beach habitat is yet to be determined. Shrimp fry collection is also undertaken on the island and the fry supplied to the Cox's Bazar shrimp farms' shrimp fry suppliers. Of 332 family heads engaged in natural resource exploitation in 2000, almost 50% were shrimp fry collectors (Islam 2002). Shrimp fry collection causes the large-scale loss of many other aquatic organisms. Boat operators are continually scooping and throwing overboard oily water that accumulates in the holds of poorly maintained boats. Marine water quality is very important for the ongoing health of marine biodiversity, particularly the coral communities, thus measures to prevent oil spillage, solid waste and sewerage disposal into the marine environment are necessary (Ryan et al.

Table 2 (continued)

Broad Category	Sub-category	Remarks
		2009). Boat groundings at low tide cause direct physical damage to the boulder reef substrate as well as direct kills of corals. The increased rubble and fine sediments become available for re-suspension and this further affects water clarity, coral re-colonization, and coral health in general (Tomascik 1997).
	Deforestation	Another major cause of recent deforestation is the clearing of vegetation including mangroves to make claims on land. Deforestation has led to increased water turbidity and sedimentation, both of which affect coral development.
	Water Pollution	Floods and heavy runoff during the rainy season introduce high quantities of sediments, nutrients and pesticides from poorly managed agricultural lands to inshore waters, and this has a negative impact on coastal ecosystems. Thus, herbicides even in low concentrations interfere with the basic food chain by damaging zooxanthellae in corals, and other primary benthic or pelagic producers. Pesticides can selectively destroy zooplankton communities and larval stages of corals, while insecticides accumulate in animal tissues and interfere with physiological processes (Tomascik 1997). According to Hossain et al. (2007), water samples from the inshore zone of Saint Martin's Island were contaminated with faecal coliform bacteria up to 6 cfu/100 ml, although this is below the intermediate risk level set by the World Health Organization, it is an indicator of sewage contamination, due to the presence in human and animal faeces. Significantly, the water also contained <i>Vibrio cholerae</i> , posing a health threat to the local people and tourists (Hossain et al. 2007; Thompson and Islam 2010).

sustainable solution to protect the community the ultimate solution is to protect the natural resources base and to explore alternative livelihood options (livelihood diversification). Controlled eco-tourism may be a good solution. Agro-farming, poultry farming and small cottage industries are some good solutions for livelihood diversification. Regular awareness programmes and the importance of community education is a must for Saint Martin's Island. The local people should have rights to these coastal resources. Therefore, resources management should be adaptive, systematic and dynamic and in every step of management the local stakeholders should be incorporated with their indigenous knowledge. In this way, they will be trained and educated to protect their own resources within a sustainable framework which will bring them socio-economic as well as ecological well-being (e.g., resource sustainability).

Integrated coastal resources management framework

The participatory integrative framework was rooted in the indigenous and historical property rights of the common people living in that area. This framework is just an attempt regarding the coral resources conservation from a relatively sterile condition with the challenge of how the coral resources are best managed within the current resources base. In this action plan, the resources were treated as belonging to the community and at the same time supporting local people to manage

their resources within a recommended framework. Through various participatory sessions regarding the value and services coral resources provide to us as well as the likely picture of a coral free habitat, local stakeholders are all now highly committed to adopting a community friendly approach instead of having any strict regulatory framework. This approach will be helpful in encouraging the participants to come forward with their own innovations regardless of any other criteria they have except they are all inhabitants. In addition, this idea is beneficial for creating employment opportunities for the participants. The conservation programme for corals in the study area allowing community participation will work with mutual collaboration.

In the proposed mechanism of action, the socio-economic background of the local inhabitants on a historical basis was critically examined to find out the extent of dependence they have on coral resources. The core stakeholder group's life history examination further favoured this effort to delineate their true relationship with the corals. Also, the indigenous people's knowledge regarding the survival, growth and development of coral resources was learned and incorporated in the planning and implementation of this framework. Therefore, this framework was recommended in this study involving all the cross-cutting issues to achieve a future environmental setting equally with a meaningful life standing platform for the coral resources.

The present study recognized that the policies and their true implementation is essential as Saint Martin's Island and the local people's livelihoods are inherently dependent on these marine resources. Therefore, any developmental policy that

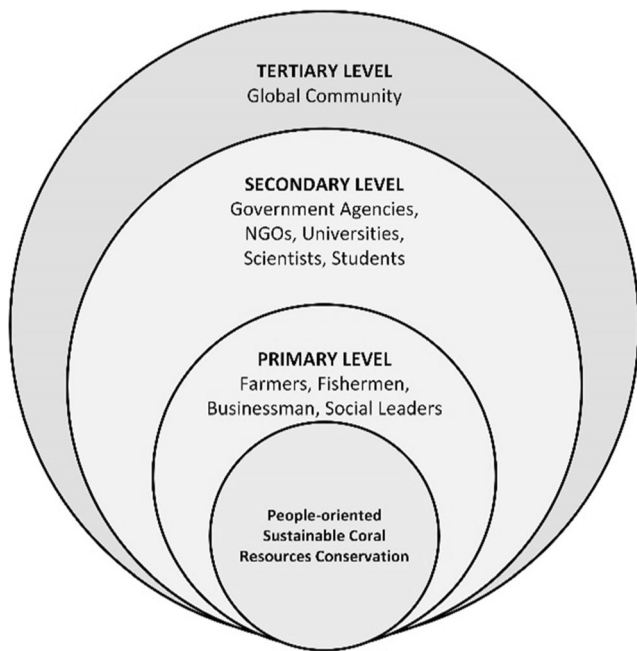


Fig. 4 Conceptualized hierarchy of the level of stakeholder participation

excludes them or that does not make them the focus will not be successful rather their full participation is recommended. The government through the relevant planning and implementing agencies will supervise the overall success and future updates, and will provide the field agency (Union Parishad: UP) with

necessary guidelines and personnel resources. There will be a chain of command involving some hub bodies including a scientific body (scientists from marine, environmental, natural resources and social sciences) to play their sectoral roles. The relevant universities and national research organizations will be represented in this programme. And finally, the local stakeholders will be principal actors in this venture within their respective roles from policy planning to the final implementation. The governmental agencies with their respective role will have a good communication chain with the proposed scientific body and with the relevant research and academic institutions. The scientists are in general engaged in research through a research organization or university faculty. They usually perform research on environmental perspectives.

The corals will be monitored and examined from time to time by the members proposed within the action plan. The government will provide financial support and the scientists will perform research work. In the case of corals, the scientists will be involved in coral environmental analysis, and at the same time they will explore the human dependency on corals through the mutual interactive sessions. Based on the scientific as well as socio-economic investigation, the scientists will formulate new policies and guidelines for coral resources and if applicable they will reform the previous policy. The government will implement the policies and guidelines for coral resources through the UP administration with the supportive

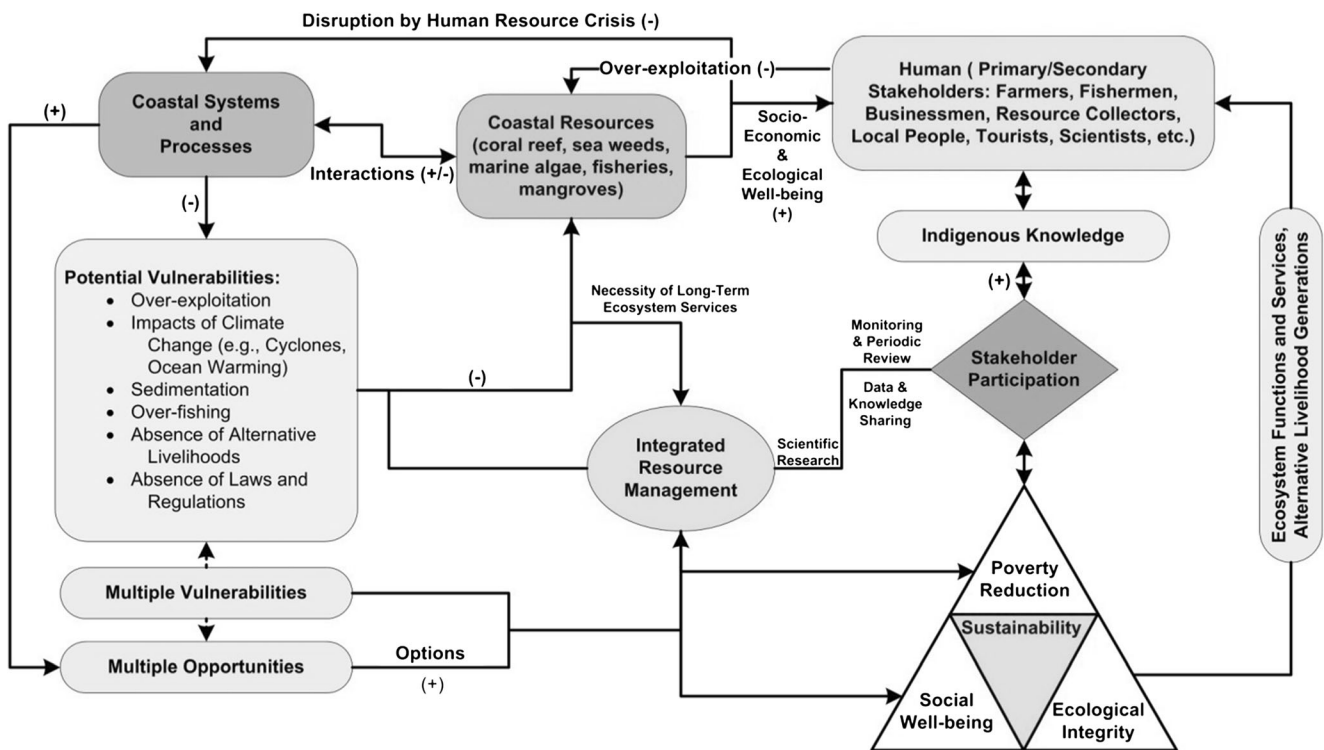


Fig. 5 Sustainable coastal resources management framework for the study area [positive signs (+) are to show positive feedbacks while negative signs (-) indicate negative feedbacks]

regular social and cultural programmes to have a positive feedback from the participants. In the case of coral resources, unsustainable human practices are the sole cause of coral resources deterioration. Therefore, under the proposed action plan the conservation programmes will be formulated to provide the local people with a sufficient level of education and subsequent training. The action plan is quite interactive with a sequential order, and will have to run over a sufficient time to achieve a positive result. This study is an interactive research to ensure the co-existence of human beings with nature.

Natural resources grow, live, serve and regenerate together naturally and there is no scope to think of them as a separate state, and the same applies to their management. Coastal ecosystems operate as a system involving numerous processes, resources, actors, vulnerabilities and opportunities (Fig. 5). Bangladesh is experiencing both predictable and unpredictable climate change impacts every year. Appropriate measures should be taken to develop environment-friendly, renewable energy sources (e.g., tide, wind, solar energy) and subsequent sustainability in use. For example, since the fishermen are still struggling with fish processing (drying) activities, harnessing solar energy is a viable means in this profitable economic sector. In addition, such potential localized power generation will raise the living standards of the people as well as their socio-economic wellbeing. Resources use should be comprehensive and in combination, thus use efficiency will be maximized. Also, in the case of critical non-renewable resource use, the policy should aim for optimum use and in some cases, we should be optimistic rather than development in using competing resources use. The current legal frameworks should be fine-tuned in line with people's expectations as well as with scientific approaches, that is we should establish a balance among people's view and practices, with the scientific truth in developing legal regimes for the protection of natural resources. Also, alternative and diversified livelihood generation is very urgent to bring any positive results. In this regard, true education and awareness building among the islanders through continuous training and awareness sessions would be successful. Finally, valuable indigenous knowledge and indigenous property rights are two very basic elements which should be valued in all aspects of management processes.

Conclusion

Since economic well-being is derived from the fisheries and tourism sector in Saint Martin's and these are closely related to the condition and productivity of critical ecosystems and shoreline features such as coral reefs, beaches,

sea-grass beds and mangroves, and thus priceless for Bangladesh, the sustainability of such assets is to be ensured to keep the ecological and socio-economic balance as a whole. In this context, some crucial messages are to be familiarized among both the stakeholders and the government authorities: proper management of the environment and its resources is critical to the ecosystem's sustainability; economic development must be sustainable and economic growth must not be allowed to lead to the long-term degradation of the environment; biodiversity conservation and management are to be the focus of each and every single management programme for marine areas in order to maximize or at least maintain the integrity of components of the environment through obtaining ecosystem services; and finally, disaster management, mitigation and associated risk assessment are also to be considered in these biodiversity conservation initiatives. The island is located far away from the mainland; thus, being self-sustaining is very much vital for this island. The coastal environment of this island is made up of an assemblage of various natural resources including both marine and terrestrial resources, which are to be conserved and need to be well-managed especially for providing ecosystem services. A tourist hotspot will directly contribute to national revenue, and an integrated management scheme should be considered to maintain the carrying capacity of the island, so that economic well-being, ecological integrity and social development will result accordingly.

References

- Alder J & Kay R (2005) Coastal planning and management. Taylor & Francis
- Alquezar R, Boyd W (2007) Development of rapid, cost effective coral survey techniques: tools for management and conservation planning. *J Coast Conserv II*(2):105–119. <https://doi.org/10.1007/s11852-008-0011-1>
- Banica A, Bastard J, Kosiek M, & Andersen LB (2003) Integrated coastal zone management (ICZM): a framework to tackle environmental issues?: Danish Approach: Citeseer
- Beatley T, Brower D & Schwab AK (2002) An introduction to coastal zone management. Island Press
- Behera M & Haider MS (2012) Situation analysis on biodiversity conservation. Ecosystems for life: a Bangladesh India Initiative, IUCN, International
- Brown K, Daw T, Rosendo S, Bunce M & Cherrett N (2008) Ecosystem services for poverty alleviation: marine & coastal situational analysis (synthesis report)
- Brundtland GH (1987) Report of the world commission on environment and development: "our common future".: United Nations
- Farhan AR, Lim S (2013) Improving vulnerability assessment towards Integrated Coastal Zone Management (ICZM): a case study of small islands in Indonesia. *J Coast Conserv 17*(3):351–367. <https://doi.org/10.1007/s11852-013-0269-9>
- Feeroz M (2009) Effects of environmental degradation on food security in the St. Martin's Island of Bangladesh

- Haslett S (2008) Coastal systems. Routledge
- Hossain MS, Chowdhury SR, Rashed-Un-Nabi M (2007) Resource Mapping of Saint Martin's Island using satellite image and ground observations. *J For Environ* 5:23–36
- Islam MZ (2002) Threats to sea turtles in St. Martin's island, Bangladesh. *Kachhapa* 6:6–10
- Jentoft S, Buanes A (2005) Challenges and myths in Norwegian coastal zone management. *Coast Manag* 33(2):151–165
- Kenchington RA, Day JC (2011) Zoning, a fundamental cornerstone of effective Marine Spatial Planning: lessons learnt from the Great Barrier Reef, Australia. *J Coast Conserv* 15(2):271–278. <https://doi.org/10.1007/s11852-011-0147-2>
- Newton K, Cote IM, Pilling GM, Jennings S, Dulvy NK (2007) Current and future sustainability of island coral reef fisheries. *Curr Biol* 17(7):655–658
- Rajasuriya A & Karunarathna C (2000) Postbleaching status of the coral reefs of Sri Lanka. CORDIO status report
- Ramesh DA, Vel AS (2011) Methodology of Integrated Coastal Zone Management Plan Preparation—Case Study of Andaman Islands, India. *J Environ Prot* 2(06):750
- Rashid H & Khan SMH (2001) Survey of flora: National Conservation Strategy (NCS) Implementation Project-1, Ministry of Environment & Forest, Govt. of the People's Republic of Bangladesh
- Rockloff SF, Lockie S (2004) Participatory tools for coastal zone management: Use of stakeholder analysis and social mapping in Australia. *J Coast Conserv* 10(1):81–92. [https://doi.org/10.1652/1400-0350\(2004\)010\[0081:ptfczm\]2.0.co;2](https://doi.org/10.1652/1400-0350(2004)010[0081:ptfczm]2.0.co;2)
- Ryan PG, Moore CJ, van Franeker JA, Moloney CL (2009) Monitoring the abundance of plastic debris in the marine environment. *Philos Trans R Soc Lond B Biol Sci* 364(1526):1999–2012
- Thia-Eng C (1993) Essential elements of integrated coastal zone management. *Ocean Coast Manag* 21(1-3):81–108
- Thompson PM & Islam MA (2010) Environmental Profile of St. Martin's Island
- Tomascik T (1997) Management plan for coral resources of Narikel Jinjira (St. Martin's Island). Final Report, National Conservation Strategy Implementation Project-1, Ministry of Environment and Forest, Government of Bangladesh, 125
- Upal NH (2015) Environmental Hazards and Conservation Approach to the Biodiversity and Ecosystem of the St. Martin's Island in Bangladesh Management of Natural Resources in a Changing Environment (pp. 259-269). Springer
- Yamindago R-I-A (2015) Restoring coastal ecosystems - a case study Malang and Gresik regency, Indonesia. *J Coast Conserv* 19(2): 119–130. <https://doi.org/10.1007/s11852-015-0373-0>

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