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An Ecological Study of Habitat of Mangrove Forest of Bangladesh

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INTRODUCTION

Mangroves are one type of forests is among the most threatened habitats in the world. Growing in the intertidal areas and estuary mouths between land and sea, mangroves provide a critical habitat for the diverse marine and terrestrial flora and fauna. Healthy mangrove forests are key indication of a healthy marine ecology. Thus the study of ecological analysis is must in the present situation to preserve and utilization point of view of mangroves.

Mangrove forests are critical to the people and economy of Bangladesh. Probably no other distinct plant community has attracted as much curiosity and scientific attention for as long as have the mangrove forests. On the basis of types, spatial distribution, spatial association, human interactions, and ecosystem of mangrove forests of the study area, authors have tried to utilize/conserve the mangrove forest resources for the Man's best use on its sustainable developmental policies. Since the future impact of climatic chan-ge and sea–level rise in the coastal zone of Bangladesh will depend on the vulnerability and resilience of its physical, biological, social and economic systems.

THE STUDY AREA

Bangladesh lies in the northeastern part of South Asia between 20°34' and 26°38' north latitude, and 88°01' and 92°41' east longitude. The coast of Bangladesh is approximately 710 km long (Snead, 1985), as estimated by measuring the distance around the Bay of Bengal between the Indian and Myanmar borders. If the length of the tidal-estuarine coast is considered, the total shoreline of Bangladesh may be around thousands of kilometers long. Bangladesh is fringed on the south by the huge expanse of marshy deltaic mangrove forest known as the Sunderbans, the abode of the famous royal Bengal tiger, where the area of this one is shared by India too. The Bengali name for the Sunderbans is Sunder-Bon "the beautiful forest".

DISTRIBUTION PATTERN AND ECOLOGICAL ZONATION

Mangrove forests in Bangladesh are widely distributed on sedimenting shores of the coastal areas. The coastline of Bangladesh can be divided into three main zones- the west, central and east coastal zones. Each consists distinct coastal landforms and specific geological, physical and biological characteristics (Barua, 1991). The west and central coasts are part of the Ganges-Meghna-Brahmaputra delta system, whereas the east coast is non-deltaic (Fig.1). Mangrove forests are extended over the coast from southeastern *technaf river* to southwestern *raimangal river*. The expansion of these forests from coast towards north is up to the limit of saltwater flow at the time of high tide of the sea. On the basis of the distribution, the mangorve forests of the study area can be divided into three; *viz.,* Sunderban, Chakaria sunderban, and Coast surrounding forest. The natural coastal forest of the Sunderban is the largest natural single area of mangroves in the world, covering 587,000ha. The formerly extensive mangroves in the east, Chakaria sunderban, cover less than 1000ha due to the felling to make way for saltpans and shrimp ponds. There is a further 104,000 to 109,000 ha of coastal mangrove forest planted under the "Coastal Afforestation Project" (Kausher et al., 1993). The mangroves were planted in coastal areas without natural mangrove forests (mostly on the central coast) in order to protect coastal embankments and newly accreted lands from the impacts of cyclones.

The Sunderban forest at the southern end of the Ganges-Brahmaputra delta stretches from the Hoogly river to the Rabnabad islands, and extends inland, in places, as far as 160 kms. Two-thirds of this forest (or more correctly, forested area) is within Bangladesh. The forest cover varies considerably from east to west, since the nature of the delta changes quite rapidly west of the Haringhata river. The salinity distribution and

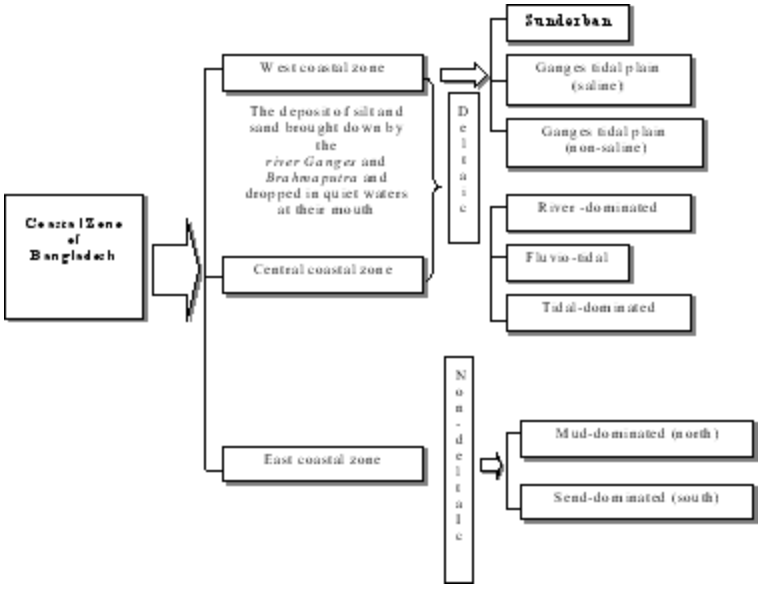

Fig. 1. Costal zone of Bangladesh

degree of water logging within the forest determines the overall ecological zonation of the mangrove forest into freshwater, moderately salt-water and saltwater zones. Differences in salinity and water logging within zones produce variations in local species. The ecological zonation of the mangrove forest in the study area shows that Moderately Saltwater Zone covers maximum area (44%) followed by Freshwater Zone (30%) and Saltwater Zone (26%) (Table 1). Two fairly distinct regions are demarcated. The forest, east of a line drawn from Kobadak forest station to Kata Khal near the mouth of the Haringhata river is the "freshwater" forest. These terms are relative since even in the "saltwater" zone the salt content in the water is fairly high in summer. The water in rivers has a dominating effect since the land is below the mean high tide level. The main characteristics of this forest are that it is both estuarine and swampy in the study area. The "freshwater" zone results from the larger quantities of water, which flows down the Pussur, Haringhata and Burishor rivers and thus maintains the surface water at lower level of salinity that is the case further west. In this zone, the main tree is Sunderi (*Heritiera fomes*). It comprises over 70% of the forest cover between Haringhata and Pussur rivers, but diminishes to 50% along the Arpangasia river followed by the Gewa (*Excoecaria agallocha*), which is next most important tree. It comprises 20% of the forest in this zone. An interesting habitat of the mangrove of this area comprises from weeds to palms are seen commonly. Along the streams the common trees are the two palms, Hantal (*Phoenix paludosa*), and Golpata (*Nipa fruticans)*. The most important weeds in this type of forest are Bhola (*Hibiscus tiliaceus*), Kewa Kanta (*Pandanus odoratissi-*

Table 1: Main economic uses and ecological zonation of the mangrove forest of Bangladesh

Zonation	*Forest cover/main species*			*Main economic uses*
	%	*Local*	*Latine name*	*Name*
Freshwater Zone	30	Sunderi	*Heritiera fomes*	Timber, honey, Fuel wood
Moderately Saltwater Zone	44	Gewa	*Excoecaria agallocha*	Pulp wood, match wood, baling board, hoeny
Saltwater zone	26	Goran	*Gerips decandra*	Fuel wood, herbs, honey

Source: ESCAP, 1987; after Chaffey et al., 1985, and personal computation

mus), Hodo or Tiger Fern (*Achrostichum aureum*), and Sundri-lota (*Browntonia lanceolata*). In the "moderately saltwater" zone, the Gewa becomes increasingly important. Along the seaface and lower estuarine reaches in the west, four types of mangroves are found; *viz.,* Bhara (*Rhizophora mucranata*), Goria (*Kandelia rheedii*), Goran and Kankara. In the extreme south, amidst the sand-beaches, various species including life weeds , common along the western coasts of the Bay of Bengal, such as *Mitreola oldenladiodes* and *Mitrascame alsinoides*, have established themselves. The Chakaria sunderban forest is in the delta of the Matamori river. The species in it are more or less the same as in the Sunderban except for the abundance of Chulia Kanta (*Dalbergia spinosa*) and Nunia (*Aegialites rotundifolia*).

ECOLOGY OF MANGROVES IN THE STUDY AREA

The mangrove belongs to the family of *Rhizophoraceae.* Mangrove forests are favoured by sheltered, low energy conditions (away from high waves) where there is sufficient interchange of water and sediment to bring nutrients. Too much sediment, as well as too little sediment, can inhibit mangrove growth. Mangrove species are specially adapted to survive in saline waters. Different species thrive in different salinities through their own specialized adaptations to ensure growth and reproduction. Like-wise mangroves have a strong interrelationship with tidal and river flows. The mangrove trees slow down these flows, allowing sediment to drop out of suspension, building up the mud flats and supplying nutrients to support further mangrove growth along with living organisms. The interplay between tree growth and the flow of fresh and saline waters through the forest is extremely subtle. Any small disturbances to the forest, particularly in terms of water and sediment flows can upset this interplay and affect the forest. In the west of the coastline of Bangladesh, mangrove forests dominate the coastal fringe. Mangroves also control the interaction of inland non-mangrove areas with the sea. In the central zone, the sediment-rich freshwater flows and their interaction with tides are important factors. In the east, wave energy dominates the open-ocean coast. Tidal mangrove forest marked in the southwestern tip of Bangladesh and it is subjected to saline water intrusion and flooded regularly. The main differences between mangrove species are the result of selection according to the amount of tidal inundation they can tolerate; the tide and continental slope and shelf are the chief selective factor in the vegetation pattern from place to place in any one mangorve forest and results in a belt zonation of typed roughly paralleling the shoreline. The nipa palm (*Nipat fruticans*; local Golpata), with short stem and feathery leaves often 10 feet long, lines estuaries where tidal influence is weakening. It is a palm of brackish but not saline preferences.

A primary factor of the natural environment that affects mangroves over the long term is sea level and its fluctuations. The seasonal variation of sea level of the Bay of Bengal is the highest in the world ocean (Das, 1992). Other minor factors are air temperature, salinity, ocean currents, storms, shore slope, and soil substrate. The coastal region, particularly the northern part of the Bay of Bengal is largely influenced by the freshwater of the rivers. The waves and ripples entering from the southern part of the Bay provide the energy for mixing the water and consequently bring uniformity in the chemical and physical properties of water. Tidal action is also of very great in the shallow coastal zones. Most mangroves live on muddy soils in these areas. It is also true that if the tidal conditions are optimal, the mangroves will flourish far inland, along the upper reaches of coastal estuaries.

Mangroves vary in height according to species, from mere shrubs to 20 meters trees in the study area. But above 10 meter trees are not more. Rhizophora have many roots supporting the trunk, which begins well above mud level, as though supported by flying buttresses. These special root adoptions protrude through the mud to reach free air and they have breathing pores (lenticels); their function may be to oxygenate the roots but they also enable fresh rootlets to be put out at higher and higher levels as the mud and silt increases and stifles the older roots. Certain species of mangroves exclude salt from their systems, others actually excrete the salt they take in through their leaves, roots, or branches. In salt excluding mangrove species, the mangrove root system is so effective in filtering out salt that a thirsty man

will drink fresh water from a cut root, though the tree itself stands in saline soil. In the study area many mangrove plants have seeds, which germinate before leaving the parent tree. Being heavy and fleshy, they can stick firmly in the mud at low tide or may float away in the tidal currents for considerable distances; other germinated seedlings are shaped like darts to pierce deeply into the mud when they fall.

HUMAN INTERACTION AND PERCEPTION

The mangrove forests are a multi-use natural resource of significance and also to the economy of Bangladesh. They supply fuel wood for domestic and industrial use, timber for industry and a range of other products. The people of the coastal zone support themselves mainly through agriculture, fishing and forestry. Approximately 24 million people were recorded in the coastal districts by the 1991 census (BBS, 1991) that may reach 45 to 50 million people by the year 2050. An estimated 600,000 to 700,000 people are directly employed in the commercial exploitation of mangrove timber, fuel wood resources, fish, honey and beeswax, and mollusk shells (used to produce lime) of the forest. Sunderi is the characteristic species of the freshwater zone and is the most commercially sought after species for use as timber. Boats and parts of boats are generally made from Sunderi. Gewa are being used by the match industry. It yields a soft timber, which is being intensively used in the large newsprint factory at Khulna as the main raw material. Most coastal industries are located in these centers. Important to Khulna are the paper and wood industries, which rely on the Sundarban mangrove forest for raw materials. In Chittagong, the Export Processing Zone (EPZ) is becoming increasingly significant, while in both Chittagong and Khulna the processing of shrimp for export has gained prominence in recent years. Artificial shrimp cultivation is going on along the sea border by destroying mangroves (Fig. 2).

The indirect economic value of the mangrove forest is also vitally important, and has recently been estimated to be seven times greater than the direct economic value of the forest (FAP 4, 1992). The forest has been a considerable source of revenue and now contributes approximately 2 percent to the gross domestic product of Bangladesh (Task Forece, 1991). The indirect value of the mangrove forests are a result of the protection the forest gives to the breeding of shrimp and fish larvae, thereby protecting the marine, brackish and freshwater coastal fishing industries. The stem, leaves, roots of the mangrove trees act as a geo-agents which itself given scope for the habitat of microorganisms, which in turn help for chain of different variety of fauna. The thick and spare mangroves along the estuaries, tidal water areas have given scope to grow a peculiar type of various fauna system. Thus there is a web relation between man and the mangroves in the study region. The roots to leaves, buds to fruits and seeds are greater help to mankind even from the point of medical herbs. The forest detritus, consisting mainly of fallen leaves and branches from the mangroves, provide nutrients for the marine environment and supports immense varieties of sea life in intricate food webs associated directly through detritus or indirectly through the planktonic and epiphytic algae food chains. The shallow inter-tidal reaches that characterize the mangrove wetlands offer refuge and nursery grounds for juvenile fish, crabs, shrimps, and mollusks. Mangroves are also prime nesting and migratory sites for hundreds of bird species. Additionally manatees, crab-eating monkeys, fishing cats, monitor lizards, sea turtles, and mudskipper fish utilize the mangrove wetlands.

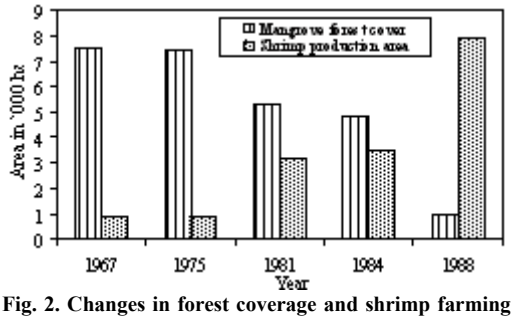

Fig. 2. Changes in forest coverage and shrimp farming area in Chakaria Sunderban, 1967-1988
Source: Choudhary et al. (1990).

The Sundarban forest supports numerous and diverse mammals, birds, amphibia and reptiles of commercial and conservation importance. It is one of the last remaining refuges of the Royal Bengal Tiger (*Panthera tigris*), the national sym-

bol of Bangladesh, and the estuarine crocodile. Both are endangered species of this area (GOB,1991). The people who are residing within and around mangrove forest their perception is that this habitat is *God gifted* for their life.

CONCLUSION

Mangrove forest in the study area is an integral part of the life cycle of many fauna including fish and shrimp species. Over the last several decades, the global area in mangroves has been increasingly diminished as a result of human activities. The main agents of destruction of mangrove forests in the study area are man, wind, rivers, and the animals. Typhoons with wind speeds up to 200 km/h do a lot of damage to young and old mangroves, as happened in 1965 and 1970, which has commonly been seen oftenly. The shifting of river courses is of course, and ever-present menace, but most of them being a decaying nature, cause influence in the ecosystem of mangroves, which have a chain link between the mangroves and their habitat. It is believed also that mangroves are being lost in the study area due to the stress given to the blue revolution by the government and public in these areas. One of the best example to it is the rich mangroves have been replaced by shrimp farming. There is estimation that Bangladesh/ Indian Sunderbans have lost at least about 10,000 hectares of mangroves in a short period of ten years. The natural Chakaria sundarban is rapidly being deforested to make way for shrimp farming. The Sundarban of the west is already extensively modified by human use. Thus it is believed that this current level of usage is not sustainable and mangrove forest management requires initiative to carry out immediately with a proper knowledge of its destructive agents and sensitivity to future risk (Fig. 3). The remote sensing and GIS techniques will also help tremendously in the forest tourism and in maintaining mangrove forest and human ecology. To save the mangroves the stricter local governmental regulations and enforcement protecting mangroves are necessary. Involvement of local communities in sustainably managing and protecting their coastal resource base, including nearby mangrove forests, is also essential because the mangroves are the nature's gift which cant be created by man in other localities. Recent resource inventories showed that the Government forests are being cut down at a rate greatly exceeding the cut allowable in the working plans. The result is that today's demand is being met at the cost of the crisis of tomorrow by disturbing nature's ecological balance. If this trend continues man loosing the beauty of mangroves and its immense beauty and will be inviting the adverse effects of nature like capturing of land mass by tidal current and losing rich resource of mangroves fauna.

KEY WORDS Ecosystem. Land. Sea. Physical Landscape. Human.

ABSTRACT The present paper aims to stress the types, spatial distribution, spatial associations, human interaction, and ecosystem of mangrove forests of Bangladesh. The study demonstrated that two fairly distinct regions can be demarcated; i.e. "*saltwater*", and "*freshwater*" zone. The complex ecosystems are found in the mangrove forests of the study area, where mangroves live in two worlds at once, acting as the interface between land and sea. Mangroves help to protect the coastlines from erosion, storm damage, and wave action. In this view, an attempt has been taken to know the spatial relationship between distribution, physical landscape and humans. The findings highlight that affects

Fig. 3. Destructive agents, sensitivity to future risk and sustainable management of Mangrove forests

mangroves over the long term in sea level and its fluctuations. Humans have traditionally altered the natural character of the Bangladesh coastal zone through their exploitation of its natural resources. The type and scale of human modifications have changed dramatically during the past 4 decades as traditional Bengali practices have given way to modern technologies. The coastal region, particularly the northern part of the *Bay of Bengal* is largely influenced by the freshwater of the rivers. On the basis of findings the possible suggestions are made to preserve the existing mangrove forests of Bangladesh.

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