

The Sundarbans: A Unique Wilderness of the World

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Abstract—The Sundarbans, natural mangrove forests of Bangladesh covers an area of 577,000 ha. It is the largest single tract of mangrove forest in the world. The members of the family Rhizophoraceae do not dominate the tree vegetation of the Sundarbans. *Heritiera fomes* and *Excoecaria agallocha* are the two most extensively occurring tree species in the forest and they are members of Sterculiaceae and Euphorbiaceae respectively. The forest is very rich in biodiversity and supports different species of about 334 plants, 120 fishes, 35 reptiles, 270 birds and 42 mammals. The Sundarbans is the only habitat of the famous Royal Bengal Tiger and estuarine crocodile.

The Sundarbans, natural mangrove forests of Bangladesh cover an area of 577,000 ha, of which 401,600 ha is land and remaining 175,400 ha are under the water in the forms of river, canals and creeks of width varying from a few meters to several kilometers. The interconnected network of waterways makes almost every corner of the forest accessible by boat. Unlike most mangrove forests, the members of the family Rhizophoraceae do not dominate the tree vegetation of the Sundarbans. *Heritiera fomes* and *Excoecaria agallocha* are the two most extensively occurring tree species in the forest and they are members of Sterculiaceae and Euphorbiaceae respectively. The forest is very rich in biodiversity.

The Sundarbans play an important role in the economy of the southwestern region of Bangladesh as well as in the national economy. It is the single largest source of forest produce in the country. The forest provides raw material for wood based industries. In addition to traditional forest produce like timber, fuelwood, pulpwood etc., large scale harvest of non wood forest products such as thatching materials, honey, bees-wax, fish, crustacean and mollusk resources of the forest takes place regularly. The vegetated tidal lands of the Sundarbans also function as an essential habitat, nutrient producer, water purifier, nutrient and sediment trap, storm barrier, shore stabilizer, energy storage unit and aesthetic attraction.

The Sundarbans is named after the principal tree Sundri (*Heritiera fomes*) found in it. Another opinion is that it is derived from the words 'Samunder Ban' meaning sea forests. It may also derived from the word 'Sundar,' meaning beautiful, because the forest is beautiful to look at (Choudhury 1968). The Sundarbans is of unique scientific and biological

interest and offers rare opportunities for ecotourism, biological research and conservation education. Some areas in the forest have been earmarked as protected in the form of wildlife sanctuary. No forestry operations are carried out in these areas, which support a rich concentration of wildlife as well as vegetation, which has not been disturbed for decades. The forest was recognized as an important resource base about five centuries ago and actual scientific management of the forest was initiated more than 120 years ago. This is very significant because even today mangroves are not considered as a viable resource base in a number of countries of Asia, Africa and tropical Latin America. For its outstanding natural value the World Heritage Committee of UNESCO inscribed the Sundarbans of Bangladesh in the World Heritage list by their 21st session in 1997 and accordingly the Government of the People's Republic of Bangladesh declared the Sundarbans as World Heritage site in December 1997 (Nuruzzaman and others 1999). This paper describes the vast wilderness of the Sundarbans, its economic and social importance and the need for integrated management and research.

Legal Status

During the Mughal period (1203-1538), the local kings leased the forests of the Sundarbans out. The history of changes in legal status boasts a number of unique features including the distinction of being the first mangrove forest in the world to be brought under scientific management. The area was mapped by the Surveyor General as early as 1764 following soon after proprietary rights were obtained from the Mughal Emperor, Alamgir II, by the East India Company in 1757. Systematic management of this forest tract started in the 1860s after the establishment of a Forest Department in the Province of Bengal, in India. The first Forest Management Division to have jurisdiction over the Sundarbans was established in 1869. The Sundarbans was declared a reserved forest in 1875-76, under the Forest Act, 1965 (Act VIII of 1965). The first management plan was written for the period 1893-98. (Hussain and Acharya 1994; UNDP 1998).

Physiography

The Sundarbans along the Bay of Bengal has evolved over the millennia through natural deposition of upstream sediments accompanied by intertidal segregation. The physiography is dominated by deltaic formations that include innumerable drainage lines associated with surface and subaqueous levees, splays and tidal flats. There are also marginal marshes above mean tide level, tidal sandbars and islands with their networks of tidal channels, subaqueous

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distal bars and proto-delta clays and silt sediments. The Sundarbans' floor varies from 0.9 m to 2.11 m above sea level (Katebi and Habib 1987).

The physical development processes along the coast are influenced by a multitude of factors, comprising wave motions, micro and macro-tidal cycles and long shore currents typical to the coastal tract which vary during the pre-monsoon, monsoon and post-monsoon periods. These are also affected by cyclonic action. Erosion and accretion through these forces maintains varying levels, as yet not properly measured, of physiographic change whilst the mangrove vegetation itself provides a remarkable stability to the entire system.

Biotic factors here play a significant role in physical coastal evolution and for wildlife a variety of habitats have developed including beaches, estuaries, permanent and semi-permanent swamps, tidal flats, tidal creeks, coastal dunes, back dunes and levees. The mangrove vegetation itself assists in the formation of new landmass and the intertidal vegetation plays an important role in swamp morphology. The activities of mangrove fauna in the intertidal mudflats develop micromorphological features that trap and hold sediments to create a substratum for mangrove seeds. The morphology and evolution of the eolian dunes controlled by an abundance of xerophytic and halophytic plants. Creepers and grasses and sedges stabilizes sand dunes and uncompact sediments

Flora

The Sundarbans flora is characterized by the abundance of *Heritiera fomes*, *Excoecaria agallocha*, *Ceriops decandra* and *Sonneratia apetala*. A total 245 genera and 334 plant species were recorded by Prain (1903). Since Prain's report there have been considerable changes in the status of various mangrove species and taxonomic revision of the mangrove flora (Khatun and Alam 1987). However, very little exploration of the botanical nature of the Sundarbans has been made to keep up with these changes. Whilst most of the mangroves in other parts of the world are characterized by members of the Rhizophoraceae, Avicenniaceae or Lagunculariaceae, the mangroves of Bangladesh are dominated by the Sterculiaceae and Euphorbiaceae (Hussain and Acharya 1994).

The Bangladesh mangrove vegetation of the Sundarbans differs greatly from other non-deltaic coastal mangrove forest and upland forests associations. Unlike the former, the Rhizophoraceae are of minor importance. Differences in vegetation have been explained in terms of freshwater and low salinity influences in the Northeast and variations in drainage and siltation.

The Sundarbans has been classified as a moist tropical forest demonstrating a whole mosaic of seres, comprising primary colonization on new accretions to more mature beach forests, often conspicuously dominated by Keora (*Sonneratia apetala*) and tidal forests. Historically three principal vegetation types have been recognized in broad correlation with varying degrees of water salinity, freshwater flushing and physiography and which are represented in the wildlife sanctuaries:

1. Sundarbans east, where freshwater and Sundri (*Heritiera fomes*) dominate interspersed with Gewa

(*Excoecaria agallocha*) and Passur (*Xylocarpus mekongensis*) with Kankra (*Bruguiera gymnorrhiza*) occurring in areas subject to more frequent flooding. There is a understory of Shingra (*Cynometra ramiflora*) where, soils are drier and Amur (*Amoora cucullata*) in wetter areas and Goran (*Ceriops decandra*) in more saline places. Nypa palm (*Nypa fruticans*) widespread along drainage lines.

2. Sundarbans south, where there is evidently the greatest seasonal variation in salinity levels and possibly represents an area of relatively longer duration of moderate salinity where Gewa is the dominant woody species. It is often mixed with Sundri, which is able to displace in circumstances such as artificially opened canopies where Sundri does not regenerate as effectively. It is also frequently associated with a dense understory of Goran and sometimes Passur.

3. Sundarbans west, in areas which support sparse Gewa and dense stands of Goran and discontinuous patches of Hantal palm (*Phoenix paludosa*) on drier ground and river banks and levees.

Sundri and Gewa occur prominently throughout the area with discontinuous distribution of Dhundul (*Xylocarpus granatum*) and Kankra. Among grasses and Palms, *Poresia coaractata*, *Myriostachya wightiana*, *Imperata cylindrica*, *Phragmites karka*, *Nypa fruticans* are well distributed. Keora is an indicator species for newly accreted mudbanks and is an important species for wildlife, especially spotted deer (*Axis axis*). Besides the forest, there are extensive areas of brackish and freshwater marshes, intertidal mudflats, sandflats, sand dunes with typical dune vegetation, open grassland on sandy soils and raised areas supporting a variety of terrestrial shrubs and trees.

Succession is generally defined as the successive occupation of a site by different plant communities (Weaver and Clements 1938). In an accreting mudflats the outer community along the sequence represents the pioneer community which is gradually replaced by the next community representing the seral stages and finally by a climax community typical of the climatic zone (Watson 1928 and Chapman 1976). Troup (1921) suggested that succession began in the newly accreted land created by fresh deposits of eroded soil. The pioneer vegetation on these newly accreted site is *Sonneratia*, followed by *Avicennia* and *Nypa*. As the ground is elevated as a result of soil deposition, other trees make their appearance. The most prevalent, though one of the late species to appear, is *Excoecaria*. As the level of land rises through accretion and the land is only occasionally flooded by tides, *Heritiera fomes* begins to appear.

Apart from a worldwide interest in botany, especially flowering plants, orchids, grasses and trees the current pervasive fashion for herbal medicines and chemical-free drugs has generated two lines of interest in plants which could be of great value to the Sundarbans Reserved Forests:

- Herbal tour—very popular in many parts of the world, even in countries like Kenya and Tanzania where there are powerful alternative attractions of 'big game and beaches.'
- The pharmaceutical industry which is searching the world for 'natural products' which could have commercial application. Supply of samples either as extractions or wet material is already being widely practiced or

where there is a 'hit' substantial revenues can accrue to the source country.

Fauna

The Sundarbans is very rich in wildlife. However the management of wildlife is presently restricted to the protection of fauna from poaching and designation of some areas as wildlife sanctuaries where no extraction of forest produce is allowed and the wildlife face few disturbance. Although it is clear that the faunal resource of Bangladesh have diminished in recent times (Hussain and Acharya 1994) and the Sundarbans has not been spared from this decline, the mangrove forest retains several good wildlife habitats and their associated fauna. Table 1 shows existing species or groups of animals that are particularly important.

Of these the tiger and dolphin are target species for planning wildlife management and tourism development. There are high profile and vulnerable mammals living in two contrasting environments and their statuses and management are strong indicators of the general condition of wildlife and its management.

The Sundarbans provides a unique ecosystem and extensive habitats for wildlife. A human interface in the Sundarbans in terms of resource extraction and forest management has important effects on wildlife habitats and populations. The river terrapin (*Betagur baska*), Indian flap-shelled turtle (*Lissemys punctata*), peacock soft-shelled

turtle (*Trionyx hurum*), yellow monitor (*Varanus flavescens*), water monitor (*Varanus salvator*), Indian python (*Python molurus*) and the Bengal tiger (*Panthera tigris tigris*) are some of the resident species. Some of these species are protected by legislation, notably by the Bangladesh Wildlife (Preservation) Order, 1973 (P.O. 23 of 1973). Some species such as hog deer (*Axis procinus*), water buffalo (*Bubalis bubalis*), swamp deer (*Cervus duvauceli*), Javan rhinoceros (*Rhinoceros sondaicus*), single horned rhinoceros (*Rhinoceros unicornis*) and the mugger crocodile (*Crocodylus palustris*) have become extinct in the Sundarbans at the beginning of this century (Sarker, 1993).

Recent studies revealed that the Bangladesh Sundarbans support diverse biological resources including at least 120 species of commercially important fishes, 270 species of birds, 42 species of mammals, 35 reptiles and eight amphibian species. This represents a significant proportion of the species present in Bangladesh (i.e. about 30% of the reptiles, 37% the birds and 34% of the mammals) and includes a large number of species which are now extinct elsewhere in the country (Scott 1991). Of these wildlife, Sarker (1993) has noted that two amphibians, 14 reptiles, 25 aves and five mammals are presently endangered. The Sundarbans is a paradise for the ornithologists for watching, study and research on avifauna (Habib 1999). An estimated population of some wildlife species of the Sundarbans is shown in Table 2.

Resource Management

The Sundarbans is the single largest source of supply of timber, fuelwood, pulpwood, thatching material and a whole array of non-wood forest products and non forestry forests products for Bangladesh. The forest has been under scientific management for about 120 years. In early days of management, *Heritiera fomes* was the only tree species, which was commercially exploited and exported from the forest. Gradually, over time, other tree species also became commercially important. The management prescriptions for different tree species in the Sundarbans have been developed gradually by fine tuning prescriptions, which were first implemented in the 19th century.

Administration

In 1875 a large portion of the mangrove forests was declared as reserved forests under the Forest Act, 1865 (Act VIII of 1965). The remaining portions of forests was declared

Table 1—Important wildlife of the Sundarbans, Bangladesh.

Bats	Strong following among wildlife specialists.
Tiger	Main national animal therefore of inestimable value; man killing behavior requires urgent study.
Fishing cat	Small but common secondary carnivore.
Spotted deer	Continental deer but unusual habitat in mangroves therefore of more than unusual value; harvesting may be possible.
Wild boar	Common and with much commercial potential.
Barking deer	Rarely seen but well represented therefore good for wildlife specialists.
Crocodiles	Infrequently seen but important in food chain and ecological stability; farming may be possible.
Otters	Of great value for biodiversity management and as a unique selling point tourist attraction with traditional fishermen; deserve special conservation attention in future.
Turtles	Strong interest among wildlife conservation specialists and deserve special attention in future; wildlife research especially to breeding areas and to secure threatened species is now essential for urgent action.
Python	Infrequently seen but must be well represented. Deserve special effort in future conservation and protection measures.
Dolphin	Indiscriminately harvested. Should be researched and actively protected.

Table 2—Estimated populations of some wildlife of Sundarbans, Bangladesh.

Animals	Number
Tiger	450
Spotted deer	80,000
Wild boar	20,000
Rhesus Macaque	68,200
Otter	20,000
Crocodile	100
White bellied-sea eagle	130 breeding pairs
Water monitor	39,795

Source: Hussain and Acharya 1994.

Table 3—Forest ranges of the Sundarbans, Bangladesh.

Name of range	Area (ha)	Total compartments
1. Sharankhola	130,998	12
2. Chandpai	100,021	15
3. Khulna	161,345	16
4. Satkhira	184,992	12

as reserve forest the following year and the forest, which was so far was administered by the civil administration district, was placed under the control of the Forest Department. A Forest Division, which is the basic forest management and administration unit, was created in 1879. The headquarters of the Forest Division was based in Khulna. The basic unit of management is the compartment. There are 55 compartments in four Forest Ranges (Table 3) and these are clearly demarcated mainly by natural features such as rives, canals and creeks. A new Khulna Forest Circle was created in 1993 and a Conservator of Forests has been posted. The direct administrative head of the Division is the Divisional Forest Officer who is also based at Khulna. The Divisional Forest Officer has a number of professional, subprofessional and support staff and logistic supports for the implementation of necessary management and administrative activities.

Forest Produce

In the 1980s the forest was producing about 45% of the total timber and fuelwood output from the forests of the country. Because of the extensive and diverse resources, which are available from the Sundarbans, the forest generates large-scale employment opportunities. The number of people entering the forest in a given year can be as high as one million. However, the number of people involved in retailing, transportation and processing of products from the Sundarbans is much higher.

The major forest products of the Sundarbans can be broadly categorized as follows for the purpose of discussing resource management practices:

1. Timber and industrial raw material.
2. Fuelwood.
3. Thatching material.
4. Non-wood forest products.

Timber and Industrial Raw Material—Until 1979-80, harvest of all wood and non-wood products in the Sundarbans was carried out on the basis of prescriptions which were laid out in the current working plans. The prescriptions provided the details of the area as well as the location of coupe for a particular year's operation. The silvicultural system prescribed is selection-cum-improvement and the cutting cycle prescribed for important species was 20 years, i.e., wood harvest in each location in the forest was carried out once in 20 years. Exploitable diameters for all timber species of three quality classes were also prescribed and tabulated. *H. Fomes* is the principal timber species in the Sundarbans. Other timber species of commercial species are *Sonneratia apetala*, *Xylocarpus mekongensis*, *Avicennia officinalis*, and *Bruguiera gymnorrhiza*. However, these occur on a much

smaller scale and are commercially not as important as *H. fomes*.

The moratorium order imposed a restriction on all tree felling in the natural Reserved Forests since 1989 and until the year 2000. However, in case of the Sundarbans cutting of Goran, Gewa and top-dying Sundri is allowed to facilitate the supply of raw material for pulp and paper industries and removal of top-dying Sundri trees is permitted.

Fuelwood—The two major fuel wood species in the Sundarbans are *H. fomes* and *Ceriops decandra*. However, there are a number of other species, which, also provide good quality fuelwood. These include *Amoora cucullata*, *Aegiceras majus*, *Rhizophora mucronata*, *Hibiscus tiliaceus*, *Ceriops candellana* and *Cynometra ramiflora*.

Thatching Material—Leaves of *Nypa fruticans* is a major source of thatching material, which is extensively used, by the poorer section of rural population in southwest Bangladesh. The Sundarbans is the only source of Nipa leaves. In addition, *Saccharum cylindricum* or sungrass grows extensively in the sandy areas on the seaward side of the Bangladesh Sundarbans. The grass is harvested in the same fashion as are cereal crops in agricultural fields and is used for thatching.

Non Wood Forest Products—In the Forest Department terminology, fishery resources in the Sundarbans are regarded as minor forest products and their harvest and management is regulated by the Forest Department. It is the most important non-forestry product of the forest. The shallow water, creeks, small and big rivers crossing mangrove forests supports many species of fish. Over 120 species of fish are caught routinely by commercial fishermen. Some species such as *Hilsha ilisha* are exclusively marine but travel through estuaries to the upstream areas for breeding and then return to the sea. Shrimps and prawns constitute the most important fishery of the zone. The most important crustaceans' species are *Penaeus mondon* and *Macrobrachium rosenbergi*. Mud crab (*Scylla serrata*) is the largest edible crab found in the forest area and has high economic value because of its very tasty meat and very high nutrient content.

Although honey and bees-wax are universal non-forest products, in the Sundarbans, these are included in the non-wood forest products and treated with particular importance with respect to their market and food value. *Aegiceras corniculatum* and *Ceriops decandra*, these two species are favored by the honey-bee *Apis dorsata*. Honey made from *Aegiceras* is of high quality and has a distinctive flavor. An estimated 185 t of honey and 45 t of wax are extracted annually.

The bark of various species is used in tannin production. *Ceriops decandra* is a major source of tannin while the barks of other species such as *Bruguiera gymnorrhiza* and *Xylocarpus granatum* also have a high tannin content. *Xylocarpus granatum* fruits are also used in tanning.

Phoenix paludosa is a thorny palm, the stems of which are used extensively in the construction of small huts as roof rafters and framework of the wall. *Phragmites karka*, a reed is collected from the forest and used extensively for making matting used for walls of houses, coverings for boats and as mats. *Myriostachyna wightiana* is collected from the newly

formed land in the forest and used for fencing and covering materials. *Acrostichum aureum* or tiger fern is a gregarious fern, the stems of which are used for the construction of mudwalls and fencing. *Entada scandens* is a woody climber, which is used for cleaning and medicinal purposes.

Wildlife Sanctuaries

There are three wildlife sanctuaries established in 1977 under the Bangladesh Wildlife (Preservation) Order, 1973 (P.O. 23 of 1973). These are: the Sundarbans East Wildlife Sanctuary extending over an area of 31,227 ha; the Sundarbans South Wildlife Sanctuary extending over an area of 36,970 ha; and the Sundarbans West Wildlife Sanctuary extending over an area of 71,502 ha of forests. The World Heritage Committee of UNESCO has declared the Sundarbans as its 522nd World Heritage Site by the 21st session for its outstanding scenic beauty and biological traits on the 6th December 1997. The UNESCO determined about 1400 km² of Sundarbans as World Heritage Site, at the inception. The Honorable Prime Minister of Bangladesh, Sheikh Hasina hoisted the Blue Flag of World Heritage Site and unveiled the plaque at Hiron Point (Nilkamal) of the Sundarbans on the 4th February 1999 (Nuruzzaman and others 1999).

Tourism

Conservation tourism or ecotourism may be developed for the Sundarbans without causing undue disturbance to the forest and wildlife. The Royal Bengal Tiger (*Panthera tigris tigris*) is, in particular, an important and alluring component of the Sundarbans and as such, should be an essential part of conservation and tourism activities. The fishing operation during winter months can also be developed as an interesting tourist spot.

Tourism in the Sundarbans is best undertaken during the winter months and the tourist season is therefore generally considered to last from October/November to February. The difficult terrain of mangrove areas further requires special facilities to be developed for transportation and accommodation needs. At the same time, the value of the Sundarbans resources and the danger of harming the fragile ecosystem must be taken into consideration in the preparation of a tourism plan.

Tourism has been recently regarded as an important component of the management and development of the Sundarbans. It has been recommended that due to the difficult terrain and the conservation needs of the forest ecosystem, the Sundarbans should be considered a site for low volume high-cost ecotourism rather than for a wider, less affluent mass market (UNDP 1998).

The National Tourism Policy of 1992 identifies the Sundarbans as one of the four key areas for development with an emphasis on wildlife. Table 4 lists some points which, have been noted as attractions of the Sundarbans Forest (Hussain and Acharya 1994).

Various constraints to developing the tourism potential of these forests have also been noted by the report and include:

1. Seasonal and climatic factors such as monsoon rains, storms etc.

2. Shortage of drinking water.
3. Lack of power and telecommunication facilities.
4. Lack of medical facilities.
5. Distance from airport.
6. Lack of tourism ethic and institutional framework.
7. Lack of infrastructure and staff for wildlife management, and conservation of wilderness values.
8. A fragile environment and difficult terrain.

Despite the difficult terrain and climatic uncertainties of the Sundarbans, the mangroves remains a source of attraction both in terms of aesthetic and wildlife value as well as in terms of research potential and educational value. The conservation of the natural ecosystem is therefore imperative, not only to maintain the productivity of the forests but for the preservation of wildlife and the various services and functions performed by the forests, many of which we have yet to discover.

Management and Research Needs

The physical environment and the mangrove biota of the Sundarbans are changing in interrelated ways. Deltas are the centers of the development of human civilization. The area presently managed, as natural mangrove forest is more than 50 per cent of the mangrove forest which, existed two centuries ago. Deforestation of the mangrove areas due to

Table 4—Attractions of the Sundarbans Reserved Forests, Bangladesh.

Description	Comments
Location	On the Bay of Bengal and largest mangrove formation in one of the world's largest river deltas.
Tropical climate	Cool and dry during the tourist season.
Waterways	Large and small waterways providing opportunities for cruising and jungle boating.
Forests	Unspoiled mangroves; forest ecology.
Wildlife	The largest single population of the Bengal tiger and exceptional populations of spotted deer and wild boar; adequate bird watching, migratory species and raptors in particular.
Beaches	Unspoiled, wild, unpolluted and totally undeveloped beaches throughout along the Bay of Bengal and around some islands.
History/archaeology	Rare sites set in the forest.
Sociology	Fishermen in particular, otter fishermen, also other traditional collectors of forest produce.
Cuisine	Many different species of edible fish, prawns and crabs.
Culture	Annual festivals at Dubla and diverse culture.

Source: de Vere Moss 1993.

increasing need for food. Fuel and shelter for the growing population had dire effects on the remaining mangrove areas.

Besides, environmental pollution like increased salinity due to altered river water flow as a result of construction of barrage and polders, oil spills in the maritime routes and over-exploitation in the Sundarbans beyond replenishment capacity of the forests, frequent cyclone and tidal surges affect the vast wilderness of the Sundarbans.

It has become a matter of immediate urgency to address the integrated management and research needs of the ecosystem. The resources and functions provided by the mangroves are essential for the coastal communities and for the national economy. In terms of scientific and educational value, and as part of natural heritage, the world's largest block of mangrove forests, straddling across the border of Bangladesh and India, is of both national and international value.

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