

Mangrove forests in Sunderbans active delta – ecological disaster and remedies

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Abstract

The coastal active delta of Sunderbans at the mouth of Bay of Bengal in India, having a complex geomorphologic and hydrological character with climatic hazards, has a vast area of mangrove forests with a variety of flora and diverse fauna in a unique ecosystem. The natural environment and coastal ecosystem of this Biosphere Reserve and World Heritage Site is under threat of physical disaster due to unscientific and excessive human interferences. Conservation and environmental management plan for safeguarding this unique coastal ecology and ecosystem is urgently required.

Keywords

Coastal ecosystem; conservation; environmental management plan; mangrove; physical disaster; Sunderbans

INTRODUCTION

The Sunderbans active delta in the West Bengal State in India is the Himalayan Ganges and Brahmaputra rivers delta at the mouth of Bay of Bengal located at latitude $21^{\circ}30'$ – $22^{\circ}15'N$ and longitude $88^{\circ}10'$ – $89^{\circ}10'E$ (Banerjee, 1998) with a network of tidal rivers, channels, mudflats, creeks, distributaries, islands and coastal dunes (Fig. 1). The inner mudflats are the natural abode of mangrove. The Sunderbans tidal estuary comprises an area of 4282 sq km, of which the tidal and inter-tidal mangrove forest area is estimated of 2328 sq km (Table 1).

NATURAL ENVIRONMENT OF THE COASTAL REGION

Eco-geography, Rivers and Watercourses

There are seven main rivers and innumerable watercourses forming a network of channels at this estuarine delta. All the rivers have a southward course towards the sea. The eco-geography of this area is totally dependent on the tidal effect of two flow tides and two ebb tides occurring within 24 hours with a tidal range of 3-5m and up to 8m (Ghosh & Mandal, 1989; Banerjee, 1998) in normal spring tide, inundating the whole of Sunderbans in varying depths. The tidal action deposits silts back on the channels and raising the bed, it forms new islands and creeks contributing to uncertain geomorphology (Bhattacharya, 1989).

There is a great natural depression called “Swatch of No Ground” in the Bay of Bengal between 21° to $21^{\circ}22'$ latitude where, the depth of water changes suddenly from 20m to 500m (Fergusson, 1963; Ghosh & Mandal, 1989). This mysterious depression pushes back the silts towards south and/or further east to form new islands.

Mudflats

The Sunderbans mudflats (Banerjee, 1998) (Fig. 1) are found at the estuary and on the deltaic islands where low velocity of river and tidal current occurs. The flats are exposed in low tides and submerged in high tides, thus being changed morphologically even in one tidal cycle. The interior parts of the mudflats are magnificent home of luxuriant mangroves (Fig. 2). The morphology of the

swamps is characterized by the occurrence of saltpans, ditches and banks with a thick mud substratum of decomposed organic matters (Bakshi & Naskar, 1987; Banerjee, 1998). The Sunderbans mudflats control the food chain in the estuarine ecosystem.

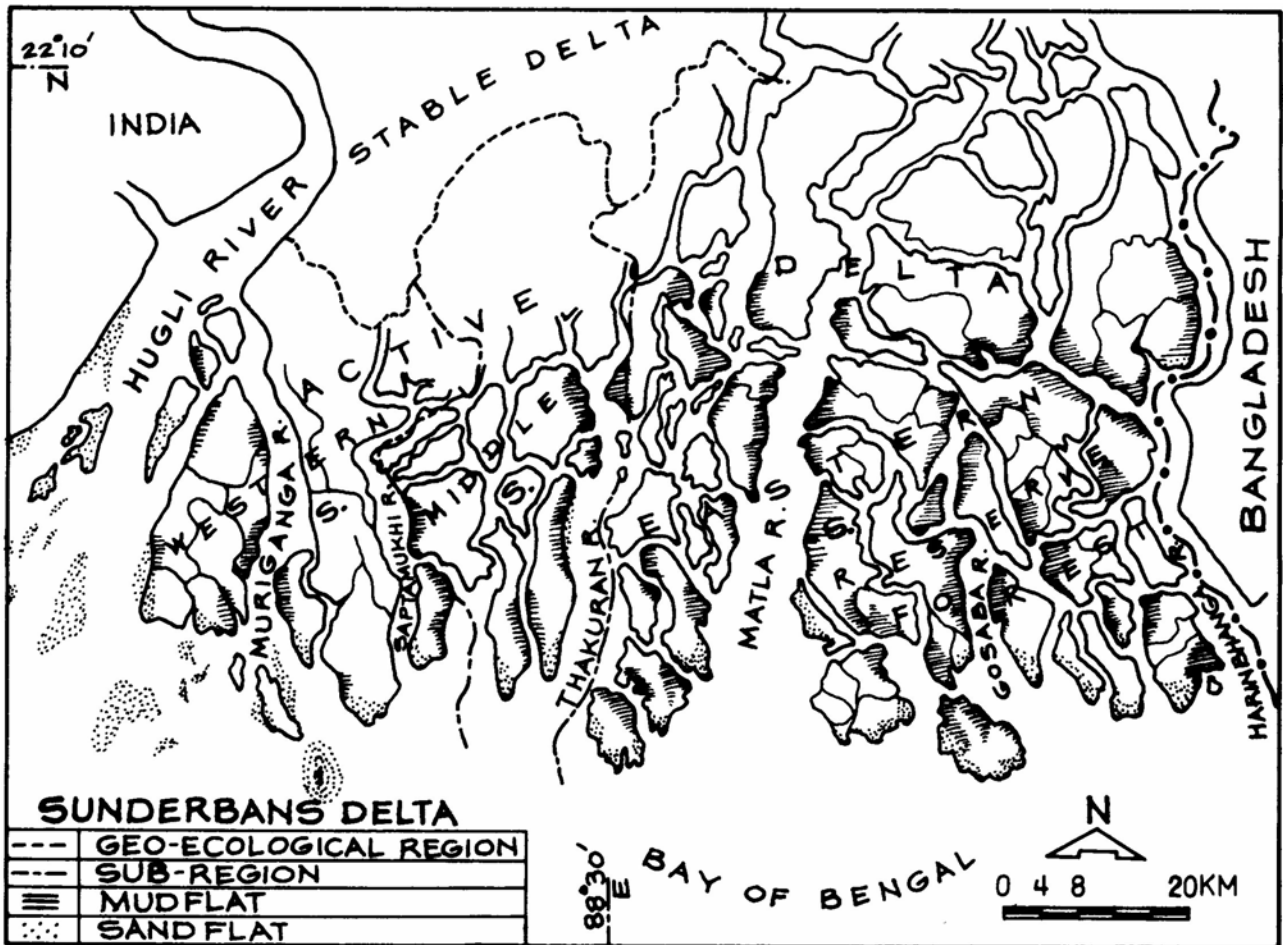


Fig. 1. Map showing geo-ecological region, sub-region, rivers, mudflats & sand flats in the Sunderbans delta in India. (Source : Paul & Bandyopadhyay, Banerjee, 1998; Bose, 2004)

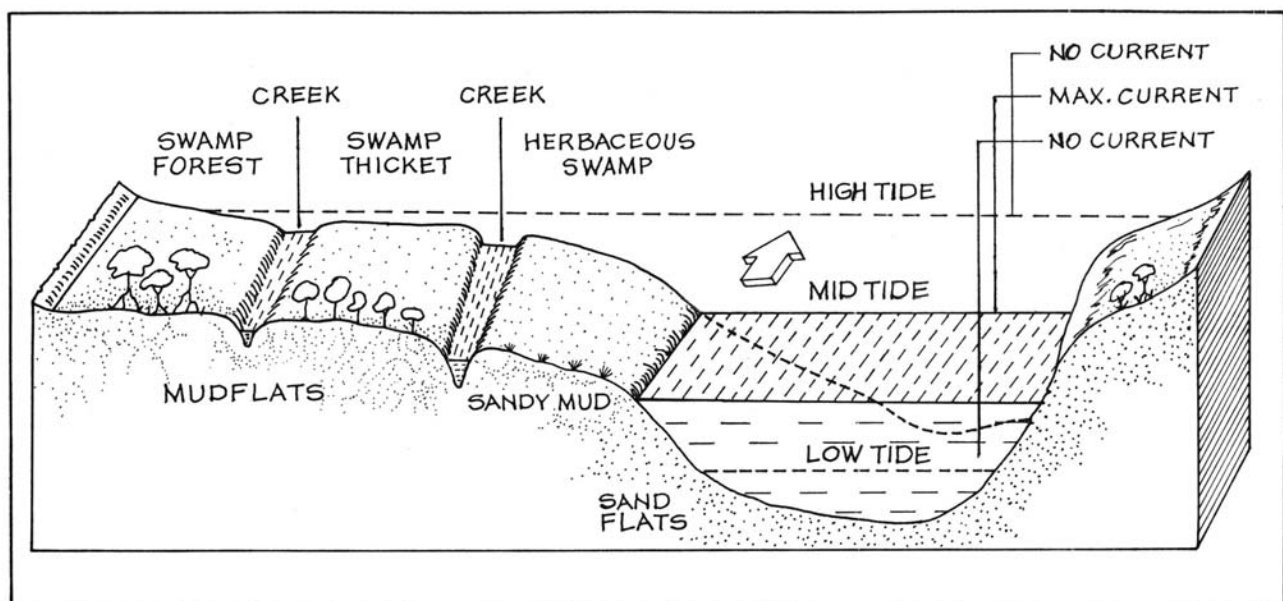


Fig. 2. Sectional view of mudflats & sand flats in Sunderbans delta (Banerjee, 1998; Bose, 2004).

Soil types

The active delta of the Sunderbans bears the soil types of silty clay loams, sandy clay and loams, soil with organic and peaty deposits, swampy and marshy soil, also called as 'Mangrove Soil' (Ghosh & Mandal, 1989). The salinity of the surface soil and the water bodies is governed by the quantity of fresh water flow and monsoon rain fall.

Coastal dunes

Coastal dunes in the Sunderbans comprise a system of low ridges parallel to the coast, separated by large dry and wet sand flats (Banerjee, 1998). In recent years, the coastal dunes of the western islands are being engulfed by the encroaching sea waves accompanied by the cyclonic storms. The rate of coastal erosion is high on the west side coasts (Bhattacharya, 1989).

Climate

The region has a tropical monsoon climate with excess of humidity. Annual average rainfall is around 1800mm, maximum and minimum temperatures in summer and winter are 40⁰C and 9⁰C. Occasionally, during pre-monsoon March to May, violent thunderstorms occur while during post-monsoon October to November, the cyclonic storms accompanied with high sea waves and tides devastate the coastal Sunderbans area (Ghosh & Mandal, 1989; Bose, 2004).

FLORA (MANGROVE) AND FAUNA

Flora (Mangrove)

The flora is confined mostly to the mangrove tidal forests. The mangrove community of trees and shrubs has stilt root with numerous lenticels and pneumatophores and adapt with high salinity, submergence, fine clayey soil, tidal currents and fresh water flow. Recent studies conducted here by the Conservator of Forest of the State government revealed that there are 84 species of mangrove and mangrove-associates found in the Sunderbans mangrove forest (Table 2), moreover the distribution of species is not uniform and primarily controlled by the level of salinity and not by the tidal inundation.

Table 1. The density status of Sunderbans mangrove forests (as monitored using RS/GIS in December 1999). (Source : Director, Sunderbans Biosphere Reserve, 2001)

Class Name	Area (Sq. Km)
Dense mangrove	1570.35
Open mangrove	577.70
Sand / grass / char land	180.59
Non-forest use	26.57
Clear water	109.58
Muddy water	1817.59
Total	4282.38

In general, the true estuarine zone, comprising the estuarine banks along the mouths of the rivers are dominated by the Baen (*Avicennia officinalis*, *A. alba*, *A. marina*), Tora (*Aegialitis*), Kripa (*Lumnitzera racemosa*), etc., the species which have tolerance to high salinity and submergence. The middle estuarine zone where, the salinity is lower but the tidal current passing through the narrow creeks and channels is high, is dominated by Garjan (*Rhizophora* spp), Goran (*Cerops* spp), Keora (*Sonneratia apetala*), etc. The inner estuarine or riverine zone comprising elevated areas with less acid (and saline) soil and more fresh water flow, is dominated by Sundari (*Heritiera fomes*),

Genwa (*Excoecaria agallocha*), Kankra (*Bruguiera* spp), Hental (*Phoenix* spp), Golpata (*Nypa*), etc, (Ghosh & Mandal, 1989; Banerjee, 1998; Govt. of West Bengal, 2002). The mangrove trees mentioned above are of great economic importance. Sweet water inflow in the western part of Sunderbans has been reduced by geotectonic and fluvial reasons and this has caused the forest cover at this area less dense and the mangroves of dwarf and bushy type.

Table 2. Floral diversity of mangroves in Sunderbans. (Source : Forest Department, Government of West Bengal, 2004)

Class of species	Number of species found
True mangrove species	26
Mangrove associates	29
Back mangrove species	29
Family	40
Genera	60
Total species	84

Fauna

The mangrove provides shelter for a large number of euryhaline / brackish water algae, shell-fish and fin-fish species, prawns, crustaceans, estuarine crabs, ghost shrimps, mollusks, nematodes, annelids, animals like various types of jungle cat, the deer, rhesus monkey, wild pig, otter, water monitor, various snakes including python, estuarine crocodiles, sharks, dolphins, marine turtles, large variety of local birds and migratory pelican, migratory rock bees from the Himalaya and the world famous ‘Royal Bengal Tiger’ (Ghosh & Mandal, 1989; Banerjee, 1998). The food chain (Fig. 3) of Sunderbans reveals that the tiger is at the apex of the hierarchy of terrestrial as well as aquatic animals.

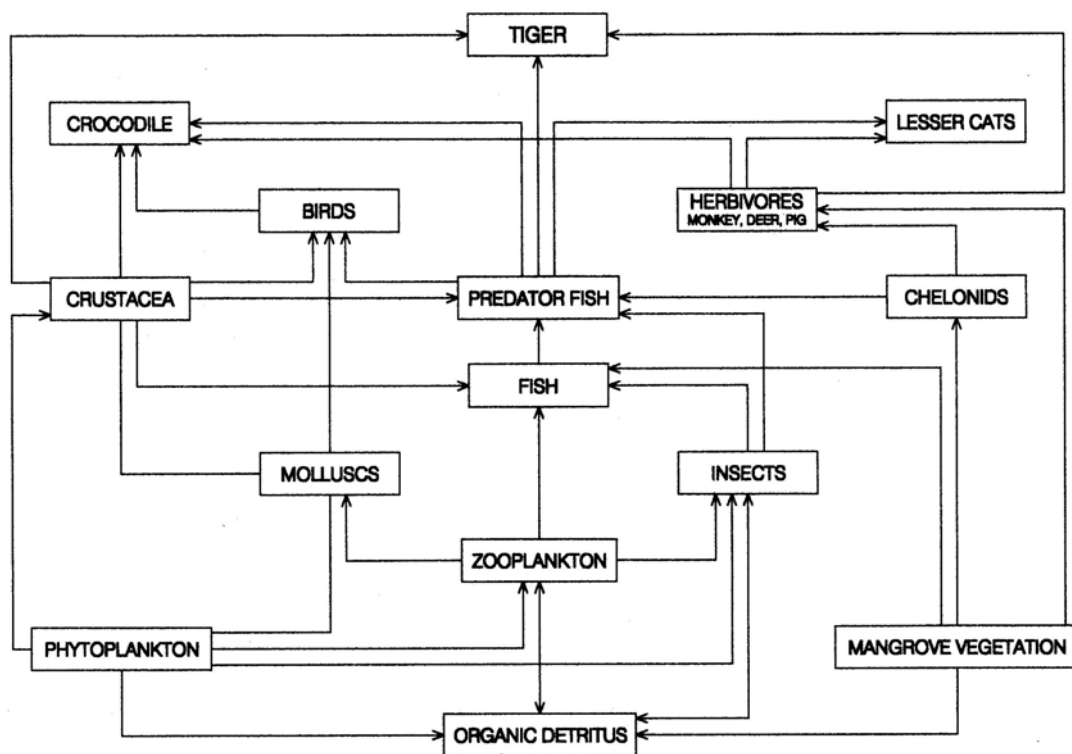


Fig. 3. Food chain in the mangrove ecosystem in Sunderbans (Banerjee, 1998).

BENEFITS FROM MANGROVE

The Sunderbans mangrove ecosystem provides an excellent floral, faunal, ecological and environmental ambience in a close network of mutual interdependence. The benefits from mangrove forest are as follows –

- Many mangrove trees are of great economic and use value as building materials for rural houses, for furniture, for making boats and as fuel wood (Govt. of India, 1989).
- Many mangrove herbs have medicinal values (Vannucci, 2004).
- Mangrove habitat along the coastline acts as natural buffer from damages by tides and surges, and trapping sediments protect the coastal region from erosion (Bandyopadhyay 1989; Mastaller, 1996; Vannucci, 2004). This has been observed as true after the tsunami attack of 26th December in 2004 in Indian Ocean.
- Mangrove functions as wind-breaking barrier, minimizing the intensity of cyclonic storms (Bandyopadhyay 1989; Mastaller, 1996).
- Mangrove functions as natural sewage treatment plant and an important carbon dioxide sink. It absorbs pollutants from both air and water. The mangrove plants have high percentage of tannin present in their barks and leaves, which can neutralize some of the industrial pollutants and reduce their detrimental effect (Naskar, 1987; Mastaller, 1996; Banerjee, 1998; Govt. of West Bengal, 2002; Vannucci, 2004).
- The mangrove forest is an important nursery, breeding, feeding and spawning ground for many brackish water animal species especially fishes of great economic importance. From the beehives, people collect 500 quintals of honey and 30 quintals of wax on an average every year (Banerjee, 1989; Banerjee, 1998; Bose, 2004).
- Sunderbans mangrove is the home of a number of endangered and globally threatened species (Govt. of India, 1989; Govt. of West Bengal, 2002).
- From coastal Sunderbans mangrove forest, an average of 6000t/ha mangrove litter is released per year. After decomposition of this huge quantity of litter through mineralization process, enormous amount of organic nutrients are released in coastal soil and water. This is a great source of natural food for fauna species (Govt. of West Bengal, 2002).
- The Sunderbans mangrove ecosystem provides scope for interdisciplinary research programme involving natural and social sciences. Mangrove restoration offers good opportunities for eco-tourism, biological research, conservation education and economic benefit to local communities (Mastaller, 1996; UNCHS, 1996; Ghosh, 2001; Vannucci, 2004; Patronobish, 2004).

PROBLEMS (ECOLOGICAL DISASTER)

The major types of human intervention, which are detrimental to the Sunderbans biosphere along with the mangrove ecosystem have been identified as follows –

- Land reclamation by people for agriculture and human settlement destructing forest area over the centuries. During the last two centuries, more than 5000 sq km of the mangrove forests in the Indian part of Sunderbans were reclaimed (Banerjee, 1998; Ghosh, 2001).
- Construction of a series of irrigation and drainage canals, which interferes the natural gradients (Bhattacharya, 1989; Bose, 2004).
- Setting up of fisheries in rivers, canals, creeks and estuary, raising embankments along the major river systems against insurgence of saline water (Ghosh & Mandal, 1989; Bose, 2004).
- Forfeiting large areas of the forest for establishment of shrimp ponds contributing to water pollution (Bose, 2004).
- Peoples' regular practice of collection of tiger prawn seeds using fine-mesh nylon nets dragging along the river banks. In this process, mangrove seedlings and many species of fish are destroyed. This has been destroying the possibility of regeneration of mangrove along the river banks and the food chain of the ecosystem. A survey conducted by the S.D. Marine Biological Research Institute of the district in 1994 revealed that for collecting 519 prawn seeds, at least

5103 gm of other seed varieties of different categories of fish are destroyed (Govt. of West Bengal, 2002; Patronobis, 2004; Various web sites, & Sunderbans' People, 2004-05).

- Excessive exploitation of mangrove forest wealth like timbers and fire woods.
- Poaching of animals of commercial importance.
- A proposal for setting up National waterway through Sunderbans, which would adversely affect the ecosystem destroying the flora and fauna due to large scale human activities (Patronobis, 2004, Various web sites & News Papers, 2004-05).
- Oil spill from old and defective launches and boats is a potential threat, which causes immense damage to aquatic fauna and the mangrove vegetation (Mastaller, 1996; Patronobis, 2004).
- Though the mangrove has an enormous capacity to absorb industrial effluents and other forms of pollutants, dumping of excessive pollutants may affect the ecosystem adversely (Govt. of West Bengal, 2002).

All these pose a serious threat on the natural environmental balance and the flora and fauna of the region, disturb the complex food chain, unbalance the animal population, enhance coastal erosion, soil erosion and provides less resistance to the ravages of cyclonic storms over the land. Several important fish species, some faunal species and mangrove trees like Sundari (*Heritiera fomes*) and others have been declining in the region (Chakrabarti, 1989; Ghosh & Mandal, 1989; Banerjee, 1998; Ghosh, 2001; Govt. of West Bengal, 2002; Bose, 2004).

ACTIONS TAKEN SO FAR

The Government of India declared the mangrove forest as the “Protected Biosphere Reserve” on 29.03.1989. A Tiger Reserve (covering 2585 sq km) at the core area of the forest was set up where Project Tiger was launched in 1973 with the help of World Wildlife Fund. Poaching of animals was banned during 1970-72. A Crocodile Project was also taken up. Three Sanctuaries were set up at Sajnekhali, Lothian and Halliday Islands. The Sunderbans Development Board, a joint enterprise of the State and Central Government, was formed in 1980s to provide for improvement of drainage, irrigation, agriculture, agro-processing, fishery, social forestry, etc (Govt. of India, Banerjee, 1989).

The core area of 1692 sq km of Sunderbans National Park is bounded by Matla River on the west, Haribhanga River on the east, Netidhopani and Gosaba on the north. The buffer zone extends over an area of 885 sq km and includes Sajnekhali Wildlife Sanctuary. Halliday Island and Lothian Island wildlife sanctuaries lie to the west of Sunderbans and are not part of the tiger reserve. The transit zone extends over an area of around 1705 sq km.

Govt. of West Bengal has set up a mangrove eco-park in Jharkhali (island) in 1999 for which the Sunderbans Development Board allotted 10 hectares of land and State Environment Department supported financial assistance with the primary objective of rehabilitating Sundari (*Heritiera fomes*) trees which have been depleted alarmingly (Banerjee, 1998; Govt. of West Bengal, 2002). Mudflats close to the periphery of the reserve are artificially being regenerated with mangrove plants to meet local demand of small wood and fuel wood and reduce the pressure on the buffer. Soil conservation measures applying vegetation method are taken up to stabilize the vulnerable sites. To facilitate availability of sweet water to the animals, ponds have been dug at several places within the forests.

The Sunderbans Tiger Reserve has received effective protection under project tiger since its inception. The core area has been free of all human disturbances. Protection against poaching and theft of forest products has been ensured through intensive patrolling over the area. The reserve has launched a special programme to conserve the highly endangered Olive Ridley Turtles.

The wildlife wing of the UNDP has prepared a project for conservation (Patronobis, 2004) of the

unique mangrove ecosystem of Sunderbans in India and Bangladesh jointly with the active participation of the local people, emphasizing on the two-country approach so that a uniform system of management for conservation of this world heritage site can be maintained. The project aims at –

- generation of income and alternative livelihood of people,
- establishment of community-based conservation / resource management committee at key villages,
- capacity building (state departments, NGOs, CBOs),
- prepare a detailed work plan,
- development of eco-tourism,
- sharing the work plan with the stakeholders through consultation, discussion and workshop.

PROPOSALS

1. Periodic mapping of Sunderbans mangrove forests has to be carried out using the Remote Sensing and GIS technology to monitor the changes in the ecosystem.
2. The conservation and management planning of the coastal areas should be based on proper understanding, analysis and assessment of the various complex geomorphologic, fluvial, oceanic and natural climatic characteristics of the whole area plus the unnatural influence by human interventions (UNCHS, 1996; Ghosh, 2001; Bose, 2004).
3. The management programme of conservation, environment and development (CED) of Sunderbans area should be planned primarily to retain the natural ecosystem of the mangrove forest, saving the diverse flora and fauna and providing for combating pollution, cyclonic hazards and coastal erosion following the “Conservation Function” prescribed by the UNESCO in its ‘Man and Biosphere Programme’ (UNCHS, 1996; Ghosh, 2001).
4. Action has to be taken for reforestation, restoration and development of the mangroves. Promotion of integrated conservation and management systems between mangroves and aquaculture is to be advocated.
5. Evaluation of various uses of mangrove plants including for medicinal purposes and as a food source is to be made.
6. Public education campaign is to be conducted to make local communities, the tourism industry and other sectors aware of the importance of mangroves. People should be informed, educated and trained for accepting and participating into the policy-enforcing actions. Training programme for communities should also include the techniques of conservation and rehabilitation of mangrove forests.
7. Social forestry can be useful for eco-restoration of mangrove vegetation through creation of employment opportunities (Bose, 2004).
8. The overall planning policy should be implemented by all sectors of the government bodies with legislative and administrative control, strict vigilance and above all with greater cooperation among them to eliminate conflict (Bose, 2004).
9. Monitoring over the situations and making necessary modifications in the implementation programme are to be done constantly along with periodic review and further assessment.
10. The beauty of the Sunderbans can be explored for attracting and managing (within tolerable limit of) tourism and associated economy. Tourism should be encouraged in the transit zone with such a control so that the natural environment, ecology and life style of the coastal people are not adversely affected (Bose, 2004).
11. To install cyclone warning system in the coastal and further areas and cyclone shelters should be constructed for people as part of disaster preparedness planning (Bose, 2004).
12. Energy requirements for local people, environmental and research programme are to be met with the help of solar and wind energies (example – utilization of solar energy at Sagar Island by Govt. of West Bengal) (Bose, 2004).

CONCLUSION

Mangrove forest on the active delta of Sunderbans is a part of a unique biosphere and a declared world heritage site. Though the economic and social benefit from this mangrove forest is perhaps more applicable to the local communities and the State, but its environmental value adds to the quality of the world seen in terms of sustainability of the man-and-biosphere environment of the earth. Moreover, the endangered and globally threatened faunal species living in this forest depend on the value of its floral and ecological characteristics. All constitute part of a complex ecosystem depending upon each other. Any damage to one part will damage and change the whole constitution of the ecology and ecosystem of this vulnerable portion of earth where the ocean meets the land.

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