

Managing mangroves in Bangladesh: A strategy analysis

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Abstract. Bangladesh, favoured by a tropical climate, houses the world's largest stretch of mangroves forests (Sundarbans Reserved Forest) and plantations. Around half of the forests of the country occur in the coastal zone. People extract various goods and services from the mangroves. Nevertheless the mangrove forests are depleting. Although the extent of the Sundarbans forest has not changed much, its decline is of a qualitative nature. Mangrove plantations are increasing in area but they are losing growing stock. To arrest this, Bangladesh has adopted several strategies.

The 'Sustainable Ecosystem Management' strategy has now been adopted instead of the 'Sustained Yield Principle'. Biodiversity conservation and enhancement has been taken as a key management goal. A zoning system is being developed for both production and protection purposes. The government facilitates alternative income for the local people by generating activities for the communities which are dependent on the forest. Different non-governmental organizations collaborate with the government in reducing the local people's dependence on the forest. Coastal plantations are erected to protect people from cyclones and to make the land more suitable for habitation. Through this greening of the coastal belt tree plantation is encouraged in coastal villages. Coastal embankments are being planted and leased to poor settlers in exchange for routine maintenance of the embankments. Plantations on newly accreted mud flats help in stabilizing the land, which can later on be settled by victims of erosion elsewhere. These adopted management measures do not only contribute to forestry resource management but also to the social, environmental and economic wellbeing of the coastal communities. These efforts are at present being integrated into an Integrated Coastal Zone Management (ICZM) project.

Keywords: Forest degeneration, ICZM; Mangrove management strategy; Participation.

Introduction

Bangladesh is a tropical developing country with a high population density, low per capita forest area but nevertheless a high tree species diversity (Anon 2001a, 2003a). It is endowed with a favourable climate that supports tropical evergreen, semi-evergreen, deciduous, mangrove and homestead forest (Anon. 2003b). The coastal zone of Bangladesh covers 32% of the country and encompasses the Exclusive Economic Zone in the Bay of Bengal and the landmass of the 19 districts. The zone is rich with numerous natural resources. Shared with India, it has the largest single tract of mangrove forest in the world. The Sundarbans located in the southwestern part and also houses a substantial amount of mangrove plantations (Siddiqi 2001). Fig. 1 presents the natural and planted mangroves distribution in the coastal zone of Bangladesh.

However, the management of the Bangladesh mangroves is facing two different problems: on the one hand mangroves are gradually declining, while on the other hand a gradual shift of mangrove management principles from monopolistic to a community-based approach occurs. Strategies are evolving to minimize the trend of forest decline and maximize the benefits of the mangroves, whose success are yet to be determined. The present review will reveal the major strategies adopted and their possible challenges.

In the following sections, the status of coastal forests, degradation of the forests, forest management strategies and recent initiatives of integrated management approach will be discussed.

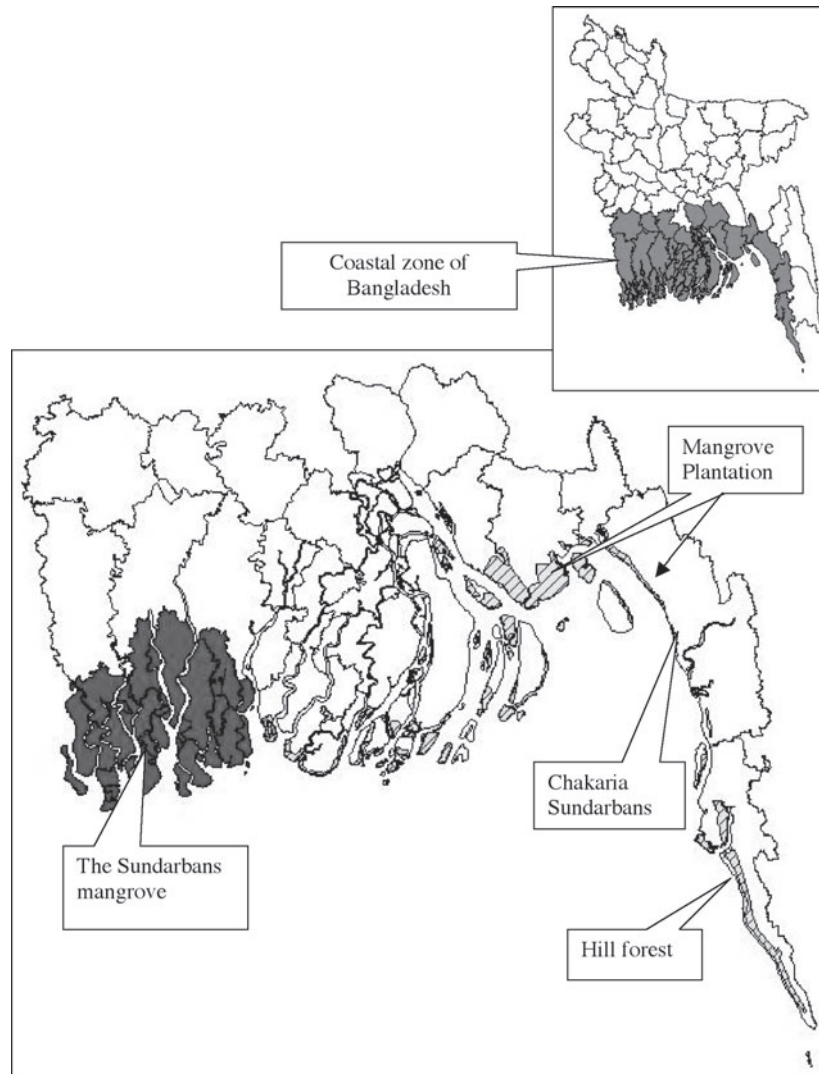


Fig. 1. Map of the Bangladesh coast showing mangroves and hill forests.

Status of the mangroves

Natural forests

The Sundarbans

The Sundarbans is the largest single tract of mangrove ecosystem in the world (for details see Hussain & Karim 1994; Anon. 2001b; Siddiqi 2001). The area is located in the SW corner of Bangladesh, between 21°30' and 22°30' N and 89°00' and 89°55' E, within the Khulna administrative division and extending over parts of Khulna, Satkhira and Bagerhat districts. As recently as 200 years ago, the Sundarbans extended farther inland, including much of the Khulna region. At the moment the Sundarbans still covers 6017 km².

Abiotic characteristics

The Sundarbans is located south of the Tropic of Cancer and at the northern limit of the Bay of Bengal. The four main seasons are pre-monsoon (March-May), monsoon (June-September), post-monsoon (October-November) and the dry winter season (December-February). Temperature varies between 37 °C and 11 °C. The rainfall increases from west to east and the mean annual rainfall varies from about 2000 mm in the east to 1600 mm in the west. It occupies a flat deltaic swamp on the greater Ganga-Brahmaputra estuarine complex, ranging between 0.9 to 2.1 m above Mean Sea Level (MSL). The soil of the forest is of recent origin consisting of alluvium washed down from the Himalayas. The surface geology consists entirely of quaternary sediments, sand and silt, interlaced with marine silt and clay.

Biotic characteristics

Trees are represented in the Sundarbans by 22 families representing 30 genera. The important tree species are listed in Table 1. The total growing stock of the forest is estimated to be 10.6 million m³ (Canonizado & Hossain 1998). *Heritiera fomes* is the single most important species of the Sundarbans. As a pure crop and in mixture with *Excoecaria agallocha*, *H. fomes* occupies ca. 18.2 % and 62.4 % of the forest area respectively (Anon. 2001b). But the dominance of *Heritiera* forest type is decreasing. The species is affected by 'top-dying disease'. Around 20.18 million *Heritiera* trees covering 198.5 km² are severely affected by this disease (Rahman 1995). *Heritiera* is also affected by root rot and die back disease.

A total of 453 animal species was officially listed (Anon. 2001c). Other sources report over 120 species of fish, 290 species of birds, 42 species of mammals, 35 reptiles and 8 amphibian species for the Sundarbans, representing 36-37% of the birds, 28-30% of the reptiles, and 33-34% of the mammals of the country. The Sundarbans is the largest remaining habitat of the renowned Bengal Tiger, *Panthera tigris tigris* (Hussain & Karim 1994). The forest also provides habitats to the Otter (*Lutra spec.*), Squirrels (*Callosciurus pygerythus* and *Funambalus pennati*), the Rhesus Macaque (*Macaca mulatta* Zimmermann), Spotted Deer (*Axis axis*), Barking Deer (*Muntiacus muntiak*), Wild Boar (*Sus scrofa*), and, in rivers and sea, a number of Dolphin species.

Chakaria Sundarban

The Chakaria Sundarban was used to be a mosaic of newly formed grassy islands, mangrove forests, river channels, aquaculture ponds, tidal creeks and inter-tidal mudflats located in the estuarine system of the Matamuhuri river and several smaller rivers in the Bay of Bengal. Unfortunately most of the forests have been cleared for aquaculture. In this zone several mangrove species were once abundant. The more important species are listed in Table 1. Nowadays most of these species have disappeared. Similarly the forest was rich in animal diversity, which has now been reduced to a few invertebrate species such as *Penaeus indicus*, *P. monodon*, *Metapenaeus monoceros* and *M. brevicornis* (Anon. 2002).

Other mangrove forests

A small strip (1800 ha) of mangroves consisting of scattered *E. agallocha* and *Ceriops spec.* occurs along the banks and estuarine islands of the Naaf river. Jhaliardwip island near Teknaf is covered with *S. apetala* forest. Other small off-shore islands such as Sonadia support some mangroves.

Table 1. Main tree species with vernacular and Latin name and family in the Sundarbans mangrove (S) and the Chakaria Sundarban (CS). mc = major canopy species; oc = other canopy species; u = understorey species; + occurred in CS.

Vernacular	Latin name	S	S	CS
Sundri	<i>Heritiera fomes</i>	<i>Sterculiaceae</i>	mc	+
Gewa	<i>Excoecaria agallocha</i>	<i>Euphorbiaceae</i>	mc	+
Passur	<i>Xylocarpus mekongensis</i>	<i>Meliaceae</i>	oc	
Keora	<i>Sonneratia apetala</i>	<i>Sonneratiaceae</i>	oc	
Baen	<i>Avicennia officinalis</i>	<i>Avicenniaceae</i>	oc	
Kankra	<i>Bruguiera gymnorrhiza</i>	<i>Rhizophoraceae</i>	oc	+
Dhundal	<i>Xylocarpus granatum</i>	<i>Meliaceae</i>	oc	
Golpatta	<i>Nypa fruticans</i>	<i>Palmae</i>	oc	
Goran	<i>Ceriops decandra</i>	<i>Rhizophoraceae</i>	u	+
Hantal	<i>Phoenix paludosa</i>	<i>Palmae</i>	u	+
Shingra	<i>Cynometra ramiflora</i>	<i>Leguminosae</i>	u	
Khalsi	<i>Aegiceras corniculatum</i>	<i>Myrsinaceae</i>	u	
Bhola	<i>Hibiscus tiliaceus</i>	<i>Malvaceae</i>	u	
Hargoza	<i>Acanthus ilicifolius</i>	<i>Acanthaceae</i>	()	+
Nuniagach	<i>Aegialitis rotundifolia</i>	<i>Leguminosae</i>	()	+
Ananta kata	<i>Dalbergia spinosa</i>	<i>Papilionaceae</i>	()	+

Planted forest

The coastal afforestation program in Bangladesh was started in 1966. Up to 1996 the program was funded by the World Bank and the Government of Bangladesh and a total of 765 km² of plantations were established (Revilla et al. 1998). Planted species are mainly *Sonneratia apetala* and *Avicenna officinalis*. Others are *Excoecaria agallocha*, *Bruguiera gymnorrhiza* and *Nypa fruticans* (Serajuddoula et al. 1995). The primary objective of developing mangrove plantations was to mitigate disastrous effects of cyclones and storm surges, with which some other objectives were added later:

- Conservation and stabilization of newly accreted land, and acceleration of further accretion with the ultimate aim of transferring a large part of this land to agriculture;
- Production of timber for fuel wood and industrial uses;
- Supply of urgently needed resources into national economy (i.e. timber and new land);
- Creation of employment opportunities for remote rural communities;
- Development of suitable environment for wildlife, fish and other estuarine and marine fauna (Siddiqi 2001).

Several projects with forest management components have been implemented or are currently being implemented in the coastal zone, e.g. Coastal Greenbelt Project (CGP), Forest Resources Management Project (FRMP), Sundarban Biodiversity Conservation Project (SBCP), Jhau Plantation in the Cox's Bazar Sea Beach Area, Coastal Embankment Rehabilitation Project (CERP), Char Development and Settlement Project (CDSP), etc. Under these projects, a substantial amount of plantations have been developed.

Role of mangroves in coastal ecology and economy

The mangroves supply a variety of goods and services to the people. It has been estimated that ca. four million people are dependent on mangroves for their livelihood (Anon. 2004a). In the impact zone of the Sundarbans around 18% of the households are directly dependent on the Sundarbans. Some specialized livelihood groups, e.g. the Bawali (wood collectors), Mawali (honey collectors), crab collectors, and fishermen group, have evolved over time. The mangroves also provide raw material for paper, wood and furniture industries.

The coast of Bangladesh is frequently ravaged by tropical cyclones causing massive damage of life and property. Mangroves play a pivotal role in reducing the impact of cyclones. They also help in land maturation by reducing the velocity of the water flow and help in settling the sediments. The mangroves provide necessary nutrients and habitats for fish and wildlife species and rich fishery resources on the coast of Bangladesh can be attributed to this factor. The Sundarbans is the last abode of the famous Royal Bengal Tiger.

Degeneration of the coastal forests

Bangladesh has 18% of the land designated as forest but the actual coverage is less than 7%, and these remnants are further disappearing at a rate of 90 km² per year (Anon. 1999). The once flourishing Chakaria Sundarbans has been totally destroyed (Anon. 2002). Although the boundary of the Sundarbans is almost unchanged, its quality is degrading (Hussain & Karim 1994; Siddiqi 2001; Iftekhar & Islam 2004).

The merchantable volume of the major species of Sundarbans, *Heritiera fomes* and *Excoecaria agallocha* have been depleted by 40% and 45% respectively, since the Forestal 1959 inventory. This depletion was due to overexploitation for saw timber and fuelwood (Hussain & Karim 1994). As mentioned, *H. fomes* is moreover affected by top dying disease.

There are four Coastal Afforestation Divisions. Successful coastal plantation has been observed in Noakhali and Patuakhali Forest Divisions (Table 2). But recently most of the plantation area of the Noakhali Forest Division has been encroached. Absentee landlords and local landless people are identified as the main agents of mangrove destruction (Anon. 2004b). Moreover, the growing stock of the forest is also depleting. The volume has decreased from 35.68 m³.ha⁻¹ in 1984 to 24.55 m³.ha⁻¹ in 1996, which means a 31.2% depletion in 12 years; Revilla et al. 1998). Under the present management system, mangrove plantations face several problems, e.g. site suitability, provision for the second rotation

crop, encroachment and insect infestation. Raising plantations of some mesophytic species in the coastal areas is envisaged (Serajuddoula et al. 1995).

Present management of mangroves

In the current (1994) forest policy multiple use of the Sundarbans has been targeted through sustained management keeping the bio-environment of the area intact. Newly accreted lands in the coastal areas will be afforested through coordinated efforts of the government, NGOs and local people. The general objectives are to protect and improve the coastal environment by augmenting tree cover in the coastal region and to help in poverty alleviation of the local people by generating supplementary income opportunities.

The main objectives of the present management plan of the Sundarbans has been set to: (1) regulate the harvest of timber and other resources to sustainable levels; (2) improve the regenerative capacity of timber, non-timber and aquatic resources; (3) reduce the rate of unofficial extraction of timber resources; (4) generate stakeholder support and build new constituencies in resource conservation and (5) enhance biodiversity and tourism potential of the Sundarbans (Canonizado & Hossain 1998).

Management plans for coastal plantations have been developed with the objectives of (1) to continue the establishment of coastal forest plantations and initiate management of existing ones for their timber value; (2) to protect and preserve areas of environmental value relating to conservation of biodiversity resources; (3) to integrate people's participation and development and (4) to enhance and promote recreational and tourism potential. Programs are implemented to meet the objectives, such as (1) management of forest plantations; (2) operation of continuous forest inventory system; (3) participatory forestry, (4) forest recreation and tourism, (5) protected area management and (6) environmental services (Canonizado 1999).

Table 2. Division-wise distribution of coastal plantations.

Division	Total plantations established 1960-2001 (km ²)			Failed plantations (%)		Net plantations (%)
	Eroded	Encroached	Total	Eroded	Encroached	
Noakhali	595	24	17	41	59	
Bhola	302	39	7	46	54	
Patuakhali	220	10	1	11	89	
Chittagong	368	31	15	46	54	
Total	1485	27	12	39	61	

Source: Gani, Osman (pers. com.) (2004). FD and ICZMP. Presentation made on the workshop on partnership building in ICZM process (Agency Forum) – Forest Department (FD) and WARPO on 6 October 2004.

Strategic elements of mangrove management and their challenges

The Forest Department is the responsible agency for the forest management. Some NGOs and local people's groups are now engaged in forest management activities. Bangladesh has adopted several strategies to manage the mangroves. Some have been implemented already and others are to be followed. Key management strategies are elaborated hereunder.

Adoption of holistic management approach

The Sundarbans have been under systematic management for ca. 130 years. In the past, a sustained yield principle under the selection system was applied and main emphasis was given to two or three timber species. Recently, emphasis has been put on ecosystem management; timber felling in the forest is now banned. Salvage felling and enrichment planting has started to restore forest health (Siddiqi 2001). However, continuous pilferages of valuable species are a major threat to sustainability. Moreover, it is found that lack of freshwater is affecting the forest health by causing 'top dying disease' to the *H. fomes* tree. In the Indian part of the Sundarbans it has been already observed that the vegetation composition has been changed (Naskar 1999). Plans have been made to increase the supply of freshwater to the Sundarbans through excavation of rivers and revision of treaties with India. Integrated regional development plans are necessary.

Biodiversity conservation and enhancement

Bangladesh has signed the treaty 'Convention of Biological Diversity'. As a signatory, the country has started a project on biodiversity conservation of the Sundarbans in 2000 named the 'Sundarban Biodiversity Conservation Project'. Another project, 'Biodiversity Management in the Sundarbans World Heritage Sites: An Integrated Two-Country Approach in India and Bangladesh', is currently being implemented.

Within these projects attempts are being made to conserve biodiversity in the Sundarbans. In collaboration with the Forest Department IUCN-Bangladesh is developing health indicators for the Sundarbans mangroves. Indicators will be developed at species, habitat and ecosystem level (Choudhury 2003). A draft document on the 'Code of Conduct for the Sustainable Management of Mangroves' has been prepared under the World Bank's initiatives.

Mangrove plantations are offering a new habitat for the wildlife of the Sundarbans. Successful introduction of deer and monkey species has been made in the

mangroves plantations of the central coastal islands and some areas have now been designated as wildlife sanctuaries. In addition, some parts of the mangrove forest and plantations have been declared protected areas under a different status e.g. Wildlife Sanctuaries, National Park, Ecologically Critical Areas.

Recently an initiative has been started to develop mangrove plantations in the Chakaria Sundarbans by IUCN-Bangladesh, as a pilot project to restore the degraded mangrove ecosystem. Restoration experiences in countries in East Africa, has revealed that attention should be paid to factors such as, soil stability and flooding regime, site elevation, salinity and freshwater run-off, tidal and wave energy, propagule availability and predation, spacing and thinning of mangroves, nursery techniques, community participation, etc. to make this initiative successful (Kairo et al. 2001).

Impact zone management

A 20-km strip of land adjacent to the Sundarbans has been declared an impact zone. It is argued that the bulk of the resource harvesters live in this area (Anon. 2001c). Efforts to create alternative employment opportunities will reduce dependence on the resources of Sundarbans. The main strategies of the Forest Department in this zone are to: (1) reduce demand and extraction of SRF products by alternative social and economic development; (2) promote environmental awareness and (3) organize people to attain support for SRF conservation.

Facing the continuous pilferage, zoning could be done for the mangrove plantations also. Besides conservation zones certain area could be managed by the communities within the designated mangrove area. In other countries, like, Ecuador, Senegal, Thailand, Myanmar these types of zoning exercises have shown successes (Oo 2002; Anon. 2003c; Aksornkoae 2004).

Collaboration in forest management between NGOs and the Government

The Government under ADB supported projects, facilitates alternative income generating activities for the forest dependent community. Different NGOs collaborate in reducing local people's dependence on forest. Ca. 20 NGOs are working within the SBCP framework, and ten others within the Coastal Embankment Rehabilitation Project (CERP).

NGOs are typically responsible for community mobilization, motivation, group formation and care taking of the formed groups. They also provide training to the members on plantation techniques and management. In some cases, NGOs negotiate and make agreements for benefit sharing with the land-owning agencies for strip/

block plantation on behalf of the members.

However, the major limitations on effective NGO involvement include low institutional capacity and technical capacity of the NGOs, inadequate coordination and collaboration with the Forest Department, insufficient financial capacity and political influence on decisions and operations.

People's participation in forest management

For the management of the Sundarbans a Stewardship Committee of eminent concerned persons provides overall guidance; a Steering Committee facilitates policy implementation and a Stakeholder Council represents extractor groups and others in the impact zone. The Upazilla Councils, facilitate people's organization for all activities supporting Forest Department activities. A social forestry program has been started in the impact zone of the Sundarbans under the supervision of the Social Forestry Circle, Jessore, in collaboration with NGOs.

Under the Coastal Greenbelt Project (CGP), a people-oriented participatory forestry program was targeted to improve the socio-economic condition of the rural poor, improve the role and status of women in rural enterprises, diversify and supplement farm income, substitution of locally produced coconut for improved oil and enhance the environmental quality including the restoration and/or protection of critical mangrove habitat (Canonizado 1999). Poverty alleviation has been targeted by participatory plantation formation on government fallow land, embankment, roads and railways. Beneficiaries groups are formed for strip and roadside plantations (Khan et al. 2004). Under the CERP, khas lands are leased to the Embankment Settler Group in exchange for routine embankment maintenance.

NGO initiatives to establish plantations

Various non-government organizations have programs to establish plantations in homestead, institution, roadside and khas land and fallow land. Homestead plantations are established by group formation, institutional plantations are established in cooperation with the authorities. Roadside and khas land plantations are formalized by obtaining a lease from the local government.

Promotion of non-exploiting uses

The mangroves offer some major tourist attraction spots in the country, as every year a large amount of people visit the Sundarbans. The current management plan for the Sundarbans has the objective of utilizing the tourism potential. Several infrastructures including an

information center, rest houses, etc. have been constructed. Commercial organizations are operating regular touristic trips to the Sundarbans. The mangroves plantations accommodate several wildlife sanctuaries, which are tourist attractions. In countries like India and China (Hong Kong), ecotourism into mangrove forests provide valuable income sources for the coastal dwellers (Tam & Wong 2002).

Modeling for optimizing plantation design

Due to its geographical position, Bangladesh is one of the countries most affected by tropical cyclones. Where for the world as a whole casualties of tropical cyclones are in excess of 5000, more than half of them occur in Bangladesh (Ali 2003). The mangrove plantations are playing an important role in reducing the impact of these cyclones and accompanying surges. It is suggested that it is essential to maintain the shelter belt, but as yet, no fixed width has been determined. In Vietnam, the maintaining of a 500 - 1000 m wide shelter belt; in the Philippines a 20 - 50 m wide shelter belt is mandatory (2003c). In Bangladesh, modeling studies are being carried out to find the optimum plantation width and the number of rows to increase protective efficiency.

Plantation for land reclamation

Estimates for each year suggest that ca. 500 km² of new land are accreted in Bangladesh estuaries (Islam, 2004). According to existing laws newly accreted lands are brought under the jurisdiction of the Forest Department to develop plantations for a stipulated period of 20 years. This time is needed to make the land mature enough for human settlement. After that it is envisaged to be handed over to the public land authority. But it is commonly observed that after 5 to 6 year people start tree felling and begin living there. Moreover, mangroves provide fertile ground for shrimp cultivation. This is also a major stimulus for forest clearing. For these reasons no formal hand over of matured land to the District Administration has yet taken place.

Impact of the management strategies

The significance of the Sundarbans mangrove forest regarding environment, biodiversity and recreation have been appreciated by experts, but the local people have also become more conscious about the value of the forest. As a result the forest is now considered for management at the ecosystem level.

The coastal afforestation program of Bangladesh has come into being primarily to reduce the effect of

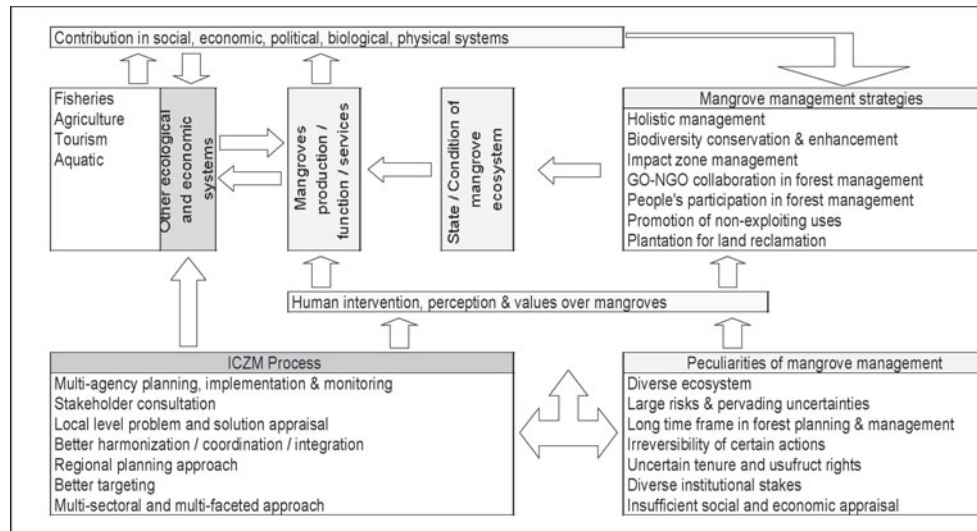


Fig. 2. Relationship between mangrove management and ICZM process.

cyclones and tidal surges, by creating a protective belt of coastal mangrove forests (Baksha & Islam 1997). It has been estimated that a 100 - 200 m wide mangrove belt reduces wave heights by 20 to 25% (CPP-II 1992 in Anon. 2000). The efficiency of protection belts in taming the impact of cyclones has been observed by coastal people. Mangrove plantation also helps in land maturation and makes the land suitable for human settlement. Plantation on new accreted land enhances the process of siltation. Within 9 - 10 months of planting, silt deposition of up to 3 m has been recorded (Das & Siddiqi 1985). Plantations are also becoming a new habitat for the endangered species of the Sundarbans. These activities have contributed to the amelioration of the ecological conditions of the area.

The livelihood of the people living in newly accreted areas and of-shore islands has been improved as they are getting timber, fodder and fuelwood from the plantations. Moreover, participation in the group-based forestry activities is bringing a cash income. Most importantly by stabilizing and protecting the newly accreted lands, coastal plantations facilitates the settlement of the destitute and displaced people.

Integration in the ICZM process

Mangroves have directly tangible values, e.g. timber, fuelwood and fruit, and also intangible values, such as their function as a shelter belt, attraction for tourists, biodiversity, and feeding and breeding ground for fish, and wildlife. These values result from intrinsic characters of the mangrove ecosystem and the continuous

interaction with other ecosystems. Some of the values are well appreciated while others are still in the process of evaluation. The realization of the benefits depends on people's attitude, values and perceptions. For sustainable management of mangroves a multifaceted and multi-scaled approach is required. The Integrated Coastal Zone Management (ICZM) process should provide a sound basis of integrated planning through stimulating multi-agency and multi stakeholder participation in the planning, designing, implementation and monitoring process (Fig. 2). Bangladesh is going to adopt an integrated coastal zone management concept and a program development office has been set up. Ways to integrate forestry activities with other sectors and realization of benefits to the people are being planned. A draft Coastal Zone Policy has been formulated with specific objectives of 'Sustainable management of coastal resources' and 'Preservation and enhancement of critical ecosystems and ecological processes'. Elaboration of strategies to meet the objectives are taking place now. Simultaneously some priority investment programs are developed to conserve and sustainable manage the mangroves.

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