

*Review***DISTRIBUTION AND STATUS OF FORESTS IN THE TROPICS:
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Summary: This paper reviews the distribution and overall status of different types of forests in Bangladesh, highlighting their floral and faunal diversity. The objective was to provide a foundation for the national and international communities dealing with sustainable management strategies for tropical forests. There is a total of 2.53 million hectare forestland in Bangladesh, which is 17.5% of the total area of the country. The forests are situated in the southeastern, middle and southwestern regions holding the names of hill forests, Sal (*Shorea robusta*) forests and mangrove forests, respectively, with a rich biological diversity. Village forests also occupy a remarkable portion of the country. Along with the floral and faunal compositions, the present state of management strategies in different forest types is also enunciated.

Keywords: Tropical forests, flora, fauna, forest types, forest management

Introduction

According to the data of 1980, the forest resource of the world has been estimated at 3600 million ha. Besides, there are 1700 million ha of wooded lands not classified as forests. In all, about 40% of the world's land surface is still under some type of tree cover. However, deforestation is a serious concern throughout the world. The estimated rate of forest depletion in the tropical zone in the decade 1981 to 1990 was 15.4 million ha per year, significantly greater than the annual depletion of 11.4 million ha assessed in the decade 1971 to 1980 [1]. International Tropical Timber Agreement (ITTA) defines tropical forest as a forest lying between the tropics of Cancer and Capricorn, although it has proved difficult to apply this in all cases. For example, many countries have forests at higher altitudes within the tropics that effectively are temperate forest types. Moreover, several countries--Brazil, India, Mexico and Myanmar--have significant areas of forest outside the tropics.

These countries usually do not distinguish between 'tropical' and 'non-tropical' in their forest statistics; therefore, it has not always been possible to maintain the distinction [2]

Bangladesh is a tropical country. It is a rural-based developing country that 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 country is bounded by India on the West, the North and Northeast, Myanmar on the Southeast and the Bay of Bengal on the South [3]. The percentage of forest cover in relation to total land area is 10.2%; forest plantations were 625,000 ha in 2000 [4]. The area of forestland is 2.53 million ha which is 17.5% (Fig. 1) of the country's total area [5]. Bangladesh Forest Department (BFD) manages 1.53 million hectares of forestland [5]. The natural forests of Bangladesh are considered as one of the richest and biologically diverse forest resources due to its unique geo-physical location [6]. About 5000 plant species are estimated to

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occur here [7]. The forest cover, flora and fauna, and a smoothing natural environment are mingled with our tradition. Different regions of Bangladesh manifest different natural heritage. In the southwestern region of the country there lies the great forest of Sundarbans, the Sal forest in the middle and the evergreen hill forests in the southeast. A great variation in flora and fauna develops different and distinct ecosystems in the forests of Bangladesh.

The fate of the tropical forests has been on the global agenda since at least the 1970s [8]. Some countries have already lost a significant part of their natural forest heritage and now have relatively little forest and large areas of degraded, unstable and unproductive land. Since tropical forests are important at the global level, the international community must strengthen its assistance to countries in their quest to establish sustainable forest management across their permanent forest estates. However, such a task requires first the available information on the overall status and condition of the forestlands and resources of a country. Regarding Bangladesh, information on the forest types and the floristic composition is rather scattered. This study for the first time attempts to gather information on all categories of tropical forests, and makes a critical assessment of the state of management prevailing in different forest divisions of the country. It also deals with the status and distribution of flora and fauna of the forests in Bangladesh.

Forest types of Bangladesh

A forest type is a unit of vegetation, which possesses broad characteristics in physiognomy (general appearance) and structure (floristic composition) sufficiently pronounced to permit its differentiation from other such units. Many factors such as temperature, topography, aspect and gradient of hills, wind, microclimate, soil types, and moisture in the soil, rainfall and

humidity, geography of the area greatly influence the formation of different forest types [9]. Tables 1-3 show the statistics of the forest area of Bangladesh and forestlands managed by the Forest Department (FD) [5].

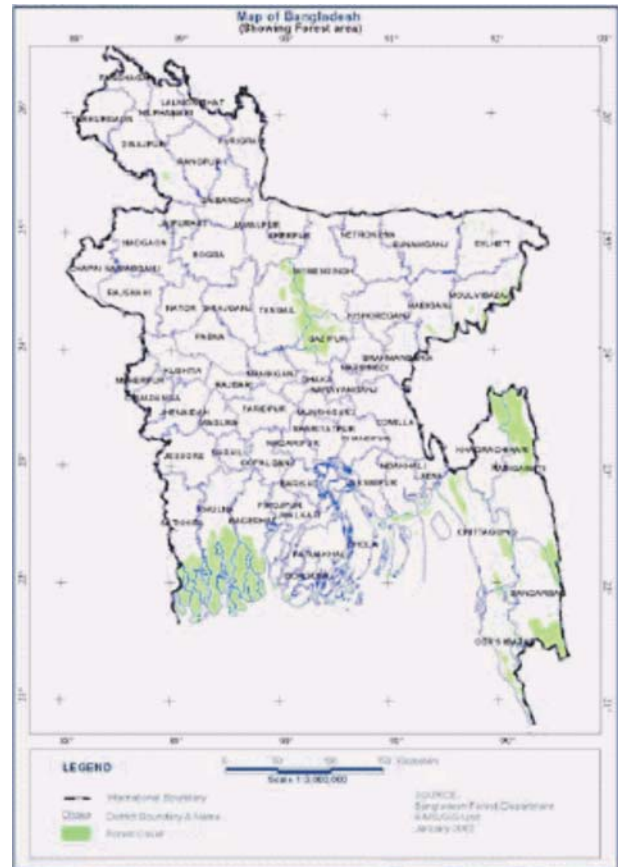


Figure 1. Map of Bangladesh showing the forest cover.

Table 1. Forest areas of Bangladesh.

Forest types	Area (million ha)	% of country's total area
FD managed Forests	1.53	10.54%
Unclassified State Forests	0.73	5.07%
Village Forests	0.27	1.88%
Total	2.53	17.49%

Hill Forests

The total Area of Hill Forests is 6, 70,000 hectares, which is 4.65% of country's area and 44% of total forestland managed by the Forest Department. Hill Forests are spread over the

hilly areas of Chittagong, Cox's Bazar, Sylhet and Chittagong Hill Tracts. Based on the topography, soil and climate, the Hill Forests can be classified into:

- (a) Tropical Wet Evergreen Forests.
- (b) Tropical semi Evergreen Forests.

Table 2. Different Forest types of Bangladesh.

Forest types	Total area (m. ha)	Area under tree cover (m. ha)	% of total land under tree cover
Hill Forest	1.40	0.33	2.3%
Mangrove Forest	0.74	0.46	3.2%
Sal Forest	0.12	0.05	0.3%
Village Forest	0.27	0.27	1.9%
Total	2.53	1.11	7.7%

Table 3. Forestlands managed by the Forest Department.

Forest types	Area (m. ha)	% of country's total area
Hill Forests	0.67	4.65%
Natural Mangrove Forests	0.60	4.09%
Mangrove Plantations	0.14	0.97%
Sal Forests	0.12	0.83%
Total	1.53	10.54%

Flora and Fauna

The Hill Forests are rich in diverse variety of flora and fauna. Champa (*Michelia champaca*), Chapalish (*Artocarpus chaplasha*), Chickrassi (*Chickrassia velutina*), Civit (*Swintonia floribunda*), Garjan (*Dipterocarpus spp.*), Telsur (*Hopea odorata*), Dhakijam (*Syzygium grande*), Mangium (*Acacia mangium*), Mehogony (*Swietenia spp.*), Lohakat (*Xylia dolabriformis*), Bailam (*Anisopera scaphula*), Sal (*Shorea robusta*), Gamar (*Gmelina arborea*), Koroi (*Albizia spp.*), Toon (*Toona ciliata*), Arjun (*Terminalia arjuna*), Bandarhola (*Duabanga grandiflora*), Jarul (*Lagerstroemia speciosa*), Kadam (*Anthocephalus chinensis*), Kainjal

(*Bischofia javanica*), Pitali (*Trewia nudiflora*), Shimul (*Bombax ceiba*), Kamdeb (*Calophyllum polyanthum*), Uriam (*Mangifera sylvatica*), Tali (*Dichopsis polyantha*), Jhau (*Casuarina equisetifolia*), Khair (*Acacia catechu*), Minjiri (*Cassia siamea*), Sissoo (*Dalbergia sissoo*) and others are found in the Hill forests. Besides, bamboo, cane, climber, fern are also found in there. Some of the common bamboo species are: Bariala (*Bambusa vulgaris*), Basali (*Teinostavhayum griffithi*), Daloo (*Neohuzeaua dullooa*), Kali (*Oxytenanthera nigrociliata*), Kaiera (*Oxytenanthera auriculata*), Mitenga (*Bambusa tulda*), Muli (*Melocana baccifera*) and Orah (*Dendrocalamus longispathus*) [10].

Planted forests are coming to play a much more significant role in the supply of tropical timber [2]. Plantation has been a regular activity in the Hill forests of Bangladesh since 1871. At present, plantation programs are being implemented on a massive scale under different development projects. Important plantation species include Teak (*Teaktona grandis*), Gamar (*Gmelina arborea*), Mehogony (*Swietenia spp.*), Chapalish (*Artocarpus chaplasha*), Jarul (*Lagerstroemia speciosa*), Sal (*Shorea robusta*), Koroi (*Albizia spp.*), Chickrashi (*Chickrassia velutina*), Lohakat (*Xylia dolabriformis*), Kadam (*Anthocephalus chinensis*), Telsur (*Hopea odorata*). According to the latest forest inventory the Hill forests have a growing stock of 23.93 million cubic meters of wood. This forest region is also rich in faunal diversity. Important mammals include Elephant (*Elephas maximus*), Rhesus Macaque (*Macaca mulatta*), Wild Pig (*Sus scrofa*), Barking deer (*Muntiacus muntjak*), Sambhar (*Cervus unicolor*) and Indian Leopard (*Panthera pardus*). Of the reptiles, King Cobra (*Ophiophagus hannah*), Monitor Lizard (*Calotes versicolor*) and Bengal Monitor Lizard (*Varanus bengalensis*) are common. [5].

Management Approach in Hill Forests

The management approach is traditional, i.e., clear felling followed by artificial regeneration of valuable species with a rotation of 40 years (long rotation), 18 years (short rotation) and very short rotation of 6 years. The bamboos appear either as pure stand or as understorey, and are managed under the culm selection system with a felling cycle of 3 to 4 years [11]. The forest reserves shrank dramatically over time. To overcome this situation a new approach, named participatory management, was introduced in 1981 at northern part of Bangladesh [12]. At present, the forest management in different Hill Forest Divisions is totally based on participatory approach [10].

Mangrove Forests

Bangladesh is gifted with both natural and planted mangrove forests.

Natural Mangrove Forests

The natural mangroves include the Sundarbans and Chokoria Sundarbans. The Sundarbans is the unique largest continuous productive mangrove forest of the world, spreading over the southern part of Bangladesh and west Bengal State of India. About 62 percent of the Sundarbans are in Khulna District of Bangladesh, and the remaining 38 percent is in the 24-Parganas District of West Bengal [13]. The total area of Sundarbans is 6, 01,700 hectares, which is 4.16% of the total area of Bangladesh, and 40% of the forestland is managed by the Forest Department. Sundarbans is treated to be the treasure house for the world famous Royal Bengal Tiger. The Sundarbans World Heritage site is composed of three wildlife sanctuaries: East Wildlife Sanctuary, South Wildlife Sanctuary and West Wildlife Sanctuary. The total area of the World Heritage site is 1, 39,700 hectares. Forest inventory of 1998 shows an estimate of

12.26 million cubic meters of wood resources (15 cm and above dbh) comprising trees of Sundri (*Heritiera fomes*), Gewa (*Excoecaria agallocha*), Keora (*Sonneratia apetala*) and Passur (*Xylocarpus mekongensis*) [5].

Flora and Fauna

There are 25 true mangrove species in the Sundarbans. Of the entire tree species, Sundri (*Heritiera fomes*) is the most important one, which occupies 73% of Sundarbans. Sundri is followed by Gewa (*Excoecaria agallocha*), Baen (*Avicennia officinalis*), Passur (*Xylocarpus mekongensis*) and Keora (*Sonneratia apetala*). There are numerous minor forest products such as Golpata (*Nypa fruticans*), honey, bee's wax, fish and others. The Sundarbans is also famous for some of the important animal species (Table 4). Important mammals include Royal Bengal Tiger (*Panthera tigris tigris*), Gangetic Dolphin (*Platanista gangetica*), Rhesus Macaque (*Macaca mulatta*), Indian Fishing Cat (*Felis viverrina*), Indian Otter (*Lutra prespicillata*) and Spotted Deer (*Axis axis*). Of the reptiles, Estuarine Crocodile (*Crocodilus porosus*), Monitor Lizard (*Varanus salvator*), Rock Python (*Python molurus*) and Green Turtle (*Cheoria mydas*) are important [13].

Table 4. Status of different faunal resources in the Sundarbans.

Class	Total No. of species in Bangladesh	No. of existing species	Sundarbans No. of extinct species	No. of endangered species
Mammals	110	49	4	10
Aves	628	261	2	11
Reptiles	109	50	1	16
Amphibians	22	8	-	1

Mangrove Plantation

Besides management of the natural forests, the Bangladeshi foresters are also engaged

in extensive mangrove afforestation activities along the 710 km long exposed coastal areas facing the Bay of Bengal during the past three decades. Mangrove afforestation program supported by GOB (Government of Bangladesh) fund was launched by the Forest Department in 1960-61 in the coastal districts of Bangladesh. It gained momentum from 1965-66 through implementations of different development projects in the coastal embankments, chars and islands. Till now, an area of about 1, 70,000 hectares of mangrove plantation has been raised [13].

Management Approach in Mangrove Forests

The basic unit of management in the Sundarbans is compartment. There are 55 compartments in the Sundarbans and these are demarcated mainly by rivers, canals and creeks [14]. All management prescriptions are formulated on compartment basis. The silvicultural system in the Sundarbans is selection-cum-improvement. The forest management system is based on the recommendations laid down in the management plan. The total operation is divided into working circles, which have specific objectives. The working circles are: (a) Gewa (*Excoecaria agallocha*) circle (b) Keora (*Sonneratia apetala*) circle (c) Sundri (*Heritiera fomes*) circle (d) Golpata (*Nypa fruticans*) circle (e) Wildlife and Recreation circle, and (f) Miscellaneous circles [10].

Sal (*Shorea robusta*) Forests

The total area of Sal Forests is 1, 20,000 hectares, which is 0.83% of country's area and 7.9% of forestland managed by the FD. Sal forests spread over the Central and Northern districts of Bangladesh. These forests are scattered in nature and intricately mixed with habitations. Sal forest is classified as Tropical Moist Deciduous Forest [5].

Flora and Fauna

The biodiversity of Sal forests includes a wide variety of flora and fauna. The dominant tree species found in the Sal forests is Sal (*Shorea robusta*). Other species include Banyan (*Ficus bengalensis*), Ashwath (*Ficus religiosa*), Koroï (*Albizia spp.*), Ajuli (*Dillenia pentagyna*), Sonalu (*Cassia fistula*), Bohera (*Terminalia balarica*), Haritaki (*Terminalia chebula*), Kanchan (*Bauhinia acuminata*), Jarul (*Lagerstroemia speciosa*), Jam (*Syzygium spp.*), Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*), Guava (*Psidium guajava*), Pineapple (*Ananus sativa*), Lemon (*Citrus spp.*), Sharifa (*Anona squamosa*), and Grape fruit (*Citrus decumana*). A total of 36 families including 63 common plant species are present in the Sal Forests. According to an inventory estimate, Sal Forests have a growing stock of 3.25 million cubic meters of wood. A massive plantation programme under Social Forestry program is in progress on the basis of benefit sharing mechanism with the local communities residing in and around the forest area.

Important mammals include Jackal (*Canis auveus*), Bengal Fox (*Vulpes bengalensis*), Rhesus Macaque (*Macaca mulatta*), Jungle Cat (*Felis chaus*). Of the reptiles, Bengal Monitor Lizard (*Varanus bengalensis*) and Common Cobra (*Naja naja*) are important. A total of 220 species of wildlife including 12 amphibians, 25 reptiles, 148 birds and 35 mammal species are available in the Sal forests [10].

Management Approach in Sal Forests

The Sal forests are being managed in two working circles: (a) community forest working circle, and (b) commercial forest working circle [16]. In both circles, the silvicultural system prescribed is clear-felling followed by Simple Coppice and Coppice with Standard System.

The ban on felling in Sal forests has been continuing since 1972. The ban has been now extended for a further period of five years. The ban on Sal forests will continue until 2010 [10].

Table 5. Reed land areas in Sylhet Division of Bangladesh [16].

Range	Number of beat	Total area (ha)
North Sylhet 1	9	14493.16
North Sylhet 2	6	5837.27
Sunamgonj	3	3240.96
Total	18	23571.39

Reed Land Forests

The reed-land forest situated in the Sylhet Division of the country comprises a total area of 23571.39 hectares. Reed land areas are distributed in three ranges under 5 upazillas (sub-districts) namely Chattak & Dowarabazar of Sunamganj District and Gowainghat, Companigonj & Jaintapur of Sylhet District (Table 5).

Flora and Fauna

The reed lands are dominated by the reed swamp association known as Pajuban and consist of tall grasses mainly Nal (*Phragmites kakra*), Khagra (*Saccharum spontaneum*), and Ekra (*Eranthus ravannae*). Meadow grasses such as Binna (*Vetivera zizanioides*) dominate the open areas. Woody shrubs such as Shatamuli (*Asparagus racemosus*), Chitki (*Phyllanthus disticha*), and Baladumur (*Ficus heteriphylla*), occur with the tree vegetation sporadically found in higher ground and are generally of the scattered tree type. The main tree species include Hijal (*Barringhonia acutangula*), Karach (*Pongamia pinnata*), Barun (*Crataeva nurvata*), and Bhuri/Pitali (*Trewia nudiflora*).

The reed land areas are also very rich in faunal diversity. A survey reported 27 mammals, 49 birds, 22 reptiles and 9 amphibians from the reed-land forests. All of them are used as food, medicine, bait, for commercial trade and recre-

ation. The reed-land flood plains are also rich in fisheries resources. Due to indiscriminate harvesting, this reed resource is declining. The rate of depletion is as high as 60 per cent in particular areas [16].

Village Forests

The tree cover in village forests is 2, 70,000 hectares. A reasonable portion of the total demand of forest products is being met from homestead forest. According to the latest inventory report, the village woodlots have a growing stock of 54.7 million cubic meters [5]. Generally, Homestead or village forest is a land owned by a family and used as developing and as a production unit for plants, animals, fish, under integrated farming system in which continuous interaction takes place among man, trees, livestock, soil and water. It includes immediate area surrounding the dwelling unit [17]. Homestead farming is an age-old practice in Bangladesh [18] involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably, livestock, within the compounds of individual houses; the whole crop-tree-animal unit being intensively managed by family labor [19]. There are no village forests assigned to the villagers under the Forest Act in Bangladesh [20]. What are known as village forests or village groves in the country are these homesteads-- entirely private properties. About 70 percent of fuelwood and timber come from homesteads. Also, 90 percent of bamboos used in construction and cottage industries come from the homesteads [21].

The size of homestead forests varies within various farm categories. A positive correlation exists between the farm size and homestead size. The larger the farm, the larger the homestead. From a recent study it is found that the average farm size for various categories (i.e., large, medium, small, marginal and landless)

of landowner is 3.9 , 1.6, 0.6, 0.2 and 0.08 ha, respectively, whereas the average homestead size for various categories (i.e., large, medium, small, marginal and landless) is 0.3, 0.2, 0.15, 0.10 and 0.07 ha, respectively [22].

The number of plants per 100 m² area of homestead decreased gradually in the recent past from landless farm (3.45 plants/m²) to

large farm (1.85 plants/100 m²) [23]. But the average total number of plants per farm is more than twice the number in the large farms (57 plants/farm) compared to the landless farms (21 plants/farm). The lower number of plant species in the landless group of farms is due to a much smaller homestead than that in the large farms. It is felt that the farmers with limited land attempt to maximize output by planting trees in

Table 6. Some common species in the homestead forests of Bangladesh.

Category of plants	Local name	Scientific name
Trees (Fuelwood/timber)	Mahogany Koroi Eucalyptus Acacia Mangium Ipil-ipil Cham	<i>Swietenia mavorphylla</i> <i>Albizia spp.</i> <i>Eucalyptus camaldulensis</i> <i>Acacia auriculiformis</i> <i>Acacia Mangium</i> <i>Leucaena leucocephala</i> <i>Artocarpus chaplasha</i>
Fruit bearing plants	Am Kathal Peara Narikel Kul Supari Ata Sharifa Litchu Lebu Pepe Kala	<i>Mangifera indica</i> <i>Artocarpus heterophyllus</i> <i>Psidium guajava</i> <i>Cocos nucifera</i> <i>Ziziphus mauratiana</i> <i>Areca catechu</i> <i>Anona squamosa</i> <i>Anona reticulata</i> <i>Litchia chinensis</i> <i>Citrus spp.</i> <i>Carica papaya</i> <i>Musa sapientum</i>
Medicinal plants	Neem Arjun Amloki Bohera	<i>Azadirachta indica</i> <i>Terminalia arjuna</i> <i>Emblica officinalis</i> <i>Terminalia bellirica</i>
Non-wood species	Bash Bet Patipata	<i>Bambusa spp.</i> <i>Calamus spp.</i> <i>Schumannianthus dichotoma</i>
Fodder/forage	Ipil-ipil Akh	<i>Leucaena leucocephala</i> <i>Saccharum spp.</i>

closer spacing. Table 6 shows some of the common plant species grown in the homesteads of Bangladesh.

Major threats to forests

The following agents and reasons are the major threats to the natural forest resource, protected area as well as biodiversity of Bangladesh [5]:

- Destruction of habitat
- Overexploitation
- Indiscriminate use of agro-chemicals
- Oil spills
- Encroachment into the natural forests
- Change in land use pattern and land use conflict
- Indiscriminate hunting
- Poaching of animals
- Habitat destruction
- Lack of people's awareness
- Poor management of protected areas
- Lack of a plan for compatible forest and wildlife management
- Inefficient implementation of law for wildlife conservation
- Natural calamities (flooding, storm surge).

Conclusion

Bangladesh is a very densely populated country containing only 17.49% forestland. This forest area is not sufficient to meet the entire needs of the country. Applying proper cultural operations in the existing forest plantation can minimize this shortage of resource. The cultural farming practices in Bangladesh (i.e. weeding, mulching, vacancy filling, fertilization, pruning, thinning and salvage or sanitation cutting) should be initiated by the active participation of expert persons or manpower having sound knowledge of sustainable forest management. It is very difficult to suggest a unique/excellent model of management for forests in Ban-

gladesh. It is a continuous process and depends on many factors. Conservation, restoration of degraded forests, expansion, multiple use management, comanagement, benefit sharing, peoples' participation, stake holder participation, strict enforcement of laws, well defined property rights, provision for livelihoods of forest dependent people, maintaining cultural identity, re-location of settlers, soil and water conservation, research and education, resource security, biodiversity conservation, ecosystem management, eco-tourism, recreation are the various elements that can lead to better forest management. A societal consensus with strong political commitment and commitment of forest officials regarding forest management is the crying need of the hour.

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