1.2.2 Status of Species Diversity

Plate 12 : Fox tail Orchid (*Rhynchostylis retusa*) Found in Northestern part of the Country.

Bangladesh possesses a good species diversity of floral and fauna. The tropical semi-evergreen forests in the country are botanically amongst the richest in the Indian subcontinent, and they also support a good diversity of mammals and great diversity of birds. For a small country like Bangladesh, the species richness is relatively large but population size of most of the species has declined drastically.

Bangladesh possesses rich species diversity particularly for angiosperms and avifauna. It has been reported from previus studies that there are a total of 3,611 species of angiosperm available in Bangladesh. Out of which, 2,623 species under 158 families belong to dicotyledons and 988 species under 41 families belong to monocotyledons. As no systematic and complete survey has been done recently, it is very likely that the total number of angiosperm species may reach up to 5,000. Although endemism is relatively low for the country, the records suggest the existence of at least 16 endemic species of flowering plants in Bangladesh.

Table 1.5: Number of Species Identified in Various Groups of Plants

Plant group	Number of species described		
	World	Subcontinent	Bangladesh
Virus/Bacteria	8,050	850	470
Algae	40,000	7,175	1988 +
Fungi	72,000	14,500	275
Lichen	13,500	2,223	*
Bryophytes	14,500	2,500	248
Pteridophytes	10,000	1,200	195
Gymnosperms	650	67	7
Angiosperms	2,50,000	17,527	3,611

Source: Based on Encyclopedia of Flora and Fauna of Bangladesh (2007) and Indian Fourth National Report to CBD
* published record not available

A total of 653 fish species are recorded, of which 251 are freshwater fishes belonging to 61 families and 402 are estuarine and marine finfishes including sharks and rays. A total of 650 bird species have been reliably recorded in the country. The country is also inhabited by 34 amphibian and 154 reptile species. The mammalian species diversity in Bangladesh is represented by 121 species of mammals, however many of which are now endangered. A more detailed account of known species in different phyla is provided in following headings:

Cyanobacteria

The phylum Cyanobacteria represents the oldest group of autotrophic bacterial organisms. Species of Cyanobacteria are quite common in Bangladesh. A total 300 species of Cyanobacteria have been described yet.

Proteobacteria

The phylum Proteobacteria represents the largest phylogenetically coherent group of bacteria and includes many common species of gram-positive and gram-negative organisms of diverse significance. A total of 59 species have been identified and described so far in Bangladesh.

Firmicutes, Actinobacteria and Bactroidetes

In Bangladesh, 41 species under the phyla Firmicutes, 70 species under Actinobacteria and 1 species under Bactroidetes have so far been identified.

Fungi

Fungi include eukaryotic organisms containing true nuclei, characteristic of eukaryotic organisms. A total of 275 fungal species have been identified so far under 125 genera in Bangladesh.

Algae

Algae are primitive, autotrophic, thallophytic plants, having great variation in their size, morphology, reproduction and habitat. Having hot and humid environment with lots of water, Bangladesh supports a suitable habitat for numerous algal species.

Although the study of algae in Bangladesh have started only in the sixties and gained momentum in last few decades, thousands of species have been identified and described. In green algae or Chlorophyta alone, 1,988 species have been identified in Bangladesh (Ahmed *et al.,* 2007), many of them new to science. Other types of algal forms such as brown and red algae (division Charophyta to Rhodophyta) found in Bangladesh.

Plate 13: Endemic rose species *(Rosa involucrata)* found in wetlands.

Bryophytes

Bryophytes love to grow in shady and moist places and Bangladesh have it plentiful. Although no extensive survey have ever been carried out to appreciate the extent of occurrence of bryophytes in the country, but it seems obvious that Bangladesh is quite rich in bryophyte flora. In a recent compilation, Siddiqui *et al*. (2007) described 248 species of bryophytes under 34 families. The dominant species of bryophytes in the country found to be *Riccia*, with 45 species, out of which 34 species were new to science.

Pteridophytes

Pteridophytes or ferns are the most primitive form of vascular plant. A total of 195 species of Pteridophytes have been identified and described from the country (Siddiqui *et al*., 2007). These are distributed under 41 families.

Gymnosperms

In Bangladesh, the existence and diversity of gymnosperm species is reportedly very low. Only seven species of gymnosperm have been reported from Bangladesh, of which only five species are found in the wild (i.e. *Cycas pectinata, Podocarpus neriifolius, Gnetum latifolium* var. *funiculare, G. montanum, G. oblongum*).

Angiosperms

The first compilation of flora of Bangladesh was done by David Prain (1887-1944) in his famous book Bengal Plants (1903), where he described approximately 2,700 angiosperm species that also include flora of west Bengal, Bihar and Orissa of India. Later on, in several publications this number gone up to even 5,700 (GoB-

IUCN, 1992), in the recent publication (Ahmed *et al.* 2008), this number fixed at 3,611 under 198 families based on available literatures. This includes all angiospermic specie native or alien to Bangladesh, whether naturalized or commonly planted for economic or aesthetic purpose. Out of the 3,611 species of angiosperm, 2,623 species under 158 families belong to dicotyledons and 988 species under 41 families belong to monocotyledons.

Protozoa

The protozoans are a heterogeneous assemblage of microscopic single celled organisms. The number and diversity of protozoans is very great, about 175 species under 71 genera have yet been identified in Bangladesh, although no extensive search for identifying the protozoan have ever been carried out.

Table 1.6: Diversity of Faunal Species in Bangladesh Compared to World and Subcontinent

Taxonomic group	Number of Species Described		
	World	Subcontinent	Bangladesh
Protozoa	31,250	2,577	175
Porifera	4,562	500	29
Cnidaria	9,916	842	102
Ctenophora	100	12	10
Rotifera	2,500	330	76
Gastrotricha	3,000	100	4
Platyhelminthes	17,500	1,622	126
Nematoda	30,000	2,850	176
Mollusc a	66,535	5,072	479
Echinode rmata	6,000	765	46+
Arthopoda	987,949	68,389	5000+
Fish	21,723	2,546	653
Amphibians	5,150	248	34
Reptiles	5,817	460	154
Birds	9,026	1,232	650
Mammals	4,629	397	121

Source: Modified after Encyclopedia of Flora and Fauna of Bangladesh (2007) and Indian Fourth National Report to CBD.

Porifera

The sponges, which constitute the phylum Porifera, seem to be the most primitive among the metazoans. In Bangladesh 29 species have yet been identified under 13 genera.

Cnidaria

The phylum Cnidaria or Coelenterata includes the familiar hydras, sea anemones, obelias, corals and the jellyfish. In Bangladesh 102 species have been identified under 66 genera.

Ctenophora

The phylum Ctenophora includes a small group of free swimming planktonic marine animals. In Bangladesh 10 species have been identified under 7 genera.

Rotifera

In Bangladesh 76 species of rotifera, under 30 genera have been identified and described.

Gastrotricha

The phylum Gastrotricha includes small microscopic aquatic animals that often occur abundantly in freshwater and marine environment. In Bangladesh, only 4 species have been described under one genera.

Platyhelminthes and Nematoda

The phylum Platyhelminthes includes relatively simple, soft-bodied invertebrate animals. Although very little effort has been made so far towards its inventory, 126 species under 63 genera of Platyhelminthes have been identified (Kabir *et al*., 2008).

Nematodes are unsegmented roundworms. In total number, nematodes exceed even the insects, although in the number of known species, insect far outstrip the nematodes. In Bangladesh, only 176 species under 111 genera of Nematodes have so far been identified (Kabir *et al*., 2008).

Mollusca

Twenty land, 22 freshwater and 437 marine and brackish water mollusc species belonging to 210 genera, 105 families and 23 orders have been recorded in Bangladesh.

Plate 14 : Yellow monitor lizard *(Varanus flaveseens)* a rare monitor species of the country.

Echinodermata

There are five classes of living echinoderms. Four of these (Asteroidea, Echinoidea, Ophiuroidea and Holothuroidea) are free living and are able to move freely; the members of the class Crinoidea are stalked and remain attached during all or part of their lives. In Bangladesh, 46 species of echinoderms under 23 genera and 17 families have been described and many species are still waiting to be recorded and identified.

Arthropoda

185 species of crustaceans under 89 genera and 45 families have been described (Ahmed et al. 2008), however many more specimen is still waiting to be identified up to species level.

Out of possible millions of insecta species, 1,270 species under 708 genera have so far been identified and described from Bangladesh (Ahmed *et al.* 2008, Ahmed et al. 2009 and Kabir *et al*., 2008). Moreover, more than 2,000 tree dwelling species of insects have been listed by Forest Research Institute (Baksha, 2008).

Sixteen species of crabs have been reported so far in Bangladesh.

Fish

Bangladesh possesses very rich species diversity for both marine as well as freshwater fish species.

Freshwater fish

In freshwater alone, 251 species of freshwater fishes, belonging to 154 genera and 55 families can be found in the county.

Marine fish

Marine and coastal waters of Bangladesh are rich in the diversity of fish and shellfish resources. There are records of 402 species of finfish including sharks and rays.

Amphibians and Reptiles

The number of amphibians and reptiles that occur in Bangladesh is still an open question. However, Bangladesh has the largest living reptile (*Crocodylus porosus*), the longest poisonous snake (*Ophiophagus hannah*) and one of the longest snakes (*Python reticulatus*). Khan (1982) listed 19 amphibians and 124 reptiles. Later Sarker and Sarker (1988) listed 23 amphibians and 154 reptiles and again Khan (2004) revised the first list with 26 amphibians and 129 reptiles. However, the most recent (Kabir et al, 2009) listing described 34 amphibians under one order, 6 families and 20 genera and 154 reptiles under 3 orders, 20 families and 84 genera. Perhaps of greatest note are the 16 species of globally threatened freshwater turtles and terrapins that are found in Bangladesh.

Birds

The national list of the birds owns as many as 650 species (Siddiqui *et al.* 2008). Out of which, 620 species of birds have been recorded in recent years and can be asserted to be present today. Of these 620 species of birds, 143 are vagrant (occurring very irregularly or seen extremely rare) to Bangladesh, which left 477 regularly seen species.

Out of these 477 regular species, 301 are resident and 176 are seasonal visitor to Bangladesh. Out of 176 regularly occurring migratory species, 160 are winter visitors, six are summer visitors and 10 are spring or passage migrants to Bangladesh. According to relative abundance, Bangladesh has 143 vagrants, 176 rare, 103 uncommon and 198 common species of birds. Of these, 40 species that presently occur are globally threatened or near threatened, and a further 13 that are globally threatened have by now been extirpated in Bangladesh (Table 1.16).

Plate 15: Flock of Plovers in estuarine mud flats

Mammals

Wild mammals are the most threatened faunal group in Bangladesh. The national list of mammals holds 121 species under 35 families and 12 orders, of these 39 are globally threatened or near threatened but still occur or are believed to occur, while a further nine globally threatened species have been extirpated from Bangladesh.

1.2.3 Genetic Diversity

Genetic variation within a species is what allows populations to adapt in changed habitat and other local environmental conditions. Bangladesh has rich genetic resources and diversity of most of its species. This is more

evident of being centre of origin for some important agricultural crops. As an example, the floodplain of Bangladesh is thought to be the centre of origin of cultivated rice. An estimated 10,000 rice cultivars have been developed in the country. Bangladesh Rice Research Institute (BRRI) has so far collected 5,978 varieties of rice germplasms from the country. Most of the other cultivated crops have similar genetic diversity within themselves. This situation is also true for banana, mango and other local fruit species. Some 1,090 landraces of Dehsi jute (*Corchorus capsularis*) and 519 of Tossa jute (*Corchorus olitorius*) were reported to be scattered throughout Bangladesh, and there are 700 tea germplasm, 300 varieties of sugarcane, and so on. A list of germplasms collected by various research institutions are provide in Table 1.7. In the wild, the genetic diversity among the aquatic macrophytes found to be very high, this may be the cause of their resilience to cope in varying environmental conditions and hydrological regimes. Richness of genetic diversity in our medicinal plant species also worth mention here.

Plate 16: Red jungle fowl *(Gallus gallus)*, wild relative of the domesticated chicken.

An excellent and commercially valuable gene pool is present in the local chicken breeds. As a close relative to wildfowl they are highly resistant to most of the common diseases suffered by commercial breeds and as a consequence their gene pool is valuable for commercial exploitation.

Table 1.7 Germplasm Collections of Some Important Crops up to 2006

Research Institutions	Crop group	No. of accessions collected up to 2006
Bangladesh Agricultural Research Institute	Cereals other than rice	1,577
	Pulses	3,333
	Oilseeds	781
	Vegetables	3,516
	Spices	156
	Fruits	89
	Field Genebank	
	Fruits and Vegetables	197
	Sub-Total	9,649
Bangladesh RiceResearch institute	Rice (Cultivated and Wild)	6,259
Bangladesh Sugarcane Research Institute	Sugarcane (Wild and Cultivated)	1,362
Cotton Development Board	Cotton	490
Bangladesh Jute Research institute	Jute (Cultivated and Wild)	5,593
Bangladesh Tea Research institute	Tea (Cultivated and Wild)	475
Bangabandhu Sheikh Mujibur Rahman Agricultural university	Various Crops	764
East West Seed (Bd) Ltd.	Vegetables	6,443
	Total	**31,035**

Source: BARC (2007)

Genetic diversity of our freshwater fishes is also found to be very high.

Among the Rhesus macaque population of Bangladesh, seven different genotypes have been identified (Feeroz *et al.* 2008). Similar types of genetic variations are expected to be present in other primate populations in the country. Genetic diversity in Bengal Tiger and cetaceans are currently being investigated also.

1.3 Present status of Protected Area (PA) and Ecologically Critical Area (ECA) in Bangladesh

Bangladesh have Nineteen nationally designated protected areas comprising approximately 2,458 km^2, which is 1.66 percent of land area of the country. These include ten national parks, eight wildlife sanctuaries and one game reserve (all of which are forests). A detailed list of these areas is provided in the Table 1.8. A map showing the protected areas is given in Figure 1.5. Moreover, in 1997 UNESCO designated three wildlife sanctuaries of Sundarbans as "World Heritage Site". Sundarbans along with Tangua Haor were designated "Ramsar sites" wetlands of international importance in 1992 and in 2000, respectively. The objectives of managing these PAs are to preserve breeding places and habitats of flora and fauna and to protect communities and ecosystems. The aim is also to maintain natural processes as well as to provide facilities for research, education and recreation. In addition to *in-situ* categories of conservation areas such as National Parks, Wildlife Sanctuaries and Game Reserves, there are seven *ex-situ* conservation areas (Table 1.9) which are Botanical Gardens, Eco-parks and Safari Parks.

Plate 17: Royal Bengal Tiger *(Panthera tigris tigris)* the national animal of Bangladesh.

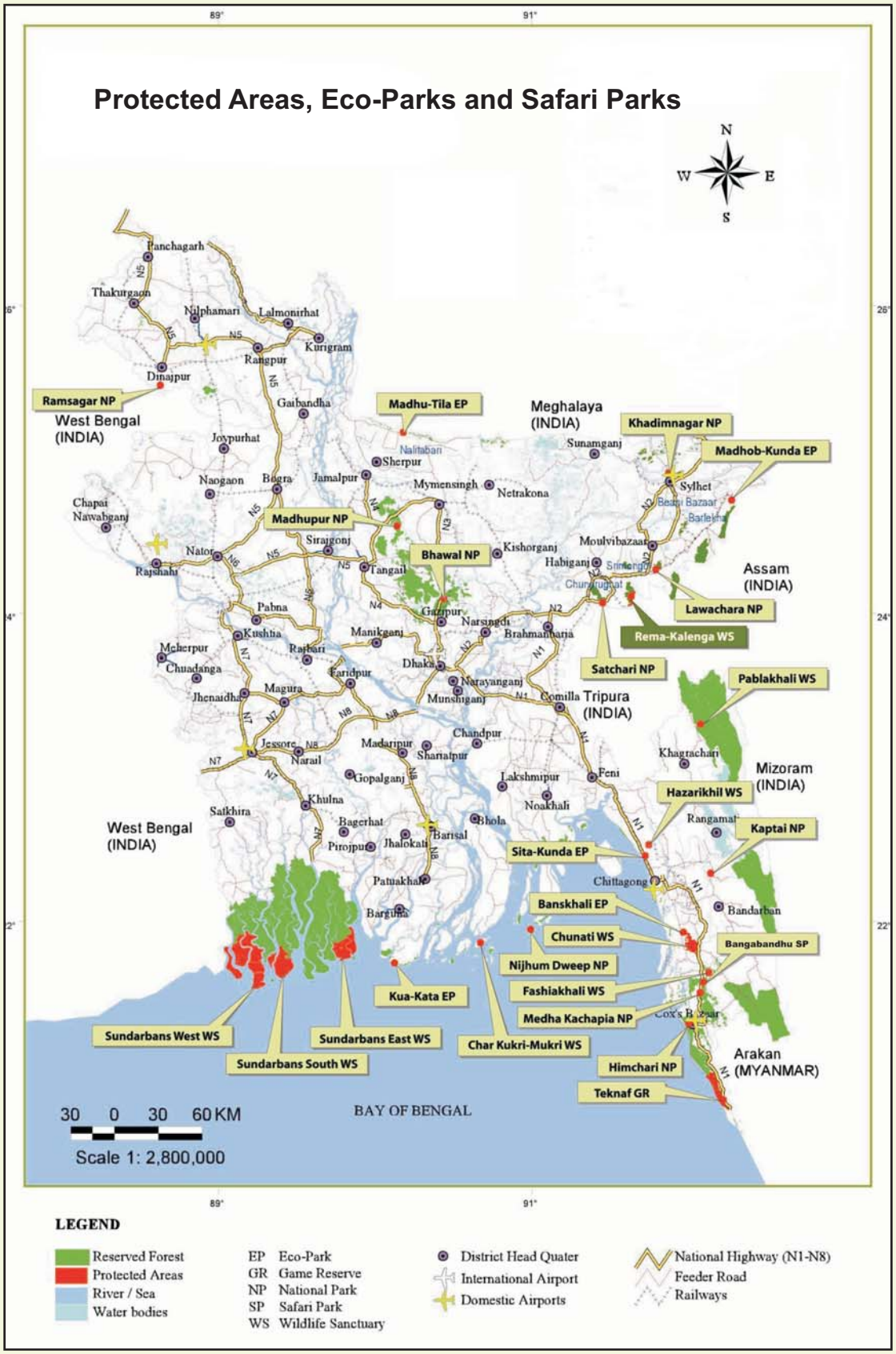


Figure 1.5 Protected Areas, Eco-parks and Safari Park of Bangladesh (Courtesy: Forest Department & IPAC)

Table 1.8: Protected Areas of Bangladesh

Name of Protected Areas	Habitat Types	Area (ha.)	Year of Notification
National Parks			
1. Ramsagar National Park	Wetland	28	2001
2. Himchari National Park	Mixed Evergreen	1,729	1980
3. Bhawal National Park	Deciduous Forest	5,022	1974/1982
4. Madhupur National Park	Deciduous Forest	8,436	1962/1982
5. Lawachara National Park	Mixed Evergreen	1,250	1996
6. Kaptai National Park	Wetland	5,464	1999
7. Nijhum Dweep National Park	Mangrove Forest	16,352	2001
8. Meda Kacchapia National Park	High Hill Mixed Forest	396	2004
9. Shatchari National Park	Evergreen	243	2006
10. Khadim Nagar National Park	Mixed Evergreen	679	2006
Wildlife Sanctuary			
11. Char Kukri-Mukri Wildlife Sanctuary	Char land & Mangrove Forest	40	1981
12. Pablakhali Wildlife Sanctuary	High Hill Mixed Forest	42,087	1962/1983
13. Chunati Wildlife Sanctuary	Mixed Evergreen Forest	7,764	1986
14. Sundarban East Wildlife Sanctuary *	Mangrove Forest	31,227	1960/1996
15. Sundarbans South Wildlife Sanctuary *	Mangrove Forest	36,970	1996
16. Sundarbans West Wildlife Sanctuary *	Mangrove Forest	71,502	1996
17. Rema-Kalenga Wildlife Sanctuary	Mixed Evergreen forest	1,796	1996
18. Fasiakhali Wildlife Sanctuary	Mixed Forest	1302	2007
Game Reserve			
19. Teknaf Game Reserve	Mixed forest	11,615	1983

* =also designated as RAMSAR Site (Sources: Forest Department)

Integrated Protected Area Co-management (IPAC)

Integrated Protected Area Co-Management (IPAC) Project is committed to develop a visible, recognizable national and integrated system of co-managed Protected Areas (PA) covering more than 367,500 hectares directly benefiting over two and a half million population. At least four major new protected areas and an expanded array of more than 50 PAs, including forests, wetlands and ecologically critical areas will come under co-management by the end of 2013. The activities envisioned in IPAC are:

- Development of a coherent strategy for integrated protected areas co-management and biodiversity conservation, through support for constituency building; visioning, policy analysis and strategy development; partnership building for sustainable financing; and development of an outreach and communication strategy with a focus on awareness raising
- Building stakeholder and institutional capacity, through support for training to GOB national and local level staff, NGOs and rural communities; strengthening of existing training centers and development of new and innovative applied training courses; and development of local support services for integrated, participatory co-management
- Site specific implementation of co-management in Protected Areas to continue field testing and institutionalization of proven approaches for integrated PA co-management in existing and new aquatic and terrestrial protected areas.

Table 1.9 Ex-situ Conservation Areas of Bangladesh

Name of Protected Areas	Habitat Types	Area (ha.)	Year of Notification
Eco-parks and Safari Park			
1. Bangabandhu Safari Park	High mixed forest	600	1999
2. Sitakunda Botanical Garden and Eco-park	High Hill Mixed forest	1,000	2000
3. Madhabkunda Eco-park	High Hill mixed forest	654	2001
4. Madhutila Eco-park	Deciduous Forest	125	2001
5. Murai Chara Eco-park	Mixed Evergreen	830	2001
Botanical Garden			
1. National Botanical Garden		84	1961
2. Balda Garden		1.37	1909

(*Source: Forest Department)*

Department of Environment (DoE) has, so far, designated nine areas significant for biological diversity as Ecologically Critical Areas (ECAs) in the country (Table 1.10 and Figure 1.6). The Department of Environment in September 2009 has declared four rivers and their banks as ECAs. These rivers namely, the Buriganga, Sitalakhya, Turag and Balu surround the capital city Dhaka (Table 1.10) and perform as the lifeline of the city.

In addition over 200 community organisations manage waterbodies following sustainable principles including protection of small sanctuaries within those waterbodies under agreements between the Ministry of Land and Ministry of Fisheries and Livestock. However, the PA network, in its broadest meaning, remains notably under-represented in terms of freshwater wetlands and coastal wetlands of the delta, considering their high biodiversity value and presence of threatened species

Table 1.10: Ecologically Critical Areas of Bangladesh

Name of the ECA	Type	Area (ha)	Year of declaration
1. Sundarbans (10 km periphery buffer around the forest)	Mangrove Forest	-	1999
2. Teknaf Peninsula	Sandy Beach	10,465	1999
3. St. Martin's Island	Coral Ecosystem	590	1999
4. Sonadia Island	Sand dunes	4,916	1999
5. Hakaluki Haor	Wetland	18,383	1999
6. Tangua Haor*	Wetland	9,727	1999
7. Marjat Baor, Jhenaidah	Oxbow Lake	200	1999
8. Gulshan-Baridhara Lake, Dhaka	Urban Wetland	-	2001
9. Rivers (Buriganga, Turag, Sitalakhya and Balu) around Dhaka city	River	-	2009

* = also designated as RAMSAR Site (Source: Department of Environment)

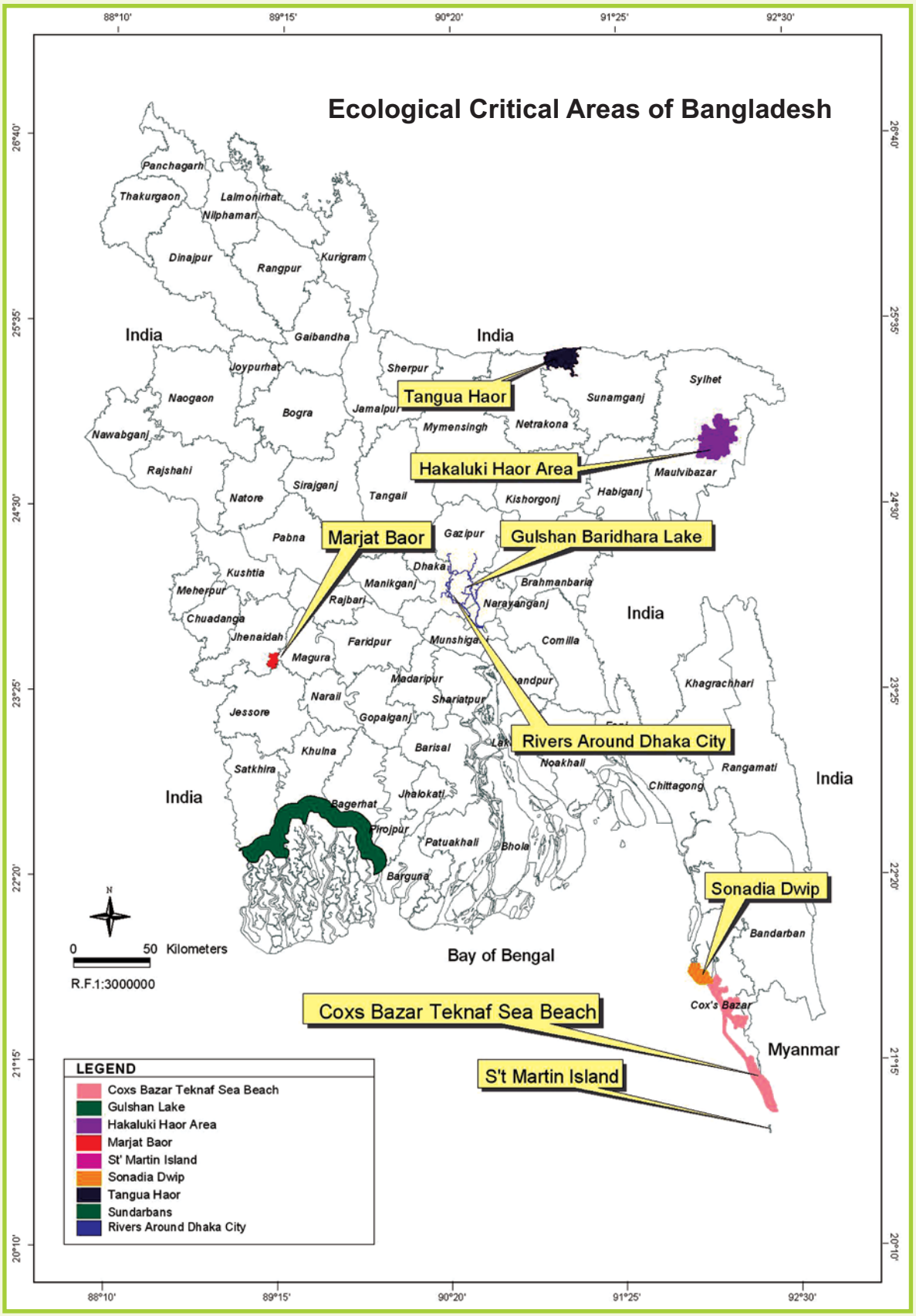


Figure 1.6 Ecologically Critical Areas of Bangladesh (CEGIS 2009).

1.4 Trends of Change in Biodiversity of Bangladesh

1.4.1 Changes in Ecosystems

1.4.1.1 Forest Ecosystem

Bangladesh's forests have decreased significantly in terms of both area and quality over the last few decades. The annual deforestation rate is estimated to be around 3.3% (Khan *et al.*, 2004). The increasing population of Bangladesh continues to put pressure on existing forest resources resulting in over exploitations. Present productivity of forest has declined to a range of 1.5-2.5 m^3 per hectare per annum from 7-8 m^3 per hectare per annum that was accounted twenty years ago (Forestry Master Plan, 1993). Moreover, canopy closure density, number of trees per hectare (Figure 1.7) and over all plant biodiversity has declined rapidly (FAO, 2000). As a consequence, the quality of the forestland as wildlife habitat has also been reduced.

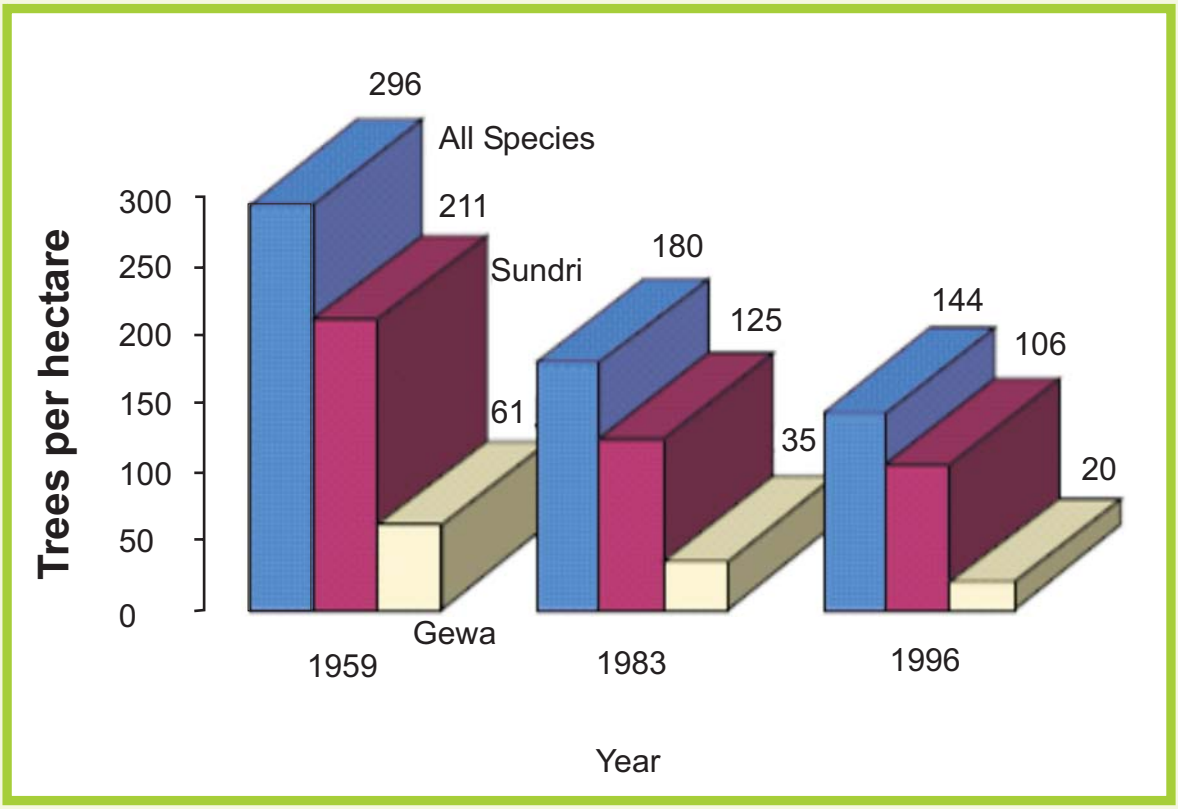


Figure 1.7 Tree densities in Sundarbans

Forest cover loss in the country has not been comprehensively studied until now and the quantification of this loss is largely assessed by periodic visual observations.

Deforestation trend could be visulized in Dinajpur forest division depicted in Figure 1.8. The map was produced by SPARRSO based on Northern Forest Division Map 1976 and Aerial Photo 2000.

Some scattered studies undertaken to assess the forest cover have been illustrated in following paragraphs and Figures 1.9 and 1.10. In this regard, two case studies, one on Madhupur (Deciduous Sal Forest) National Park and another on Sundarbans (Mangrove) Reserve Forest are presented to demonstrate deforestation trend in these forest areas of Bangladesh.

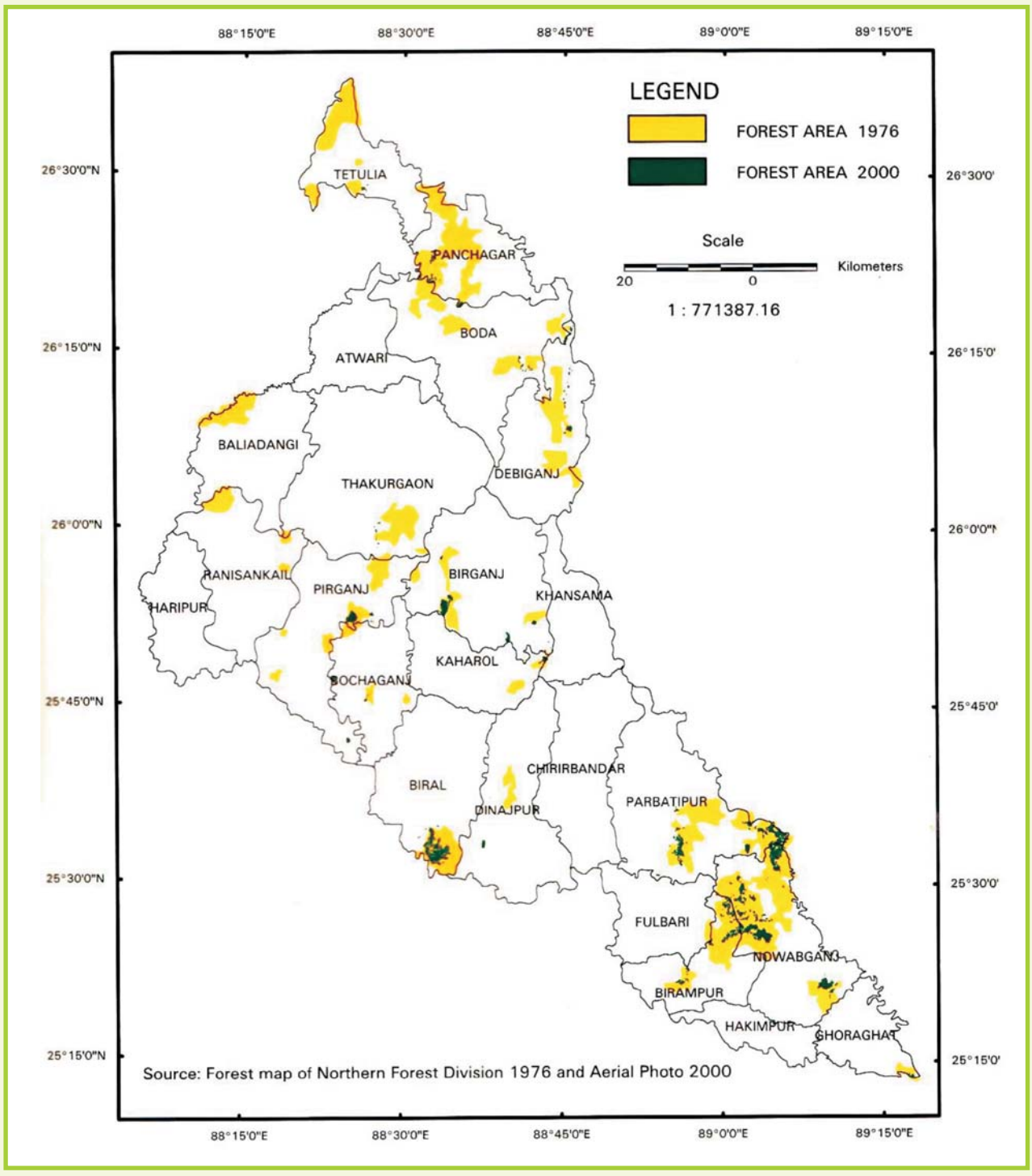


Figure 1.8 Deforestation of Dinajpur Forest Division (SPARRSO, 2005).

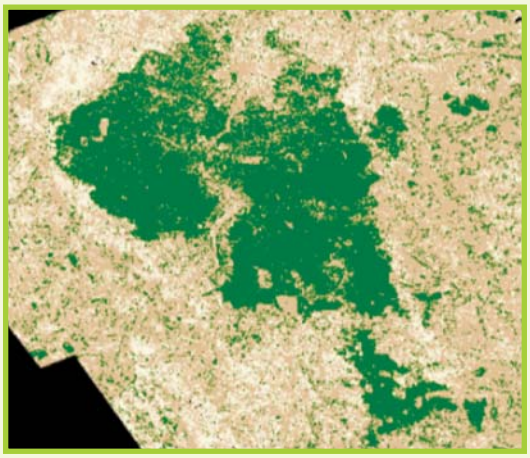
Changes in Landuse/Landcover in Madhupur National Park (MNP) between 1967 to 2007

Landuse/cover maps derived from satellite images of 1967, 1989, 1999 and 2007 are shown in Figure 1.10. The statistics of landuse/cover of the selected years derived from the time series satellite images are given in Table 1.11. The Table shows areas under different landuses/cover classes within the MNP area and a 1-km buffer around the MNP boundary.

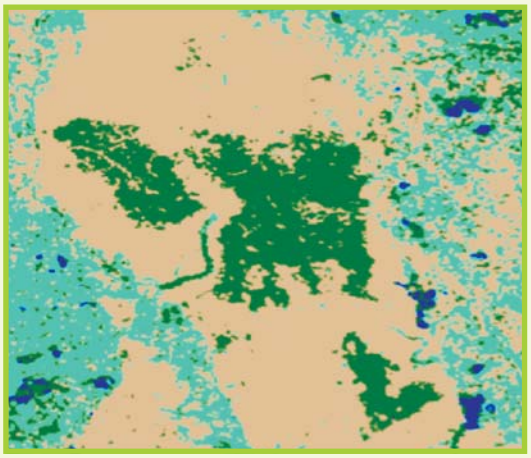
Plate 18: Deforestation due to agricultural practices.

In 1967 the total forest cover within the study area was found to be 8,875 ha which about 68.3% of the total study area . Between 1967 and 2007 it was found that the forest cover area gradually depleted and in 2007 it was found to comprise only 29.8% of the total study area. Most of the forest cover area has been converted to rubber plantations and some land is now cultivated or converted to rural settlements with homestead vegetation. It was found that the forest area had reduced by about 22.5% between 1967 and 1973. It should be noted that the 1967 image has a resolution of 12 m whereas the 1973 image is of very coarse resolution i.e. 80 m. Therefore, the area calculated from the 1973 image is much less than that of the 1967 image. An analysis of the image acquired in 1989 revealed that some forest areas that could not be identified from the coarse resolution satellite image of Landsat-MSS (80 m) acquired in 1973 were actually visible in the 1989 image. This kind of difference is expected when images of different resolution are used for comparison. Images of 1989, 1999 and 2007 are of very similar resolution and hence are more comparable. It has been found that between 1989 and 2007 there is a further reduction in forest area of 14%.

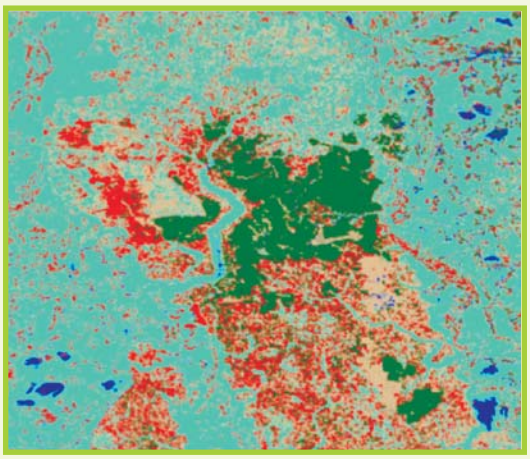
Between 1989 to 1999, a large amount of forest cover was converted to rubber plantations. The rubber plantation area increased from 4.7% in 1989 to 12.7% in 1999.



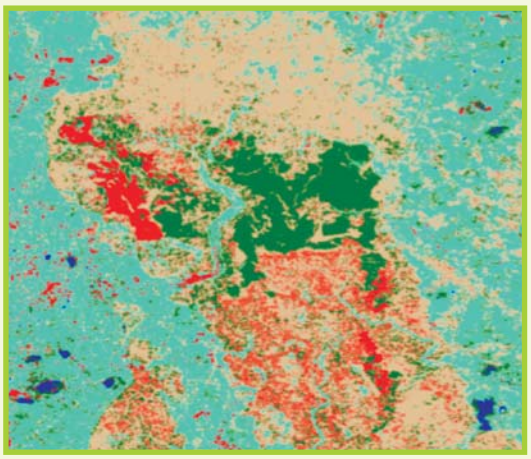
a. Corona 1962.



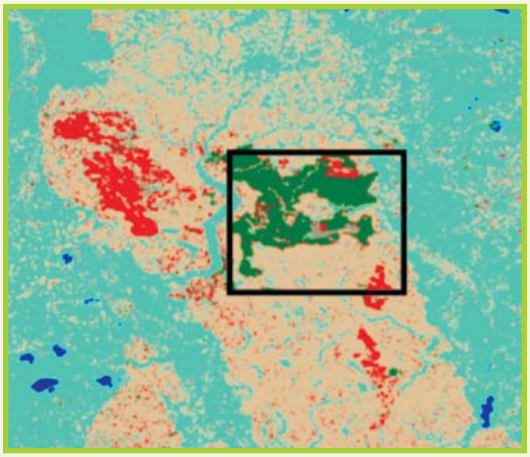
b. Landsat MSS 1977.



c. Landsat TM 1997.



d. ASTER 2002



e. Landsat TM 2003

Figure 1.9 Forest Distribution in Madhupur Tract Area. Source: Islam (2009)

Table 1.11 Changes of Landcover within MNP and 1 km. Buffer of the Area

Landuse/cover	Year									
	1967		1973		1989		1999		2007	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Forest cover	8875	68.3	6011	45.7	5718	43.8	4360	33.5	3879	29.8
Rubber plantation					612	4.7	1656	12.7	1537	11.8
Agriculture land					5808	44.5	5901	45.3	6172	47.3
Settlements with vegetation					545	4.2	874	6.7	1165	8.9
Water					211	1.6	101	0.8	115	0.9
Seasonal water bodies					94	0.7	68	0.5	95	0.7
Others	4128	31.7	7128	54.3	76	0.6	69	0.5	73	0.6
Total	**13,003**	**100**	**13,139**	**100**	**13,064**	**100**	**13,029**	**100**	**13,036**	**100**

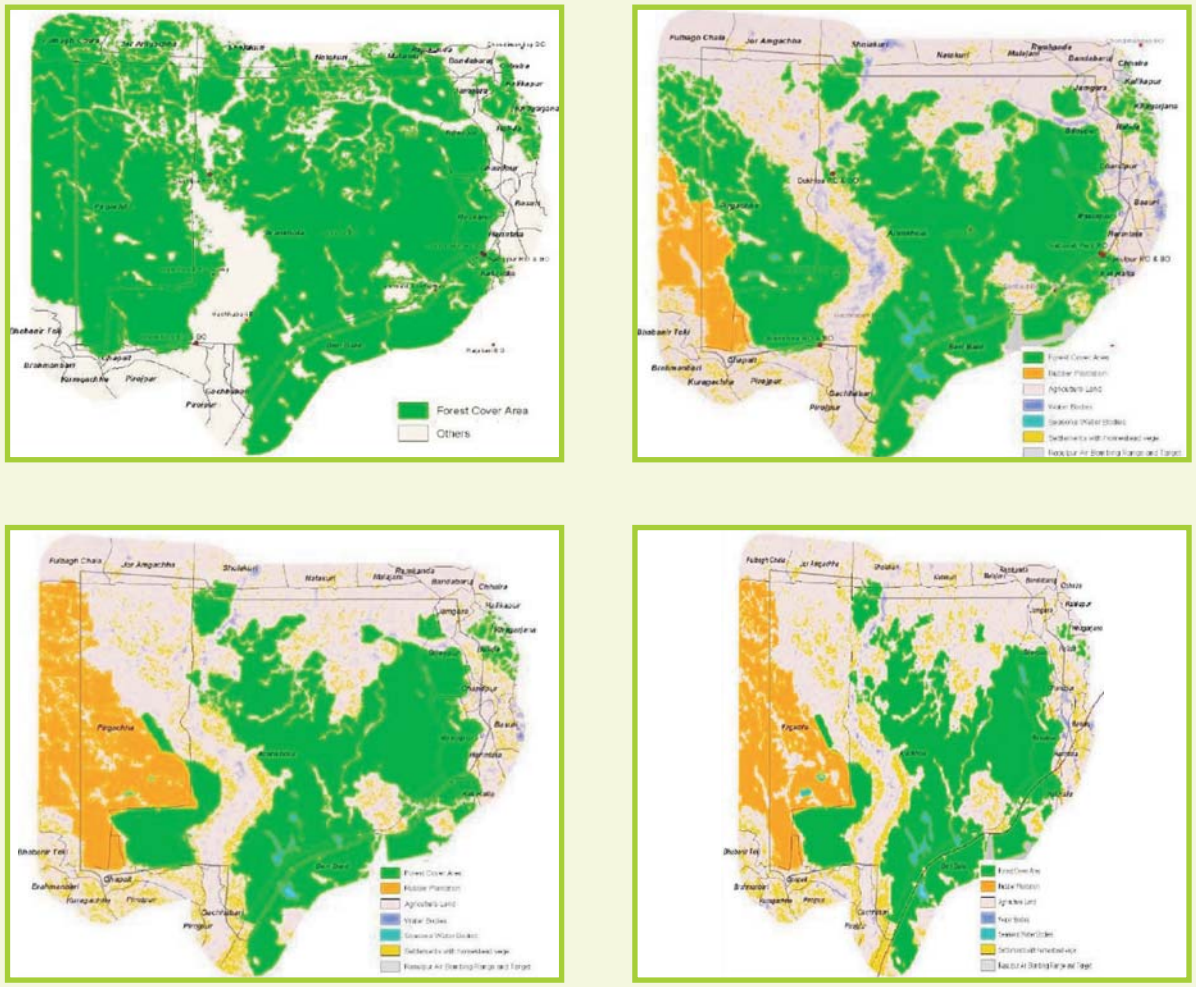


Figure 1.10 Landuse/cover maps of MNP Derived from Satellite Images of 1967, 1989, 1999 and 2007. Source: FD/CEGIS

Changes in the Coastal Mangrove Forests (The Sundarbans)

The pattern of vegetation succession in the Sundarbans depends upon the development stages of the land building process under particular sets of the fluvial regime. Salinity gradients, which in turn depend on the quantity of freshwater flushing from the upstream, also play an important role in shaping the vegetation development. The Sundarbans vegetation consists of recurrent patches of vegetation types. Overall, the mosaic formed by these patches represents the equilibrium for the whole ecosystem. It is, however, argued that the mosaic of forest types represents the serial stages towards an equilibrium condition of vegetation development. Depending on the stresses, both biotic and abiotic including management conditions, there are a number of self-maintaining terminal stages of vegetation development, which differ from the traditional concept of climax. The most favourable development of vegetation occurs in the freshwater dominated area where the Sundri (Heritiera fomes) is the dominant plant. Another extreme condition under the high salinity terminal community is dominated by the Goran (Ceriops decandra), which is a thicket of scrub. In both cases, grasses and/or trees dominate the initiating and pioneer stage of vegetation development.

The floristic composition of different successions depends upon the species niche and the physical conditions of each specific site. At the present level of information, potential changes in hydrology due to the changing flow of freshwater from upstream could best be understood by a comparison of salinity of the eastern region with that of the western region and its significance on the structural characteristics of vegetation.

Trend of coastal mangrove forest composition has been assessed by CEGIS between 1985 and 1995 using data obtained from the Forest Department as two vegetation maps depicting polygons of different dominant plant communities. The vegetation class codes are presented in Table 1.13 and the changes, detected by overlaying the two maps, are provided in Table 1.14 and Figure 1.11. Table 1.15 provides the comparison matrix between the years 1985 and 1995.

During this period, major changes have occurred in the Sundri and Gewa (Excoecaria agallocha) dominated areas. Gewa is gradually replacing Sundri as the dominant tree species. Pure Sundri dominated areas reduced by about 86 km^2 or about 11 percent of their previous extent, most of which are converted into the Sundri-Gewa and Sundri-Passur-Kankra (Heritiera fomes-Xylocarpus mekongensis-Bruguiera gymnorrhiza) community.

Plate 19: Bengal tiger in its natural habitat.

Tiger Action Plan

Bangladesh Government has recently published its first Tiger Action Plan to protect its national animal. The Bangladesh Tiger Action Plan (BTAP) marks the beginning of a structured approach to achieving long-term conservation of tigers in Bangladesh. The BTAP is a policy-level document that provides a vision, goals, and objectives to guide an integrated and focused tiger conservation programme. The vision is to ensure protected tiger landscapes in Bangladesh, where wild tigers thrive at optimum carrying capacities and which continue to provide essential ecological services to mankind. Bangladesh Forest Department in association with the Wildlife Trust of Bangladesh (WTB) has taken initiatives to implement the Action Plan for conservation of the flagship species.

The Sundri-Gewa community also followed a decreasing trend, as it lost 146 km^2 or more than 10 percent of its land to the Gewa-Sundri and Gewa-Mathal (Gewa Coppice) community. Therefore, the overall shift is from Sundri to Gewa and from Gewa to other more saline tolerant species. A similar trend is also visible even in the higher saline zone where the high saline loving Goran (Ceriops decandra) is replacing the Gewa and Sundri. Keora (Sonneratia apetala) dominated areas have also increased from 37 km^2 to 79 km^2 resulting in an expansion of 43 km^2 or 110 percent. Grass and bare ground areas also increased by about 15 km^2.

The general trend during this ten-year period indicates the reduction of important tree species like the Sundri and Gewa and increase of smaller tree species. From Figure 1.13, it is evident that the changes that occurred during this period are mostly concentrated in the eastern part of the Sundarbans. This might be because of a changed salinity regime there due to decreasing freshwater influx from the Gorai River. The vegetation community in the western region seems to be more stable as the hydrological regime in this area remained stable during the period.

Plate 20: Pneumatophore, the main characteristics of mangroves

Plate 21 : Kingfisher in Sundarban Forest

Table 1.12: Change of Vegetation Cover (in km^2) of in Sundarbans from 1985 to 1995

Vegetation communities	1995	1985	Difference	% area of 1985 remaining unchanged in 1995	% area of 1995 remaining unchanged from 1985
Water	4.46		4.46		
Sundri	750.30	836.50	- 86.20	72.70	81.05
Sundri-Gewa	1061.70	1208.29	-146.59	66.70	75.91
Sundri-Passur	24.71	21.84	2.88	77.40	68.39
Sundri-Passur-Kankra	73.94	67.32	6.63	85.18	77.54
Gewa and Gewa - Mathal (Coppice)	213.86	193.40	20.46	56.05	50.69
Gewa-Goran	348.96	373.70	- 24.74	73.52	78.74
Gewa-Sundri	764.83	597.97	166.86	70.44	55.07
Goran	83.34	85.50	- 2.16	65.35	67.04
Goran-Gewa	563.70	5 71.87	- 8.17	86.87	88.13
Passur-Kankra	2.86	9.55	- 6.70	15.65	52.36
Passur-Kankra-Baen	25.85	16.77	9.08	78.29	50.80
Baen	11.47	9.28	2.19	32.48	26.28
Keora	79.32	36.61	42.71	75.62	34.91
Grass and Bare Ground	58.91	43.68	15.23	38.63	28.64
Tree Plantation	2.10	3.52	- 1.42	31.20	52.26
Sandbar	9.45	3.97	5.49	26.54	11.14

Source: Forest Department

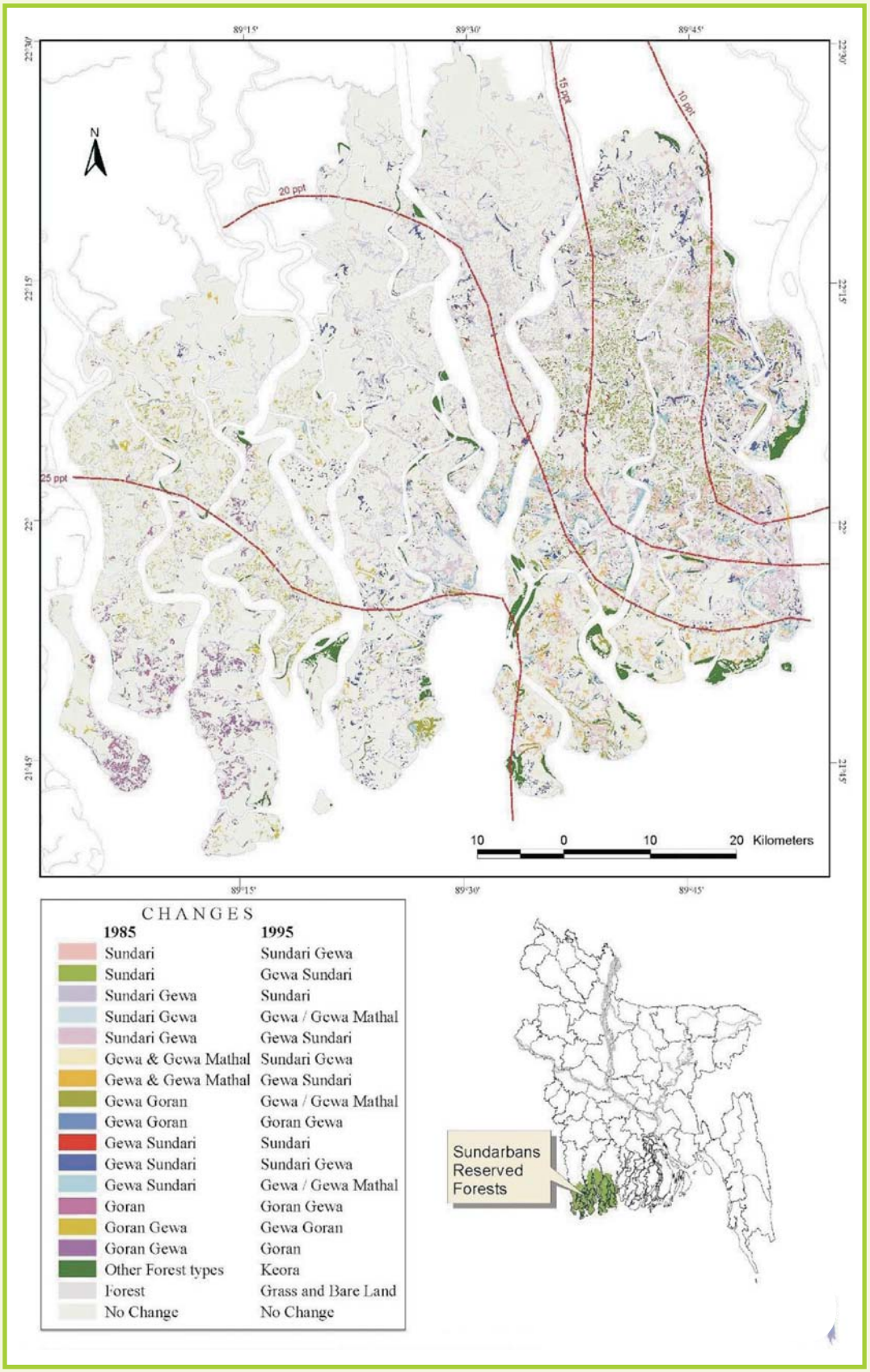


Figure 1.11 Changes of Vegetation Cover in Sundarbans Between 1985 and 1995

Swamp forest

A detailed account on the status and distribution of swamp forest of Bangladesh does not exist. Some larger patches are listed with the revenue officers of the districts; these are leased out, mostly to jalmohal owners.

Degradation of swamp forest continued until mid eighties of last century, later government in association with NGOs and local communities took the initiative to re-establish some of these forest patches.

CNRS initiatives to promote swamp plantation

CNRS has been taking part to support restoration and sustainable management of swamp forests in the *Haor* basin. The NGO took initiative to restore at least 30 small patches of swamp forests having more than 1 million plants in 800 ha areas.

The initiatives include awareness campaign, plantation programme, habitat restoration and other related conservation activities. In addition the declaration of Tangua Haor as a Ramsar site has helped to protect one of the remnant swamp forests in the country.

Plate 22: Age-old Hijal (*Barringtonia acutangula*) tree in the middle of a haor in Sunamganj district.

1.4.1.2 Wetland Ecosystem

Over the last three decades, massive physical infrastructures in the form of rural road and flood embankments have been developed in the wetlands including floodplains and haor areas. Many of these infrastructures have disregarded local topographic condition and natural water flow direction, which have often resulted in loss of connectivity, enhanced drainage and reclamation of wetlands, and in other areas waterlogging; all have affected the local surface water regime. The critical point of such development activities in the wetlands led the transformation very rapidly at a massive scale. In the Ganges-Brahmaputra floodplain area, about 2.1 million hectares of wetland have been lost to Flood Control, Drainage and Irrigation development projects (FCDI). Human interference in the wetlands has been damaging the fragile ecosystem and to long-term sustainability of the wetlands. For instance, in the southwest brackish water coastal plains of Bangladesh farmers used to have a single paddy crop during monsoon when surface saline layer depletes due to heavy rainfall and for rest of the months the fields were left for grazing. The practice of this culture evolved and was enriched by local knowledge for centuries. However, in the last two decades, this entire practice has been abandoned to provide space for more profitable shrimp farming. As a result, local ecosystems changed because of changed water exchange system, rapid siltation of the channels and continuous inundation of land with saline water.

In the haor areas, large scale settlement was initiated at the mid-20th century from surrounding

CWBMP initiatives under DOE

Establishing an innovative management system to ensure conservation and sustainable use of biodiversity resources of Ecologically Critical Areas (ECAs) of Bangladesh, the Deaprtment of Environment with assistance from UDNP-GEF has been implementing the “Coastal and Wetland Biodiversity Management Project in four ECAs of the country, namely Teknaf Peninsula, Sonadia Island, St. Martin's Island and Hakaluki Haor. The project has established ECA Management Units at the sites, formed Village Conservation Groups (VCGs) with the participation of local communities, formed ECA Coordination Committees at Union, Upazila and District levels and developed ECA wise Conservation Management Plans (CMPs). The project is implementing activities for conservation of significant biodiversity and restoration of habitats according to the CMPs. The project is working towards building capacity of local people on biodiversity conservation, organization management and providing training, as well as, financial assistance to CBOs for generating alternative income sources.

densely populated regions and since then the resources of the haor basins are being exploited at an increasing rate causing adverse effects. Continuous exploitation of aquatic vegetation and fruits like Makna (*Euryale ferox*), Singara (*Trapa bispinosa*), Lotus, Waterlily, Hogla (*Typha elephantina*) has caused serious degradation of the quantity and quality of the habitat required for fish and migratory birds in the haor areas. Similarly, embankment constructed for FCDI projects reduced floodplains and made obstacles to fish movement and migration from rivers as well as beels to the remaining floodplains for feeding and breeding. As a result, many fishers have lost their livelihood.

MACH Project accomplishments

- Promoted policy-level coordination among the government ministries, the NGO community and donors. Encouraged and effected cooperative approach to policy change through the Bangladesh Wetlands Network.
- Helped form Resource Management Organizations around entire continuous wetlands or around portions of larger wetland areas bringing together diverse groups of resources users.
- Obtained a total of 24 water bodies handed over to MACH-supported Resource Management Organizations for improved management and conservation.
- Led development of co-management between local communities (Resource Management Organizations), Union Parishads, and Upazila administrations through Upazila level committees.
- Restored wetland habitat excavating 57 ha of beels and 31 km of canals, and planted over 644,000 trees (including 153,000 swamp forest trees) reducing siltation, providing future habitat and potentially boosting community yield from the trees.
- Establisehd the first substantial permanent community managed wetland sanctuary in 100 ha of Hail Haor.
- Left endowment funds to support communities to continue these practices indefinitely.
- Influenced adoption of effluent treatment plants and changes in some polluting manufacturing processes.
- Worked on degraded hilly areas to address land use issues radically improving watershed management practices with selected.
- Prepared the first economic valuation of wetlands assets in Bangladesh showing that the very poor are the biggest beneficiaries of improved ecosystems.

As a whole, degradation of wetlands has caused several problems including extinction and reduction of wildlife, extinction of many indigenous wild and domesticated rice varieties, loss of many indigenous aquatic plants, herbs, shrubs and weeds, loss of natural soil nutrients, loss of natural water reservoirs and of their resultant benefits, increase in the occurrence of flooding and degeneration of wetland based ecosystems, occupations, socio-economic institutions and cultures.

However, some noteworthy endeavours can be mentioned both from government and NGO sectors in restoration of wetland habitat in the country. CWBMP has been working in several inland and coastal wetlands to protect biodiversity thereof involving local communities. MACH was another project where ecosystem protection approach was used to conserve the habitat and its resources. CBRMP programme of LGED is also working on fisheries restoration and resource management.

1.4.1.3 Homestead ecosystem

The area of settlement and consequently homestead vegetation is growing gradually for the last few decades with population growth, resulting in loss of other ecosystems. However, tree density of the homesteads has increased in the recent past. A comparison between the first village forest assessment conducted in 1981 (Hammermaster, 1981) and the recently conducted national forest and tree resources assessment 2005-2007 have shown this increase up to 300% in volume in certain parts of the country. Comparison of volume between the inventory of 1981 and 2007 is shown in Table 1.15. However, the quality of the homestead ecosystem has declined rapidly, because of the commercialization of the land. Species diversity reduces drastically with rapid increase of commercially valuable species. Loss of plant species diversity also reduces the quality of wildlife habitat by reducing food sources and other microhabitats essential for supporting the integrity of the food chain.

Table 1.13 Comparison of Gross Wood Volume per hectare in VFI 1981 with NFA 2005-2007

Strata (Division)	Village Forest inventory 1981 Gross Volume per hectare (Mm^3/ha)	NFA Inventory 2005-2007 Gross Volume per hectare (Mm^3/ha)	Percent increase
Rajshahi	3.85	5.93	54
Dhaka	3.76	6.58	72
Jessore	4.82	17.03	252
Barisal	5.55	24.03	333
Chittagong	7.0	16.14	131
Sylhet	2.04	4.90	141

1.4.1.4 Coastal and Marine Ecosystem

The coastal zone including the world's largest stretch of mangrove ecosystem, the Sundarbans (declared as Ramsar Site in 1997), is facing a serious threat of loss of biodiversity due to change in climate. Other issues of ecosystem health that are common throughout the coast are: environmental stresses on the Bay of Bengal's water quality; the degradation of many of the coral, mangrove, wetland and seagrass bed habitats that support fisheries; and the use of fishing gear that may affect the long-term sustainability of the fisheries resources.

Northward penetration of the salinity front due to climate change would result in further salinity induced succession problems in the Sundarbans and as a result, the symbiotic process in the entire ecosystem would change completely. Since the rate of these changes are much higher compared to the rates at which forest species migrate to suitable places, the size of the (actual) forest will be less compared to its present size. The major rivers bring in large concentrations of pollutants from agricultural pesticides and industrial waste that damage fish spawning and nursery areas, cause death of fishes and lead to possible changes in trophic structure.

Plate 23: a. Hachery operation (upper plate), b. Turtle hatchlings heading towards sea (lower plate)

CNRS is involved in sea turtle conservation activities at the southeast coastal region of Bangladesh. As of June 2009, they released 133,205 hatchlings into the Bay of Bengal.

High levels of pesticides can be found along the coast, especially near cities and ports. Input of freshwater from upstream and silt influence the pollutant dilution and salinity of the coastal and estuarine waters as well as coastal circulation patterns. It is also seriously threatening the existence of the corals at their one site in the country. Moreover pollutants from the substantial and largely unregulated ship-breaking industry pose an unquantified hazard to coastal and marine life. Development in the coastal zone is set to continue to threaten ecosystems and biodiversity. The rapid growth of the domestic tourism industry has harmful impacts in St Martin'sIsland and Cox's Bazar including collection of shells and corals. A deep water port has recently been proposed for Sonadia Island ECA, one of the very few coastal protected areas and main site of wintering Spon-billed Sandpipers. More generally the huge population burden and associated poverty, unsustainable fishing practices and a decline in income from fisheries are contributing to crisis generation. Other activities like tourism, collection of sand and stone is also hampering the marine environment.

1.4.1.5 Trends of Agro-Ecosystem

Recent research findings have indicated a rising trend of imbalance and indiscriminate use of agricultural inputs, which has already created a threat to the proper functioning of the country's agroecosystems. Land degradation due to over utilization, landuse change and construction of various man-made infrastructures has

aggravated this situation in most of the agroecological regions of the country. Moreover, with the ensuing threat of climatic change, existing agroecosystems of the country could be under heavy pressure to feed the population.

1.4.2 Trends of Species Diversity

For a small country like Bangladesh, the species richness is relatively large but population size of most of the species are gradually declining. Twenty three species of globally threatened mammals, birds and reptiles are so far extinct from Bangladesh (and non-threatened species would expand this list). A list of these species is

Table 1.14 Globally Threatened Species of Mammals, Birds, and Reptiles that are now Considered to be Extirpated from Bangladesh

Scientific Name	English Name	Status	Comment
Macaca arctides	Stump-tailed Macaque	VU	Occurred in SE forests, no recent records
Melursus ursinus	Sloth Bear	VU	
Dicerorhinus sumatrensis	Sumatran Rhinoceros	CR	Last record 1867, SE
Rhinoceros sondaicus	Javan Rhinoceros	CR	Sundarbans in 19th century, also shot in NE in early 20th century
Rhinoceros unicornis	Indian Rhinoceros	VU	Last record 1908, once occurred across northern half of Bangladesh
Bos gaurus	Gaur	VU	Last resident records about time of 1971 liberation war, may still stray over border
Bos javanicus	Banteng	EN	Once occurred in SE
Bubalus arnee	Asian Buffalo	EN	Occurred up to mid 20th century
Rucervus duvaucelii	Barashingha	VU	Apparently occurred in past
Francolinus gularis	Swamp Francolin	VU	Formerly in Sundarbans
Pavo muticus	Green Peafowl	EN	Formerly in hilltracts
Cairina scutulata	White-winged Duck	EN	Up to 1980s in hilltracts
Rhodonessa caryophyllacea	Pink-headed Duck	CR	Probably globally extinct, last Bangladesh records in 1930s
Houbaropsis bengalensis	Bengal Florican	CR	In 19th century in Dhaka division
Sypheotides indicus	Les ser Florican	EN	Recorded in 19th century
Grus antigone	Sarus Crane	VU	Only recent records are vagrants
Sarcogyps calvus	Red-headed Vulture	CR	Recorded into early 20th century, as with other Asian vultures now in a global catastrophic decline
Pelecanus philippensis	Spot-billed Pelican	NT	Recorded in 19th century
Prinia burnesii	Rufous-vented Prinia	NT	No recent records
Chaetornis striatua	Bristled Grassbird	VU	Last record mid 20th century
Paradoxornis flavirostris	Black-breasted Parrotbill	VU	Last reco rds in 19th century
Elachistodon westermann	Indian Egg-eating Snake	DD	Collected in Rangpur in mid 20th century, no other records
Crocodylus palustris	Broad-snouted Crocodile (Mugger)	VU	Extirpated in wild, captive breeding attempts

Note : Global threat status is taken from IUCN 2010, IUCN Red List of Threatened Species, Version 2010.1. www.iucnredlist.org. Downloaded on 22 March 2010;
Sources for distribution and comments include relevant volumes of: Siddiqui, K.U., Islam, M.A., Kabir, S.M.H., Ahmad, M., Ahmed, A.T.A., Rahman, A.K.A., Haque, E.U., Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A. Khondker, M., & Rahman, M.M. (eds.) (2008-9) Encyclopedia of flora and fauna of Bangladesh. Dhaka: Asiatic Society of Bangladesh. IUCN Bangladesh. (2000).
Red Book of Threatened Wildlife of Bangladesh. IUCN The World Conservation Union, Dhaka; This list does not include other species that have also been extirpated in Bangladesh but are not globally threatened;
Sequence follows that of Siddiqui et al. Scientific names follow IUCN Red List;
English names follow Siddiqui et al. with alternate names from IUCN Red List also given.

provided in Table 1.16. Among this list, except Pink-headed Duck, which suffered global extinction, all other species are locally extinct.

1.4.2.1 Flora

There is a common conception that floral diversity is being lost, although no scientific surveys for this purpose have been conducted in the recent past. The number of angiosperm flora described in the recently published *Encyclopaedia of Flora and Fauna* is 3,611. According to its authors (Ahmed *et al*., 2008), at least one fourth of these species are very rare and many not seen or collected after their first collection about 100 or more years ago. As an exercise, they have carried out an analysis on family Lamiaceae and found that out of 77 wild species, 27 species have not been reported in the past several decades. Similar situation is also observed for genus *Hoya* (a genus of 200-300 species of climbing plants in Apocynaceae family, native to Southern Asia), in which out of 9 species which were reported earlier only one has been found in recent past. Many of the endemic flora have not been collected or reported since they were first described. Bangladesh National Herbarium (2001) published a Red Data Book of Vascular Plants of Bangladesh listing 106 species of threatened plant species of various categories. A second volume of Red Data Book of Vascular Plants of Bangladesh is also under preparation.

Table 1.15 National Status of Inland and Resident Vertebrates of Bangladesh (IUCN, 2000; Siddiqui et al 2008)

Group	Species	Extinct in Bangladesh	Threat category (national)				Data Deficient (DD)
			Critically Endangered (CR)	Endangered (EN)	Vulnerable (VU)	Total	
Fishes	653	0	12	28	14	54	66
Amphibians	34	0	0	3	5	8	7
Reptiles	154	1	12	24	22	58	39
Birds	650	30	19	18	4	41	158
Mammals	120	10	21	13	6	40	53
Total	1611	41	**64**	**86**	**51**	**201**	**323**

Note: this table does not consider all globally threatened species of these groups occurring in Bangladesh. For further details of globally threatened species see Table 1.1

1.4.2.2 Fauna

Status and threats of wildlife as described by IUCN (2000) is shown in Table 1.15

Mammals

A high proportion of the native mammal species of the country are threatened with extinction in one way or another (32% globally threatened, 33% nationally threatened), and 8% have already been lost. It is evident from the Table 1.17 that mammals are the most threatened group of wildlife. Most of the larger mammals are either extinct from the country or on the verge of being so.

Birds

Of the 30 species of birds with historic records from Bangladesh and that have become nationally extinct, only one species (Pink-headed Duck) has likely become globally extinct. The remaining 29 species of birds that have become extinct locally continue to occur elsewhere in the region. However, 6% of the recorded avifauna are globally threatened, and Bangladesh hosts significant populations for some migratory species, for which the national red list is incomplete as it did not fully consider species for which Bangaldesh is a wintering ground.

Plate 24: Domesticated form of Gaur (*Bon gaurus*) by indigenous people.(Wild forms still exist at the border areas of Banderbans)

Amphibians and Reptiles

The diversity of both amphibians and reptile species is declining fast due to the destruction of their habitats. It is highly probable that many amphibian species may become extinct even before the discovery of their presence in Bangladesh. Also 17% of reptile species are globally threatened and many freshwater turtles are likely to be on the brink of national extinction.

Invertebrates

Invertebrate population and diversity in the country is reducing. Although few studies have yet been carried out in this regard, indiscriminate use of agricultural chemicals, especially chemical fertilizers, herbicides and pesticides are the main cause of declining trends of invertebrate population of the country.

1.4.3 Trends of Genetic Diversity

Plate 25: Green Frog *(Euphlyctis hexadactylus)*

Genetic diversity of different crops and cereals are declining sharply. In the name of green revolution, new high yielding varieties are introduced from early seventies. Out of thousands of rice varieties, the farmers now commonly use only about 25 varieties. Similar kind of declining trend has been occurred in other cultivated crop varieties as well. Reduction in number of species and decline of wild flora and fauna is also a common trend like elsewhere in the world.

For wild flora and fauna declining trend is mostly attributed to habitat loss. Fragmentation of forest and other natural areas caused great loss of species diversity as well as its genetic resources. Reduction of population size, and fragmentation of habitat forced the wildlife to inbreed, causing genetic erosion.

1.5 Threats to Biodiversity in Bangladesh

There are many threats causing as drivers to biodiversity loss, among which some are direct and dynamic while the others are indirect. Direct threats include changes in landuse, habitat destruction, introduction of invasive alien species etc. On the other hand, indirect threats are economic system and policy of the state, unsustainable exploitation of resources and weak management system, gaps in spatial information, lack of public awareness etc. The following sections describe how these drivers contributed in deteriorating the state of biodiversity in Bangladesh.

1.5.1 Direct Threats Causing Biodiversity Loss

- **Change of landuse (High population growth and natural resource consumption)**

  The pressures that brought change in the landuse in both terrestrial and aquatic environments include, demand for increased agricultural lands, collection of fuelwood and non-timber forest products by the local communities. More and more natural habitats are converting into human habitations due to high growth of population and economic activities. As a small country with high population and limited natural resources, it is obvious that the competition for these resources is immense. At present, the country has 85 thousand hectares of agricultural lands, of which 1% is being converted annually to other land use patterns. Urbanization is another major concern for the country, causing rapid shrinkage in agricultural lands. Development of infrastructures such as communication networks, flood control and irrigation infrastructures are also bringing rapid change in the landuse.

- **Fragmentation and Loss of Habitat**

  Ecosystem fragmentation, especially in forest areas has been recognized as one of the causes of

biodiversity loss. Furthermore, the more fragmented an ecosystem is, the higher the exposure to land use change and human pressures is. Fragmentation of habitats has been extensive and continues to occur at a rapid rate across the country. Habitat fragmentation typically reduces total habitat area, size of individual habitat patches and proximity of habitat patches, and it can increase the amount of habitat edge. Reduction in the area of suitable habitat can result in population declines for most of the species by simply reducing adequate space for territories and other critical resources. Changes in habitat patch size, proximity of habitat patches, and the amount of edge-habitat can also affect wildlife populations by negatively affecting reproductive success, survival, and/or immigration rates in the remaining habitats.

One of the most warranted issues is degradation of habitats in all ecosystems and landscapes of the country. Transformation of land use patterns, expansion of agricultural lands, change in cropping patterns, introduction of HYVs, urbanization, expansion of road networks, unplanned embankments and other manmade factors have caused immense damage of habitats in all ecosystems.

- **Change in Hydrological Regime**

Reduction of upstream flow is one of the major causes of concern for reducing biodiversity of the country. Additionally, changes in land use and development of numerous flood management infrastructures have also played key role to change the hydrological cycle of the country. Other infrastructures such as roads and railways have also created obstacles for the waterways. These changes in hydrological regime not only reduced the fish production by changing the migration routes and spawning grounds but also influencing negatively the habitat quality of many other aquatic and terrestrial wildlife by changing the water availability for their existence. Reduction in the availability of freshwater is posing severe threat to the species composition and biodiversity of Sundarbans, the largest mangrove in the world.

Plate 26: Chunati WS in 1990

Plate 27: Same area of Chunati in the present day

- **Pollution**

With the increase of industrial units across the country without very effective waste management practices, the pollution level for both terrestrial as well as aquatic habitat is on the rise. Many of these industries are dumping their waste directly into neighbouring agricultural fields or water bodies. The situation is extremely bad for water bodies near all the major cities of the country. The situation is further worsened because of the release of untreated sewage from most of the cities. Agricultural run-off, growing use of agricultural chemicals such as fertilizers and pesticides, are major source of pollutant across the country posing potential threat to the genetic resources to be faded out. Coastal areas are not immune due to the impact of activities such as ship-building.

- **Uncontrolled Tourism**

The development of unplanned and uncontrolled tourism is becoming one of the major threats for the degradation of biodiversity at hot spots. For example, the biodiversity of St. Martin's Island, Lawachara National park and Madhabkundu Ecopark have been facing a continuous threat from poorly managed tourism.

Unsustainable Agricultural Practices

Some agricultural practices, using irrigation and overuse of pesticides and chemical fertilizer, are not environment-friendly and sustainable. Introduction of high yielding varieties coupled with hybrid seeds are causing sharp decline in the country's genetic resources of crop varieties. Changes in agricultural system are the main causes of genetic erosion in agricultural biodiversity. Out of more than 10,000 rice cultivars only 22 are mostly used now, leaving behind the vast genetic resources accumulated through the painstaking work of our farmers. With the advent of High Yielding Varieties (HYVs), farmers have stopped using most of these old varieties that they used to possess earlier. Slush and burn practice in the hilly area is also not sustainable in present form. Traditionally it was done in a long 5-7 years return period, but with present population growth, the return period shrinks to 2-3 years making the area vulnerable to be denuded and thus exposed to landslide and erosion. This small return period also do not provide enough time to re-vegetate the area to support the wild flora and fauna. Moreover, agro and veterinary chemicals can have unexpected consequences for example the adverse impacts of the drug diclofenac on vultures was not anticipated and took a decade to identify and prove.

Invasive Alien Species

A large number of non-native species have been introduced in Bangladesh with various purposes including agriculture, horticulture, forestry, animal husbandry, fisheries development, pet animal and ornamental aquarium species. Some of them escaped in the wild and adapted with local conditions, and several of them became invasive. Most of the identified alien invasive species found in Bangladesh are plant species and are known worldwide for their invasiveness. Two of the most common are Chromolaena odorata and Lantana camara; these two cryptic invaders are established in our forest floor and competing out our local species, especially in the open areas of forest margins. While waterhyacinth has major impacts in wetlands where it is now a dominant species.

Plate 28: Two IAS, *Chromolaena odorata* and *Lantana camara* are occurring side by side in all the forest lands in the country.

Climate Change

Bangladesh is one of the most vulnerable countries to climate change, variability and extreme events. The country is suffering from severe impacts because of its low-lying nature and dense population. The lowlands and particularly all wetlands are vulnerable to rise in sea level that is considered as an effect of climate change. The impact of climate change on biodiveristy of Bangladesh is incalculable as large part of coastal region of the country is under threat of being inundated. The increased salinity in the estuarine region is changing the species composition of freshwater fishery, as many freshwater fish are sensitive to salt water.

As climate change over the past 30 years has produced numerous shifts in the distribution and abundance of species worldwide. Climate change has already produced shifts in the distribution of some species, such as amphibians, grasses, migratory birds and butterflies. Coral reefs are threatened by the bleaching that occurs with changes in ocean temperature and chemistry. Forests and agricultural systems are vulnerable to increased incidents of disease and pest outbreaks as a result of changing climatic conditions.

While over-exploitation, deforestation, habitat change to agriculture, pollution, and invasive species are

being considered the most important current drivers of biodiversity loss in Bangladesh, climate change is going to be one of the major concerns for survival of important ecosytems and genetic diversity of Bangladesh. A wide range of mammals, birds, amphibians, reptiles, crustaceans, and above all the Bengal Tiger will face extinction in Bangladesh, if appropriate adaptation measures are not in place. Because, for some species there will no longer be anywhere with a suitable climate-habitat combination to survive; in other cases they may be unable to reach distant regions where the climate is suitable. Other species may survive elsewhere only to face new threats, notably if the new area is covered by crops or urban sprawl.

Given the situation above, biodiversity conservation demands to be the number one adaptation option for addressing climate change risks in Bangladesh.

1.5.2 The Indirect Threats of Biodiversity loss

- **Economic Systems and Policies**

The economic system and policies of the country grossly underestimate the value of biodiversity and its services, although, ecosystem services are essential for the very existence of our society. While some values have been placed on resources that are directly traded such as fish, timber and medicinal plants, most other species and ecosystem services have little value in the country in national resource accounting system.

- **Lack of Knowledge and Awareness**

Lack of information and knowledge generally leads to gaps in awareness. Gaps in awareness have been identified at various levels. To start with, most people do not even know that there are so many species of organisms occurring in Bangladesh. Most of the people do not know that there are laws that ban hunting and trade in wild animals, there are laws that protect certain species and ecosystems and that there are laws that are meant to control environmental pollution.

Plate 29: Freshwater turtles are under continuous pressure of poaching.

- **Legal and Institutional Systems that Promote Unsustainable Exploitation**

A number of laws have been come into force in last four decades those are directly or indirectly addressing the issue of biodiversity conservation. Bangladesh Environment Conservation Act 1995 is one that has

clear mandate to conserve overall environment along with biological diversity and ecosystems. To fulfil the mandate of the Environment Act, the Department of Environment (DoE) is not yet strengthened enough with adequate work force and other facilities. To deal with the three basic obligations of the Convention on Biological Diversity (CBD) viz., conservation of biological diversity, sustainable use of its components and fair and equitable sharing of benefits arising out of uses of genetic resources, the institutional setup at the policy level is not mainstreamed and sensitized. Outdated management system is still very strong and playing a great hindrance for moving ahead towards knowledge-based conservation and management of biodiversity in Bangladesh.

Plate 30: Critically endangered crocodilian species gharials *(Gavialis gangeticus)*.

It was presumed that there are no adult gharials in Bangladesh. In a recent investigation by CARINAM, an adult gharial was found in Godagari, Rajshahi. Six young gharials were also recorded from the Padma and Jamuna rivers.

Overall, there is a lack of integration of environmental considerations in planning, resulting in the absence for a truly integrated land and water resources management. Due considerations on environmental issues were farsighted off the development activities like roads and highways development, polders and embankments development etc. Excessive climatic uncertainty, fishing and overexploitation of coastal resources, water quality deterioration, mangrove destruction for shrimp pond excavation, rampant rural poverty, institutional and legal limitations, repeated cyclones and storm surges etc. are some of the major problems which need to be addressed on a priority basis to conserve biodiveristy in Bangladesh.