



Fifth National Report of Bangladesh to the Convention on Biological Diversity



**Department of Environment
Ministry of Environment and Forests
Government of the People's Republic of Bangladesh**



**Fifth National Report
to
the Convention on Biological Diversity
(Biodiversity National Assessment 2015)**

Department of Environment

Paribesh Bhaban

E-16, Agargaon, Sher-e-Bangla Nagar

Dhaka-1207, Bangladesh

Ph -88-02-8181800

Fax-88-02-8181772

E-mail: dg@doe.gov.bd; haider.doe@gmail.com

www.doe.gov.bd

November 2015

Biodiversity National Assessment 2015
(The Fifth National Report of Bangladesh to the Convention on Biological Diversity)

Published by: Department of Environment (DoE), Paribesh Bhaban, E-16 Agargaon, Sher-e-Bangla Nagor, Dhaka – 1207, Bangladesh.

Published in: November 2015, Dhaka, Bangladesh

Copyright: ©2015, Department of Environment, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh

Reproduction of this publication for resale or other commercial purpose is prohibited without prior written permission of the copyright holder.

Citation: Department of Environment. 2015. The Fifth National Report of Bangladesh to the Convention on Biological Diversity. Department of Environment, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka.



Minister

Ministry of Environment and Forests
Government of the People's Republic of Bangladesh



MESSAGE

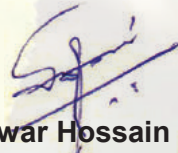
It is my great satisfaction that Bangladesh presents the Fifth National Report to the Secretariat of the Convention on Biological Diversity, (Biodiversity National Assessment 2015), which fulfils an important national commitment under the Convention. The Report results from broad consultations carried out with the various sectors of people working on biodiversity. I am very pleased with the publication that depicts an update on biodiversity status, trends, and threats and implications for human well-being, progresses made on implementation of NBSAP and its mainstreaming as well as progress towards achieving Aichi Biodiversity Targets and Millennium Development Goals (MDGs).

Bangladesh is biodiversity rich a country. Our people have traditionally been conserving biodiversity generations-after-generations. Maintaining the richness in biodiversity is very important for supporting the economy of Bangladesh with food supply and livelihoods. To this end, Bangladesh has taken various development initiatives on management of areas important on biodiversity of the country. Bangladesh has been enhancing its support for the conservation and sustainable use of its biodiversity with remarkable outcomes, such as, increase of conserved areas of wetlands, expansion of vegetation cover and reduction of deforestation, as well as, generation of knowledge on biodiversity. At the same time, our citizen's living standards are improving significantly through effective efforts to eradicate poverty and hunger. As one of the parties to CBD, Bangladesh remains committed to develop and implement policies and solutions to integrate the conservation and sustainable use of biological resources into sustainable development strategies.

The Government of Bangladesh strongly believes that there is no alternative to conserve biodiversity for ensuring well-being of the people. Our efforts towards protecting the ecosystems and the diversity of its biological components will further be enhanced with the publication of the report. The report will concurrently help communicate information on biodiversity and related action plans to global partners and guide the government for implementing its actions for the betterment of the local and global community.

Let us make our all-out effort that will enable us to do everything possible towards conservation and sustainable use of biodiversity.

I wish the report would go a long way towards its implementation.


(Anwar Hossain Manju, MP)



Deputy Minister

Ministry of Environment and Forests

Government of the People's Republic of Bangladesh



MESSAGE

It is indeed a great pleasure for us to see the publication of Fifth National Report to the Secretariat of the Convention on Biological Diversity, (Biodiversity National Assessment 2015). The report updated pictures of biodiversity that could be a useful document not only to the decision makers but also to the academicians and students who may use it as an education material.

It is widely acknowledged that the current status of biodiversity in Bangladesh is under stress. Population pressure that makes over-dependence on ecosystem's goods and services, pollution, habitat destruction through land use change, invasive of alien species and, above all, climate change is taking a huge toll on our biodiversity.

The indomitable force of our people living in harmony with nature has been jeopardized by the frequent disasters of climate change. Despite all these odds and obstacles, we never followed do-nothing policies. Bangladesh signed CBD in 1992 and ratified in 1994. We ratified Cartagena Protocol on Biosafety in 2004. We've also signed Nagoya Protocol on Access-Benefit Sharing in 2011. To the cause of biodiversity conservation, we developed National Biodiversity Strategy and Action Plan (NBSAP) in 2004 and National Biosafety Framework (NBF) in 2006. Towards protection and improvement of environment and biodiversity, our government in 2011 inserted the Para 18A in the constitution as fundamental principles of our state governance. The Para provides that *the State shall endeavour to protect and improve the environment, preserve and safeguard the natural resources, biodiversity, wetlands, forests and wildlife for the present and future citizens.*

The status and trends portrayed in the report have the impetus on implementing stronger efforts towards conservation of biological diversity, ensuring the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Being bio-rich a country, Bangladesh has to adopt adequate measures to halt further degradation of our precious biological resources.

I strongly believe that our efforts towards biodiversity conservation would re-energize with the publication of the report.

(Abdullah Al-Islam Jakob, MP)



Secretary

Ministry of Environment and Forests

Government of the People's Republic of Bangladesh



FOREWORD

I am pleased to observe the publication of the Fifth National Report. I am happy to note that the Biodiversity National Assessment 2015 has been prepared following consultative process involving a wide range of stakeholders and I wish to thank all of those who contributed to the process of development of the report. This report provides an opportunity to share experiences of Bangladesh with rest of the world.

The report reveals that our biodiversity is under huge pressure of population and the onslaught of extreme events of climate change. Yet, Bangladesh made a tremendous progress in terms of taking development initiatives towards conservation and sustainable use of biodiversity. Bangladesh has already increased its protected areas and ecologically critical areas. The alternative income generating activities has already been taken in various wetlands and forest communities to conserve biodiversity. However, the initiatives are proving inadequate because of our resource constraints. We have to work towards fast-track mobilization of adequate financial as well as technological resources from developed world to halt the further degradation of biodiversity in the developing countries like Bangladesh.

Bangladesh has taken development activity towards updating and mainstreaming NBSAP in line with Aichi Biodiversity Targets. Mainstreaming of biodiversity in different sectors would also be taken into account in the process of NBSAP updating activity.

The report opens our eyes that we have great challenges ahead, but we are determined to achieve success in conserving biodiversity.

Let us all work together and forge a network of cooperation to reverse the challenges of ensuring conservation of biodiversity and sustainable use of its components.

(Dr. Kamal Uddin Ahmed)



Director General

Department of Environment

Government of the People's Republic of Bangladesh



PREFACE

Fifth National Report has been prepared in accordance with Article 26 of the Convention and decision X/10 of the Conference of the Parties. The structure of the report is based on the Guidelines for the Biodiversity National Assessment 2015 published by the secretariat of CBD. The report has been prepared by the Department of Environment with the gracious support of the Global Environment Facility (GEF). Thanks go to all the relevant stakeholders who contributed through workshops, written submissions and inputs.

The report presents different aspects of biodiversity in Bangladesh in three chapters addressing the status and trends of biodiversity, progresses on implementation of National Biodiversity Strategy and Action Plan (NBSAP), the Aichi Biodiversity Targets and the Millennium Development Goals (MDG). The content of the report could be an important reference material to update the country's National Biodiversity Strategy and Action Plan (NBSAP).

The Department of Environment has taken various initiatives towards conservation and sustainable use of biodiversity. Various policies, acts and rules-regulations have been formulated, development projects are implemented. Media campaigns to raise public awareness on biodiversity were taken by various government and non-government organizations. In addition, citizen's actions on biodiversity and nature conservation have increased. The academic institutions are being actively engaged in incorporating biodiversity in their curricula and research on various components of biodiversity.

Yet, the present situation of biodiversity gives strong signals that we need concerted efforts to protect the remaining biological resources. Without active participation of the people from all walks of life, biodiversity conservation would be an unattainable task by the Government or any individual organization. On behalf of the Department of Environment, we always welcome collaboration of nature-loving people in our every initiative. We expect that the findings of the report will help formulating future conservation strategy and action plan on biodiversity.

(Md. Rāisul Alam Mondal)

Director General



Director (Planning)

Department of Environment

and

Project Director

Updating and Mainstreaming of National Biodiversity Strategy and Action Plan (NBSAP)



Acknowledgements

Fifth National Report (Biodiversity National Assessment 2015) is an outcome of a comprehensive consultation involving diverse range of stakeholders including representatives of relevant government agencies, NGOs, academia and development partners.

Development of this important piece of work would never have been possible without active participation of renowned individuals and experts dealing with biodiversity issues. On behalf of the Department of Environment, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, I would like to thank the distinguished individuals, researchers, authors, experts, representatives of various ministries, agencies, research institutes and universities, as well as, the representatives of the NGOs and the private sectors who have actively participated in the process of developing the report. Without their valuable contribution to the report it would have never taken a shape. Representatives of the local communities and various NGOs participated in the stakeholder meetings and national consultation, taking trouble to come to Dhaka from the distant areas of the country, I am indebted to them for their spontaneous support in the development of the report.

My sincere appreciation goes to the Chair and members of National Steering Committee and members of the review committee for their thoughtful opinions and guidances.

I would like to express my gratitude to Dr. Kamal Uddin Ahmed, Secretary, Ministry of Environment and Forests for taking his personal interest, providing valuable and pragmatic guidelines in preparation of this report.

I would like to acknowledge Mr. Md. Raisul Alam Mondal, Director General, Department of Environment, for his constant support, guidance and contribution in generating this report. Thanks go to all my colleagues in the Department of Environment. Dr Sultan Ahmed, Director (NRM and Research) in particular for providing all kinds of supports in the process of development of the report.

I appreciate the engagement of IUCN team with the Department of Environment towards drafting the report.

We are grateful to Dr. Sainer Alam (Department of Fisheries), Prof. Badrul Amin Bhyuian (Chittagong University), Dr. Md. Tariqul Islam (Bangladesh Agricultural Research Institute), Dr. Mohammad Khalequzzaman (Bangladesh Rice Research Institute), Prof. Mohammad Zabed Hossain (University of Dhaka), Dr. Md. Mahabub Hussain (Bangladesh Jute Research Institute), Mr. Md. Tariqul Islam and Begum Fatima Tuz Zohora (Bangladesh Forest Department), Mr. Md. Manzoorul Kibria (University of Chittagong), Prof. Md. Niamul Naser (University of Dhaka), Dr. N.R. Sarker (Bangladesh Livestock Research Institute), Dr. Md. Sarder Nasir Uddin (Bangladesh National Herbarium) and and Dr S. M. A. Rashid (CARINAM) for their excellent contribution to the report.

Finally, we are thankful to Global Environment Facility (GEF) for the generous support to accomplish the report.

Mohammed Solaiman Haider
Director (Planning)

Table of Contents

Message	iii
Foreword	v
Preface	vi
Acknowledgements	vii
List of Tables.....	ix
List of Figures	x
List of Boxes	x
List of Tables in Annex.....	xi
Acronyms & Abbreviations.....	xii
Executive Summary	xiii
1. An Update on Biodiversity Status,Trends and Threats in Bangladesh and Implications for Human Well-being	1
Well-being	1
1.1 Introduction.....	1
1.2 Biodiversity Status and Trends	3
1.2.1 Ecosystem Diversity.....	3
1.2.1.1 Terrestrial Ecosystem	3
A. Forest Ecosystem.....	3
B. Agro Ecosystem	10
C. Homestead Ecosystem.....	10
1.2.1.2 Inland Water Ecosystem	12
1.2.1.3 Coastal and Marine Ecosystem	17
1.2.2 Species Diversity	20
1.2.2.1 Floral Diversity	20
1.2.2.2 Faunal Diversity	22
1.2.2.3 Status and Trends of Threatened Species.....	28
A. Flora	28
B. Fauna	30
1.2.3 Genetic Diversity.....	37
1.2.3.1 Crop Diversity	38
1.2.3.2 Wildlife and Fish Diversity	42
1.2.3.3 Domesticated Biodiversity.....	43
1.3 Status of Conservation of Ecosystems	47
1.4 Threats to Biodiversity	55
1.4.1 Main Threats to Biodiversity	55
1.4.2 Threats to Major Ecosystems	60
1.5 Importance of Biodiversity and its Implications for Human Well-being	66
1.5. 1 Agriculture.....	67
1.5.2 Fisheries	67
1.5.3 Livestock	72
1.5.4 Forestry	73
1.5.5 Nature-Based Tourism.....	74
2. National Biodiversity Strategy and Action Plan: Progress of Implementation and Mainstreaming.....	75
2.1 Introduction	75
2.2 Implementation of NBSAP.....	75
2.3 Mainstreaming Biodiversity into Sectoral and Cross-sectoral Policies, Strategies and Programmes	89
2.4 Challenges for implementing NBSAP.....	91
3. Bangladesh's progress towards Aichi Biodiversity Targets and Millennium Development Goals.....	92
3.1 Introduction	92
3.2 Achievements towards Aichi Targets	92
3.3 Contribution to the Millennium Development Goals.....	97
4. Concluding Remarks	99
References	100
Annex – Tables	106

List of Tables

Table 1 Area of Forests Managed by the Bangladesh Forest Department	3
Table 2 Forest Area under Different Management Categories	4
Table 3 Total Forest Areas of Bangladesh by National Land Use Classes. All area is in hectares	4
Table 4 Tree Cover in Bangladesh	4
Table 5 Coastal Plantation During 1965-2013	5
Table 6 Activities and Investment of the Project <i>EKTEE BARI EKTEE KHAMAR</i> .	11
Table 7 Hydrological Regions of River System in Bangladesh	12
Table 8 Changing Trend of Species Diversity in Tanguar Haor, Sunamganj	15
Table 9 Floral Diversity in Bangladesh	20
Table 10 Tree Species Mostly Used in Plantations in Bangladesh	21
Table 11 Faunal Diversity in Bangladesh	22
Table 12 List of Invertebrates so far Recorded from Bangladesh	23
Table 13 Zooplanktons Reported from Freshwater and Marine Environment of Bangladesh	25
Table 14 Marine Fauna Present in Bangladesh	27
Table 15 Number of Threatened Species in Major Vascular Plant Groups According to the <i>Encyclopedia of Flora and Fauna of Bangladesh</i>	28
Table 16 Group-Wise Distribution of Species Recorded and to be Assessed	31
Table 17 Possibly Nationally Extinct Riverine Fishes of Bangladesh	32
Table 18 Cryopreservation of Sperm of Some Indigenous Fish Species in Bangladesh	32
Table 19 Rice Genetic Resources in the BRRI Gene Bank	38
Table 20 Ecosystem-wise Genetic Diversity of Rice Germplasm	38
Table 21 Jute and Allied Fibre Germplasm Stored in the Gene Bank	41
Table 22 Status and Trends of Genetic Diversity of Sugarcane	41
Table 23 The Domesticated Indigenous Fishes of Bangladesh	43
Table 24 Different Genotypes of Indigenous Farm Animal Genetic Resources	44
Table 25 Exotic Species, Type and Breed of Farm Animal Genetic Resources	45
Table 26 Different Crossbred Genotypes of Livestocks	45
Table 27 Wild Relatives of Farm Animal Genetic Resources in Bangladesh	46
Table 28 Genotypes of Cow in Bangladesh	46
Table 29 List of Fodder Germplasms Available at BLRI Germplasm Bank.	46
Table 30 Protected Areas (National Parks, Wildlife Sanctuaries, Special Biodiversity Conservation Area and Marine Protected Area) of Bangladesh	47
Table 31 Ecologically Critical Areas (ECAs) of Bangladesh	50
Table 32 Botanical Gardens, Safari Parks and Eco-Parks	52
Table 33 Hilsha (Fish) Sanctuaries in Bangladesh	53
Table 34 Floral Diversity in Six Protected Areas	54
Table 35 Number of Wildlife Species in Seven Protected Areas	54
Table 36 Exotic Fish Species and the Countries they are Imported from	57
Table 37 Negative Impacts of Exotic Fishes on the Indigenous Fishes	58
Table 38 Fisheries Production in Different Water Bodies (2012-13)	69
Table 39 Number of Livestock and Poultry	72
Table 40 Production of Milk, Meat and Egg	72
Table 41 Progress of Implementing the National Biodiversity Strategy and Action Plan (2010-2015)	75
Table 42 Analysis of Biodiversity Related Major National Policies	90
Table 43 Achievements under Strategic Goals of Aichi Biodiversity Targets 2020	93
Table 44 Current Status and Challenges in Attaining Targets of MDG 7	98

List of Figures

Figure 1 Basin Map of the Ganges, the Brahmaputra and the Meghna Rivers Showing the Location of Bangladesh	1
Figure 2 Map of the Oriental Realm	2
Figure 3 Sundarban Reserved Forest, Bangladesh	7
Figure 4 Marine Reserve of Bangladesh	18
Figure 5 Possible Land Accretion Sites at the Meghna Estuary	19
Figure 6 Relative Abundance of Tigers in the Sundarbans of Bangladesh	33
Figure 2 Protected Areas of Bangladesh	49
Figure 3 Ecologically Critical Areas of Bangladesh	51
Figure 4 Map Showing the Routes, Corridors and Human-Elephant Conflict Areas in Chittagong Region	56
Figure 5 Degree of Threats in 55 Compartments of the Sundarban	60
Figure 6 Contribution of Fisheries Sector to the GDP of Bangladesh during 2006–2013	68
Figure 7 Fish Production During 1960-2013 from Culture and Open Water Sources	68
Figure 8 Total Inland and Marine Hilsa Catch of Bangladesh 2001-2011	70
Figure 9 Hilsa Migration Route in Bangladesh	71
Figure 15 Trends in Production of Milk Products	72

List of Case Boxes

CASE BOX 1 – Forest Types in Bangladesh	5
CASE BOX 2 – Village Common Forests in the Chittagong Hill Tracts	9
CASE BOX 3 – One Home One Farm Activities and Investment	11
CASE BOX 4 – Maritime Boundaries in Bangladesh	19
CASE BOX 5 – Newly Accreted Area – Riverine Estuary	19
CASE BOX 6 – Four New Species of Butterflies Recorded from Kaptai National Park	24
CASE BOX 7 – Red List of Animals in Bangladesh	31
CASE BOX 8 – Status of Tea Cultivars	42
CASE BOX 9 – The River Halda	42
CASE BOX 10 – Nijhum Dweep National Park	53
CASE BOX 11 – Floral Diversity of the Selected Protected Areas of Bangladesh	54
CASE BOX 12 – Degree of Pressures and Threats to Protected Areas	55
CASE BOX 13 – Impacts of Climate Change on Bangladesh's Biodiversity	59
CASE BOX 14 – Zoonotic Diseases	64
CASE BOX 15 – Importance of Biodiversity and Ecosystems in Disaster Resilience	66
CASE BOX 16 – Culture and Indigenous Knowledge-Based Technologies Practiced in Hill Farming Systems in Bandarban Hill District	67
CASE BOX 17 – Inland Fisheries in Bangladesh – Production and Demand Trend	70
CASE BOX 18- Use of Multiple Species in Plantation Programme	73

List of Tables in Annex

Annex : Table 1 Government Revenue from Forestry	106
Annex : Table 2 Major Wildlife found in Different Forests	107
Annex : Table 3 Review on the Status of Plant Species in Different Forest Areas	108
Annex : Table 4 Community Conserved Areas as Village Conservation Forests (VCF)	109
Annex : Table 5 Important Bird and Biodiversity Areas (IBAs) of Bangladesh	110
Annex : Table 6 Shark Fisheries in the Bay of Bengal	110
Annex : Table 7 Present Status of Banspata (<i>Podocarpus nerifolius</i>) in Natural Forests and Plantations	112
Annex : Table 8 Threatened Vascular Plants of Bangladesh (Ara <i>et al.</i> , 2013); CR: Critically Endangered, EN: Endangered, VU: Vulnerable	113
Annex : Table 9 Germplasm Conservation of Forest Tree Species During 2000-2012 in Different Silviculture Research Stations, BFRI	115
Annex : Table 10 Species Taken Under Conservation Programme in the Campus of University of Chittagong During 2011-2014	117
Annex : Table 11 Seedling Seed Orchards Established at the University of Chittagong Campus	118
Annex : Table 12 Review on the Number of Insect Species Reported from Bangladesh	118
Annex : Table 13 Status and Trends of Crop Diversity	119

Acronyms and Abbreviations

AEZ	Agro-Ecological Zones
AF	Arannayk Foundation (an NGO)
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCCSAP	Bangladesh Climate Change Strategy and Action Plan 2009
BFD	Bangladesh Forest Department
BINA	Bangladesh Institute of Nuclear Agriculture
BJRI	Bangladesh Jute Research Institute
BLRI	Bangladesh Livestock Research Institute
BRRRI	Bangladesh Rice Research Institute
BSRI	Bangladesh Sugarcane Research Institute
BTRI	Bangladesh Tea Research Institute
CBA-ECA	Community-Based Adaptation in Ecologically Critical Areas (a project)
CBD	Convention on Biological Diversity
CITES	Convention of International Trade in Endangered Species of Fauna and Flora
CNRS	Centre for Natural Resources Studies (an NGO)
CREL	Climate Resilient Ecosystems and Livelihoods (a project)
CHT	Chittagong Hill Tracts
CWBMP	Coastal and Wetland Biodiversity Management Project (a project)
DFID	Department for International Development-UK
DoE	Department of Environment
ECA	Ecologically Critical Area
FAnGR	Farm Animal and Genetic Resource
FAO	Food and Agriculture Organization of the United Nations
FMBC	Fish Museum and Biodiversity Centre
GDP	Gross Domestic Product
GMO	Genetically Modified Organism
IPAC	Integrated Protected Area Co-management (a project)
IUCN	International Union for Conservation of Nature
MICS	Multiple Indicator Cluster Survey
MoEF	Ministry of Environment and Forests
NACOM	Nature Conservation Management (an NGO)
NAPA	National Adaptation Plan of Action
NBSAP	National Biodiversity Strategy and Action Plan
NEMAP	National Environment Management Action Plan
NGO	Non-governmental Organization
PA	Protected Area
PGRC	Plant Genetic Resources Centre
SEALS	Sundarban Environmental And Livelihoods Security (a project)
SRCWP	Strengthening Regional Cooperation for Wildlife Protection (a project)
SVRS	Sample Vital Regression System (BBS)
UNSD	United Nations Statistics Division
VCF	Village Conservation Forest

Executive Summary

Biodiversity National Assessment 2015 or The Fifth National Report of Bangladesh to the Secretariat of the Convention on Biological Diversity (CBD) has been prepared according to the guidelines provided by the Secretariat, through extensive literature survey, intensive review by relevant experts, and wider stakeholder consultations.

Bangladesh is a deltaic country located at the juncture of Indo-Malayan and Indo-China sub-regions of the Oriental Region. This biogeographical location favours the country to act as biological corridor of the wildlife among neighbouring countries, India, Myanmar and Bhutan. The hydrological regime of the Ganges and the Brahmaputra Rivers ecologically connected and intermingled the flora and faunal composition of Bangladesh with Nepal, India and Bhutan. Henceforth, this strategic location makes Bangladesh as one of the most ecologically significant and biologically diverse landscapes in terms of stepping stones, staging ground and flyways for wildlife migration of the region. Consequently, a large number of wildlife species traverse in widespread habitats and thereby maintain a wide range of gene pool. Moreover, the climatic variability influences the biodiversity of the country in a number of ways; most significantly in terms of species richness and on the contrary damage caused due to natural calamities, like, flood, riverbank erosion, and cyclones destroy and damage the richness in biodiversity. This report consists of three major parts with the heading as follows:

An Update on Biodiversity Status, Trends and Threats in Bangladesh and Implications for Human Well-being:

This part of the report has given a picture of the status of biodiversity in terms of improvement, decline and significance to national economy and livelihoods of the people. On the basis of occurrence and distribution of flora and fauna, Bangladesh is primarily divided into 12 major Bio-ecological Zones. In addition, the country has also been classified into thirty Agro-ecological Zones based on topography, climate, hydrology and natural resource status. Although Bangladesh is the eighth most populous country in the world (about 160 million people), with the highest population density, the country's demographic indicators have recorded considerable improvements in reducing annual population growth rate to 1.37% over the last two decades.

Keeping in mind the main biophysical characteristics, the ecosystems of Bangladesh are broadly clustered as terrestrial, inland waters, coastal and marine ecosystems. The major forest types in Bangladesh are: 1) Tropical Wet Evergreen Forests; 2) Tropical Semi-Evergreen Forests; 3) Tropical Moist Deciduous Forests (Sal Forests); 4) Mangrove Forests; 5) Freshwater Swamp Forest; 6) Homestead Forests; and 7) Plantation Forests. The total forest cover in Bangladesh is about 2.53 million hectares which is about 17.49% of the country. Out of this, 1.53 million hectares are under the management of the Bangladesh Forest Department and 0.27 million hectares are privately managed village forests. About 0.209 million hectares of newly accreted mud flats have been brought under afforestation by the Bangladesh Forest Department.

Almost half of the total area of Bangladesh is wetlands. These ecosystems are made up of a wide variety of habitats, including the main three rivers (the Ganges, the Brahmaputra and the Meghna) and their 700-plus tributaries and distributaries and their floodplains; about 6,300 beels (permanent and seasonal shallow lakes in floodplain depressions); at least 47 major haors (deeply flooded depressions in the north-east), baors (oxbow lakes); vast areas of seasonally flooded land; and fish ponds and tanks.

Important terrestrial ecosystems, namely, the Sundarban, the Chittagong Hill Tracts and the Sal (*Shorea robusta*) forests and inland freshwater ecosystems, like Ratargul Swamp Forest,

Tanguar Haor, Hakaluki Haor, Chalan Beel, and Kaptai Lake are highlighted in this report to exemplify the present status and trends of different terrestrial and aquatic ecosystems.

Bangladesh is part of the Bay of Bengal Large Marine Ecosystem, which is one of world's 64 Large Marine Ecosystems. On the basis of the Arbitral Tribunal's recent verdicts, Bangladesh's maritime area stands as 118,813 square kilometres. This has opened up the opportunity to explore marine resources including marine biodiversity in and under the water in a planned way.

This part of the report present the numbers and composition of species of both flora and fauna through adequate review and evaluation of the species recorded and reported for various taxonomic hierarchy. The Encyclopaedia of Flora and Fauna of Bangladesh (2007-2009) contains the acceptable and comprehensive list of plant and animal species of Bangladesh. It recorded 3,611 taxa of angiosperms from the Bangladesh territory. The present report, however, concluded that the total number of angiosperms stood as 3,733 species with the new plant records during 2009-2015. The country is also rich in wildlife and fish. A total of 706 bird species has been recorded in Bangladesh representing 7.2% of the world's total species. Invertebrate consists of about 4,500 species. Between 2009 and 2014, 2 mammals, 22 amphibians and 27 reptiles have been newly recorded for Bangladesh. These new records of plants and animals call for completing biodiversity inventory of the whole country.

The Fifth National Report highlights marine biodiversity by summarizing current status of different plant and animal groups, namely seaweeds, sea grasses, prawns, shrimps, crabs, lobsters, zooplankton, molluscs, fish, and turtles. The coastal and marine waters of Bangladesh supports five species of sea turtles, namely Olive Ridley Turtle, Green Turtle, Hawksbill Turtle, Loggerhead Turtle and Leatherback Turtle. Olive Ridley and Green turtles are common while Hawksbill, Loggerhead and Leatherback turtles are rare.

Bangladesh has taken various initiatives towards conservation of biodiversity. Government agencies like Department of Environment, Forest Department and Department of Fisheries, public institutions, universities, development partners, and national and international NGOs have been playing role in this regard. One of the best ways to showcase the achievements of NBSAP implementation is focusing on the progress in initiatives taken towards conserving important ecosystems of Bangladesh. The country has 40 PAs and 13 ECAs of biodiversity significance.

The population pressure alone is posing major threats to the biodiversity of the country which resulted in local extinction of 13 species of wildlife within the last half century. Considering the human-induced changes and its negative impact on the biodiversity, the Government of Bangladesh has underlined the critical situation and took effective measures to conserve and ensure sustainable use of biological diversity through policy reform, strategic conservation action and promulgation of appropriate laws, rules and regulations. Important milestones of such measures are reflected in Bangladesh Biological Diversity Act, (draft), amended Wildlife (Conservation and Security) Act, 2012 and recovery programme of critically endangered wildlife, like Asian elephant, Bengal tiger, Bengal vultures, Spoonbilled sandpiper, Gangetic Dolphins, Primates, Gharial, Freshwater turtles and Burmese Python.. The report highlights the present status and trend of these species, along with threatened plants like Boilam, Civit, Talipalm and Banspata.

According to the Encyclopaedia of Flora and Fauna of Bangladesh, 486 vascular plants are threatened in Bangladesh. The first and second volumes (2001 and 2013) of Red Data Book of Vascular Plants of Bangladesh included 124 species as threatened following IUCN's Red List categories. Challenge remains to have a clear, acceptable and comprehensive evaluation of the flora of Bangladesh following the latest guidelines of the IUCN Red List. On the other hand, the Red List of Threatened Animals of Bangladesh published by IUCN in 2000 remains the only published document on threatened animals of Bangladesh. In 2013, Bangladesh

Forest Department, with IUCN Bangladesh, took an initiative to update the Red List of animals of Bangladesh. A total of 1,608 species of seven animal groups are now being assessed.

Regarding diversity at genetic level, studies on genetic diversity of wild fauna are limited in Bangladesh, except that on *Rhesus macaques*, Hilsa Shad (*Tenuolosa ilisha*), and frogs. Regarding agro-diversity, on the other hand, this report captures germplasm collection of different crops maintained in different national agricultural research institutes. Total number of accession of jute and allied fibre crops, for example, at present is 6,012 harboured at Bangladesh Jute Research Institute. Bangladesh Agricultural Research Institute currently maintains 10,085 accessions of 137 different agri-horticultural crops in the gene banks, including those of cereals, pulses, oilseeds, vegetables, spices, fruits, and other crops. In Bangladesh, to date about 20 fish species have been domesticated and their breeding and rearing protocols have been developed. Around 50% of the domesticated fishes are cypriniformes and are now under nation-wide aquaculture. In case of domesticated livestock, not many studies have been conducted in recent years.

In Bangladesh, the main direct threats to biodiversity are habitat degradation; fragmentation at landscape level; change in land use pattern; change in hydrological regime; pollution; over-exploitation of resources; uncontrolled tourism; and invasive alien species. Impacts of climate change on Bangladesh's biodiversity are expected to be a serious concern in the coming decades. Country's rich biodiversity coupled with dense human populations provide the ideal conditions for cross-species (zoonotic) disease transmission. Indirect threats include, legal and institutional systems that promote unsustainable exploitation; economic systems and policies; inequality in ownership and benefit sharing from the use of biological resources; knowledge and awareness levels; and erosion in genetic diversity. Sundarban mangroves, freshwater wetland ecosystems, and hill forest ecosystems were discussed to elaborate these threats.

The globally important ecosystems, such as the Sundarban, freshwater wetlands, and marine fishing area indeed make up a significant portion of ecosystem services and national economy. Further, biodiversity – from ecosystem to genetic diversity – supports one of the most populous countries of the world with lives and livelihoods where about 70% population still live in rural areas. The human-nature interactions are briefly discussed at the end of this section, in pertinent, important sectors like agriculture, fisheries, livestock, forestry, water resources and tourism. Besides, role of biodiversity in reducing impacts of natural disasters and link of traditional knowledge and practices with the well-being of indigenous people are also highlighted.

Implementation and Mainstreaming of the National Biodiversity Strategy and Action Plan:

With the development of the NBSAP with 16 strategies in 2004, Bangladesh has made a significant step forward to fulfilling the global commitment to the CBD. In this part of the report, major achievements of implementing the NBSAP are recorded.

An analysis of the biodiversity conservation efforts during 2009-2014 captured the implementation of the NBSAP, since the submission of the Fourth National Report in 2010. Bangladesh has made good progress in some areas by implementing a number of ambitious, important and large conservation and natural resource management projects (e.g. IPAC, CWBMP, CBA-ECA, SRCWP, CREL, Tiger Project, and SEALS). However, mainstreaming of the NBSAP into the various sectors and cross-sector policies and programmes has not progressed up to the desired extent. An analysis on the pertinent policies suggested that most of those policies are yet to appreciate biodiversity conservation sufficiently.

Bangladesh's progress towards Aichi Biodiversity Targets and contributions to the relevant 2015 targets of the Millennium Development Goals:

The final part of the Fifth National Report is about the progress towards achieving the Aichi Biodiversity Targets and MDG's environmental targets in Bangladesh.

There are 20 Aichi Biodiversity Targets against 5 strategic goals. These are supposed to be implemented during 2011-2020. Bangladesh is in the process of developing national biodiversity targets for 2020 in the light of these global Targets. In this report, however, Bangladesh's progress has been tabulated against the global targets. Bangladesh has shown overall low to moderate progress towards achieving the Aichi Targets.

Bangladesh is considered as a role model in attaining the MDGs in most of the areas. Overall progress against the MDG 7 – Ensure Environmental Sustainability –, as came out recently in a Government assessment, is moderate with some systemic and institutional challenges.

The Fifth National Report has been prepared to meet Bangladesh's commitment to the CBD. It has, however, given the country an opportunity to take stock of its biodiversity and conservation efforts and to assess the capacity of the Government and other agencies in implementing the NBSAP or attaining Biodiversity Targets.

Bangladesh is currently updating its first generation NBSAP prepared in 2004. The updated NBSAP would give Bangladesh the opportunity to give a momentum in biodiversity conservation. On a global scale, a new set of 17 goals have recently been approved as the Sustainable Development Goals (SDGs) to guide global development until 2030. Biodiversity has been exclusively upheld in the Goals 14 and 15, focusing on marine and terrestrial ecosystems separately. It is believed that the MDG achievements will be re-energised through implementation of SDG and updated NBSAP.

1. An Update on Biodiversity Status, Trends and Threats in Bangladesh and Implications for Human Well-being

1.1 Introduction

Bangladesh stretching from 20°34' to 26°38' N and from 88°01' to 92°41' E has the boundary with India on the west and north, India and Myanmar on the east and the Bay of Bengal on the south. With a total area of 147,570 square kilometers, the country is a delta located on the Ganges-Brahmaputra-Meghna river system - one of the largest river systems of the world (Figure 1). The north-east and south-east portions of the country are hilly, with some hills rising over 1,000 meters above mean sea level. About 80% of the country is floodplain, 12% is hills, and about 8% is terrace or uplifted blocks (BBS, 2011). As per the recent (2012 & 2014) decisions of the International Arbitral Tribunal, Bangladesh currently has 118,813 square kilometers of marine area.

Bangladesh is very rich in biodiversity. The rich genetic diversity in crops, livestock, fish, trees and wildlife directly and indirectly support the lives and livelihoods of the people of the country by supplying wide range of provisional, regulatory and cultural services.

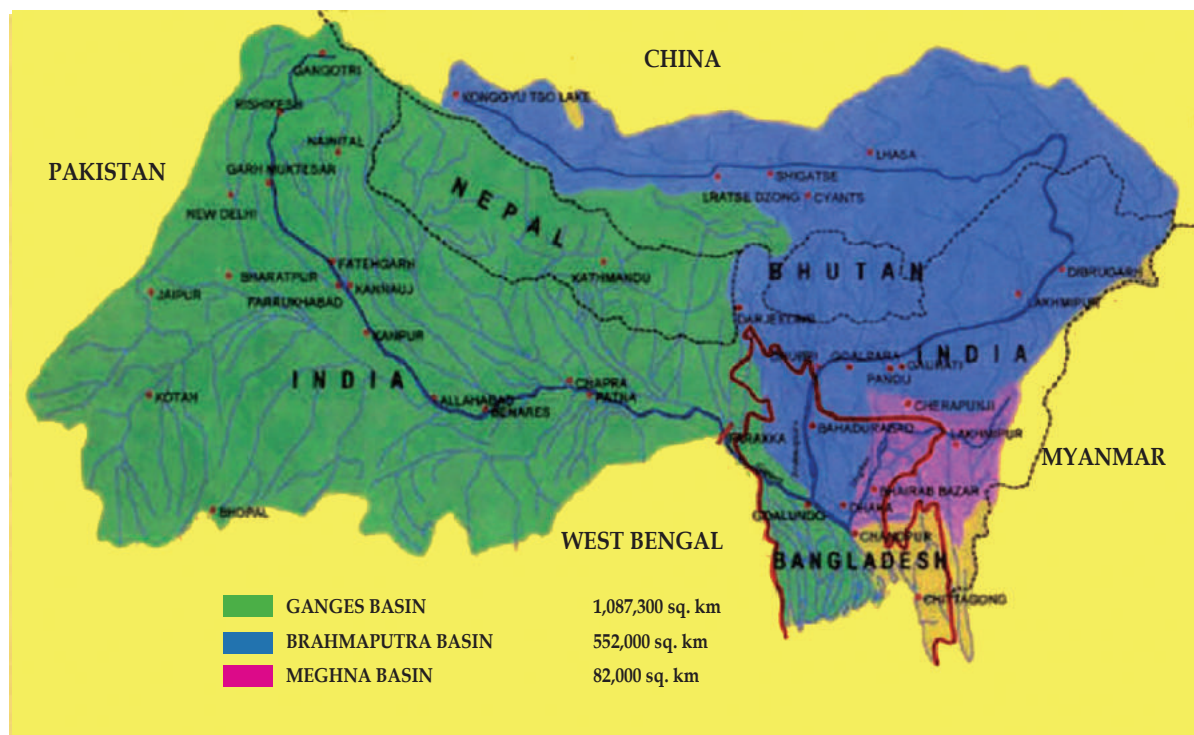


Figure 1 Basin Map of the Ganges, the Brahmaputra and the Meghna Rivers Showing the Location of Bangladesh

Although Bangladesh is the eighth most densely populated country in the world with about 160 million people, the country's demographic indicators have recorded considerable improvements in recent years. The country has made significant progress in reducing annual population growth rate to 1.37% over the last two decades (1991-2010) (GED, 2012a; BBS, 2011). Besides Bangla-speaking majority, a good number of minor anthropological communities also lives in different parts of the country, especially in the Chittagong Hill Tracts (CHT).

Biogeographically, the country is located at the cross roads of the Indo-Himalayan and Indo-Chinese sub-regions under the Oriental region (Figure 2). Thus, this country acts as an important merging and sharing habitat, land bridge and biological corridors of the flora and fauna between these sub-regions. This strategic location makes Bangladesh as one of the most ecologically significant and biologically diverse landscapes in terms of migratory species, stepping stones, staging ground and flyways for wildlife movements of the region. Consequently, a large number of plant and animal species traverses in widespread of habitats and thereby maintain a wide range of gene pool.

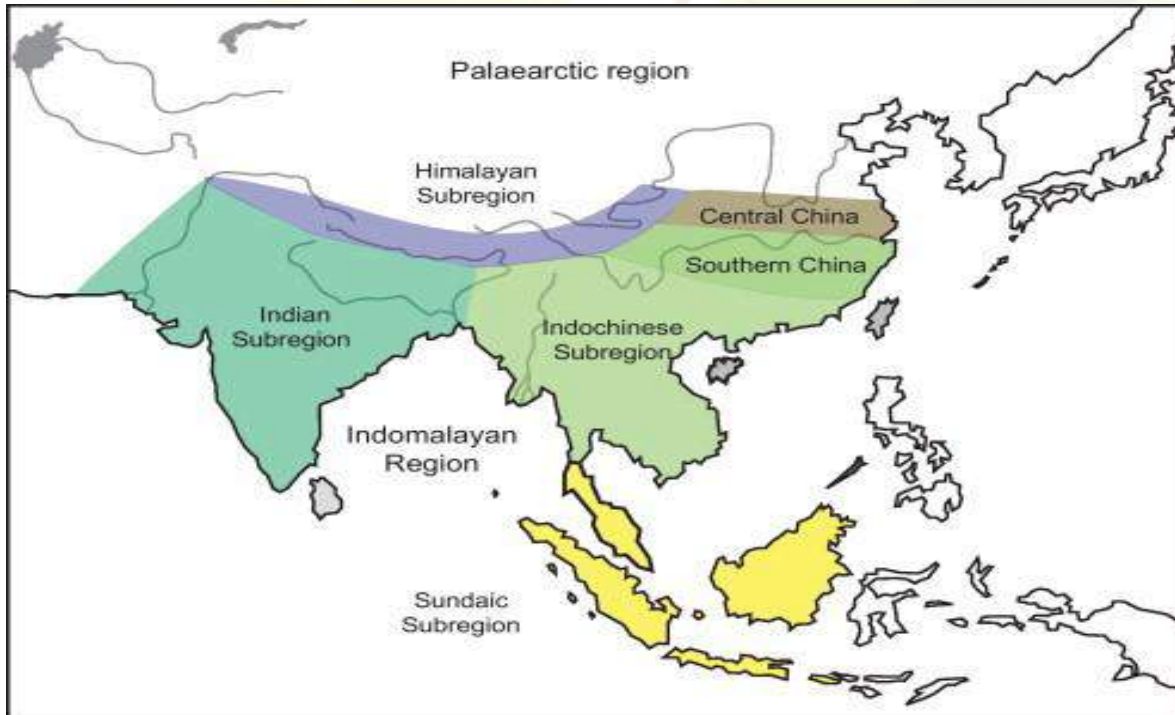


Figure 2 Map of the Oriental Realm (Corbet and Hill - Navigation AnthroScape: Human Biodiversity Forum)

On the basis of both biotic and abiotic components of ecosystems, the world is divided into five Global Ecological Domains and 20 Global Ecological Zones (GEZs) (FAO, 2001). Bangladesh belongs to two of these zones, viz. Tropical Rain Forest GEZ (33%) and Tropical Moist Deciduous Forest GEZ (67%) of the Tropical Domain of the Global Ecological Domains. The central, north-eastern and south-eastern forests belong to Tropical Rain Forest GEZ (Aitrell *et al.*, 2007). A portion of the Chittagong Hill Tracts (CHT) in the southeast Bangladesh is part of the Indo-Burma Biodiversity Hotspot (Myers *et al.*, 2000). Bangladesh is divided into 25 bio-ecological zones on the basis of biological and physical parameters (Nishat *et al.*, 2002). The atlas showed the distribution of common 395 plant species under 100 families over the bio-ecological zones (except the Coastal Marine Water). Although this categorization might not let these bio-ecological zones to be truly analogous to habitats, the existence of 25 different bio-ecological zones in a small country indicates its rich biodiversity. Additionally, Bangladesh has been divided into 30 Agro-Ecological Zones which also indicates country's richness in ecosystem diversity. This zoning is based on topography, climate, hydrology, natural resource status, food security and other related physical development potential factors (Sarkar, 2012).

1.2 Biodiversity Status and Trends

Bangladesh is endowed with rich biological diversity. It is, however, noticed that there is a declining trend in species diversity in general and mega fauna in particular. This alarming trend is mainly due to tremendous anthropogenic pressure and the adverse impacts of climate change. The ecosystem, species and genetic diversity that exist in the country are discussed in the following sub-sections highlighting their status and trends.

1.2.1 Ecosystem Diversity

Based on its geographic and biogeographic features, the country has rich diversity in its ecosystems. These in generic term are: Hill ranges; Evergreen and semi-evergreen forests; Dry-deciduous and moist deciduous forests; Grasslands; Reedlands; Floodplains; Rivers; Low-lying islands (Charlands); Ox-bow lakes (*Baors*); River backswamps (*Haors*); Open woodlands (Village Grove); Low-lying deep depressions (*Beels*); Ponds/canals/ditches; Estuary; Coastal mudflats, Coastal islands; Mangrove swamp; Coral-bearing island; and Marine ecosystems.

Keeping in mind the main biophysical characteristics, the ecosystems of Bangladesh are broadly clustered as: (a) Terrestrial, (b) Inland Water, and (c) Marine and Coastal. The status and trends of specific ecosystems under these broad clusters are discussed in the following sub-sections.

1.2.1.1 Terrestrial Ecosystem

Considering the biophysical characteristics of Bangladesh, terrestrial ecosystems are discussed under forest ecosystem and homestead ecosystem.

A. Forest Ecosystem

Forests are one of the major biodiverse areas in Bangladesh. Based on the classification of forest types of Indo-Pakistan Sub-continent, ecologically there are mainly four types of forests in Bangladesh. The main forest types and the area are shown in Tables 1 and 2.

Table 1 Area of Forests Managed by the Bangladesh Forest Department

Forest Type	Area (million hectare)	% of total land
Hill Forests	0.67	4.65
Natural Mangrove Forests	0.60	4.07
Mangrove Plantations	0.14	0.97
Plain Land Sal Forests	0.12	0.83
Total	1.53	10.54

Source: Alam, 2008

Table 2 Forest Area under Different Management Categories

Category of Forest	Area (million hectares)	% of total land
Managed Forests (Bangladesh Forest Department)	1.53	10.54
Unclassed State Forests (Ministry of Land)	0.73	5.07
Village Forests (private)	0.27	1.88
Total	2.53	17.49

Source: BFD, 2012

A recent survey on Bangladesh forests (Aitrell *et al.*, 2007), however, presents a bit different data. Of the total forest area, 84% has been classified as natural forest and 16% as plantation forest (Table 3).

Table 3 Total Forest Areas of Bangladesh by National Land Use Classes. All area is in hectares

Forest Area	Category and area	National Land Use Classes and Area	% of total forest land	
14,42,000	Natural forest 12,04,000	Hill Forest	551,000	38.2
		Sal Forest	34,000	2.3
		Mangrove Forest (salt water)	436,000	30.2
		Bamboo or mixed Bamboo/ Broadleaved forest	184,000	12.7
	Forest plantations 237,000	Long rotation forest plantation	131,000	9.1
		Short/medium rotation forest plantation	54,000	3.8
		Mangrove plantation	45,000	3.1
		Rubber plantation	8,000	0.5

Source: Aitrell *et al.*, 2007

Distribution of tree cover in Bangladesh as given by Aitrell *et al.* (2007) is shown in Table 4.

Table 4 Tree Cover in Bangladesh

Sl. No.	Category	Area (in million hectares)
1	No tree-cover (Mostly agricultural land)	7.60
2	Less than 5% tree-cover	2.89
3	5 to 10% tree-cover	1.43
4	10 to 30% tree-cover	1.27
5	30 to 70% tree-cover	1.23
6	Over 70% tree-cover	0.33
	Total	14.75

Source: Aitrell *et al.*, 2007

However, the Perspective Plan of Bangladesh (2010-2021) entitled 'Making Vision 2021 a Reality' (GED, 2012a), reported that the recorded state-owned forest land (not necessarily supporting tree cover), and potential forest/tree growing areas, has been identified as 7 million acres, which is 20% of the land area. Trees are reported to cover 12% of the land where considerable prospects for improvement exist. The coastal plantation has been established using various plant species during 1965–2013 covers approximately 209,140 hectares (Table 5).

Table 5 Coastal Plantation During 1965-2013

Forest Division	Plantation types (hectares)						
	Mangrove	Non-mangrove	Nypa plantation	Coconut	Arica	Bamboo & Cane	Strip plantation (km)
Bhola Coastal	39,203.30	1075.10	271.38				1603.17
Patuakhali Coastal	26,607.00	546.50	2601.50				3426.90
Noakhali Coastal	77,684.952	2377.25					3593.84
Barisal Social	8.50						1911.77
Chittagong Coastal (including Cox's Bazar)	48,891.41	4680.68		10	40	280.0	1591.45
Feni Social	491.46	10.0					185.0
Total	192,395.24	8689.53	2872.88	10	40	280	12127.13 (4850.85 ha)

Source: Hassan, 2013

As a whole, the various types of forests in Bangladesh could be categorized in six types which are discussed briefly in Case Box 1.

CASE BOX 1 – Forest Types in Bangladesh

1) Tropical Wet Evergreen and Semi-Evergreen Forests

As reported in the 4th National Report (MoEF, 2010), these two types of forests are present in the form of hilly forests in Bangladesh. Tropical evergreen and semi evergreen forests are extended over the eastern part of the country lying within the divisions of Chittagong and Sylhet totalling 6,70,000 hectares, which is 4.54% of total landmass of the country and 44% of national forest land. The difference between evergreen and semi-evergreen forests are minor and primarily of the presence of few deciduous species in the top canopy layer.

2) Tropical Moist Deciduous Forests (Sal Forests)

The central and northern districts of Bangladesh covering an area of 1,20,000 hectares, which is, about 0.81% of total land mass of the country and 7.8% of the country's forest land. There are three different belts of deciduous forests: the largest belt is known as "Madhupur Garh", the second belt lies along the foothills of the Garo hills and the third belt is located in the northwest part of the country. Sal (*Shorea robusta*) is the main species in these forests with 70 to 100% upper canopy coverage as reported in the Fourth National Report.

3) Mangrove Forests

The largest single tract of natural mangrove forest in the world is the Sundarbans. It consists of a total of 6,01,700 hectares in the Bangladesh part (the rest 40% is in India) which is 4.07% of total land mass of the country and 40% of total forest land. The Sundarban harbours 528 species of trees, shrubs, herbs and epiphytes and 269 species of wild animals.

4) Freshwater Swamp Forest

Freshwater swamp forest consists of flood-tolerant evergreen trees. A fully developed stand exhibits a closed canopy with mature trees standing 10 to 12 meters tall. These trees mostly produce their seeds in the monsoon period and they disperse them through water; seedlings grow in great quantities.

5) Homestead Forests

Approximately 5% area (0.45 million hectares) of total 8.4 million hectares of cultivable land is occupied by homesteads (Alam et al., 2008). There are 25.53 million homesteads in Bangladesh (BBS, 2011) that fulfill basic needs of the people such as fruit, food, shelter, cash etc and high species diversity of the homestead help to reduce the environmental deterioration. Planting trees near

homesteads is a traditional land use system in Bangladesh. Multi-layered vertical stratification, species diversity, and diversity of economic plants rather than number of individuals per species are characteristic features of Bangladesh homestead forests (Alam et al., 2008).

6) Plantation Forests

In response to the degradation of natural forests and open woodlands, Bangladesh Forest Department has taken comprehensive plantation programme in the form of social forestry coastal plantation and community forestry. During early 1980s, the Department with support from The World Bank organized massive plantation programme on the newly accreted islands at the buffer between the Bay of Bengal and Ganges-Brahmaputra-Meghna region. The purpose of this plantation was to enhance tree cover to stabilize the land and make a green belt along the coast to minimize the adverse impacts of cyclonic storm and tidal surges. The social forestry added a new dimension to the forestry practice in Bangladesh having participation of local community and sharing benefits with the communities. In addition, plantation programme was implemented along the roads, highways, railways and river banks. Later on, the social forestry practices have been furthered by the NGOs and the local government organizations throughout the country.

Status of major forest ecosystems in Bangladesh is described briefly as follows:

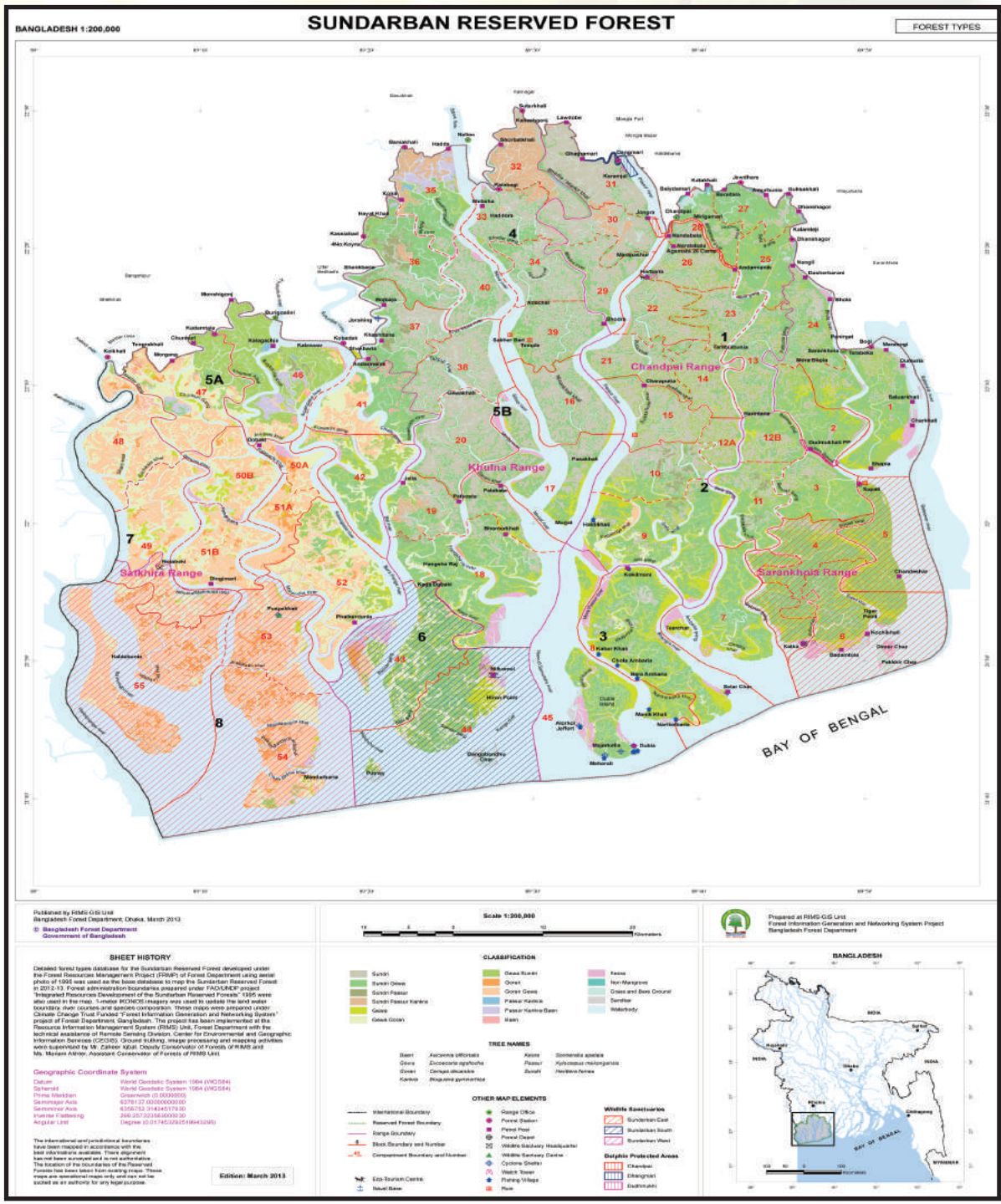
Sundarbans –The Mangrove Forest

The Bangladesh portion of the Sundarban (approximately 60% of the entire forest, the rest falling under the jurisdiction of India) is the largest productive contiguous mangrove forest in the world (Figure 3), located in the south-western part of the country between 21⁰39' and 22⁰30' north longitudes and 89⁰01' and 89⁰52' east latitudes (Hussain, 2014).



Sundarban Mangrove by Asaduzzaman Khan

This was declared as 'Reserved Forest' during 1875-76, and was placed under the Forest Department for management. The Sundarban Reserved Forest is internationally recognized as an important mangrove ecosystem of high biodiversity value. About 1,400 square kilometres of the forest was declared as a World Heritage Site by the UNESCO in 1997, of which 490 square kilometres is water. The Sundarbans has also been recognized as wetlands of international importance (Ramsar Site) under Ramsar Convention in 1992). Different assessments since 1903 reported as high as 504 angiosperms from the Sundarban along with 24 fern species (Rahman, 2015).



A recent compilation (Hussain, 2014) reported 448 species of vertebrates from the Sundarban including 10 amphibians, 58 reptiles, 339 birds and 41 mammals. Many of these are either Endangered or Critically Endangered globally; namely, Bengal Tiger, Fishing Cat, Hoary-bellied Himalayan Squirrel, Ganges River Dolphin, River Terrapin, Olive Ridley Turtle, Masked Finfoot, Spoon-billed Sandpiper, White-rumped Vulture, Pallas's Fish Eagle, Greater Spotted Eagle and Lesser Adjutant. This ecosystem is also country's largest natural fish and crustacean reserve. To date, 225 finfish, 24 shrimp, 12 crab and 48 mollusks along with a number of unidentified species have been found in the Sundarban (Bernacsek, 2001; Huda and Haque, 2003).

Although most of the previous studies emphasized mega-fauna and flora and their economic importance, microscopic flora and fauna which is the basis of whole ecosystem were often overlooked. Rahaman *et al.* (2013) studied the phytoplankton of three major river systems flowing through Sundarbans and found 134 species.

Chittagong Hill Tracts – Hill Forests

The Chittagong Hill Tracts (CHT) located at the south-eastern corner of Bangladesh, extends over 13,294 square kilometres of which 26% is considered as forest area. Hillscapes of the CHT are medium elevated ranges interspersed by low-lying valleys with inter-connected hill streams, gorges and rivers. Ecologically it has tropical wet-evergreen, tropical semi-evergreen, tropical moist-deciduous, tropical open deciduous and savannah forests.

It has Kassalong Reserved Forest (RF) (159,449.7 hectares), Raingkheong RF (76,331.0 hectares), Sitapahar RF (5,876.5 hectares), Barkal RF (235.79 hectares), and Sangu and Matamuhury RF (about 74,500 hectares). There are three protected areas, namely Pablahali Wildlife Sanctuary, Kaptai National Park, and Sangu Valley Wildlife Sanctuary (Table 30).

The mouza forest or Village Common Forest (VCF) is a traditional forest conservation practice in the CHT. It is estimated that there are still over 300 VCFs existing in the CHT – which provide livelihood support to the communities and work as micro-watersheds in the area.



Chittagong Hill Tracts by Barin Ghose

CASE BOX 2 - Village Common Forests in the Chittagong Hill Tracts

Village common forests are natural forests other than the government reserve forests around the households of the indigenous communities and is managed to fulfill their daily demands (Baten et al., 2010; Roy, 2000). Historically, indigenous people practice *jhum* (shifting cultivation) and traditionally keep a patch of forest adjacent to their village, known as a VCF, which is never used for *jhum*. They do so mainly for sustained flow of water in the streams but they also get timber, bamboo and other minor forest products from such forests for household use (AF, 2010). VCFs are good examples of Effective community-based forest management under certain customary rules and regulations (Baten et al., 2010).
Source: Uddin and Inoue (2012)



A village common Forest including water flow CHT, Arannayk Foundation, 2015

A few detailed studies have been conducted to show the species diversity trend of the forests of the CHT, namely Sitapahar and Rampahar. Harun-Ur-Rashid and Chowdhury (2013) recently added 43 taxa (38 dicots and 5 monocots) to the plant list of Sitapahar Reserved Forest. The total number of angiosperm species from Sitapahar (373 hectares area) now stands 375. A survey conducted between 2001 and 2008 found 89 monocot (Uddin and Hassan, 2012a) and 500 dicot species from Rampahar area (648 hectares). Uddin and Hassan (2012b) also reported 41 pteridophyte species under 26 genera of 13 families from the Rampahar-Sitapahar area, which constituted 21% of total 195 species of fern flora of the country.

Sal Forest

The plain land forests of Bangladesh, commonly known as Gazari or Sal forests are located in the Gazipur, Tangail and Mymensingh districts in the central region and in the greater Dinajpur, Rangpur, and Rajshahi districts in the northern region. The Sal forests originally comprise an area of 120,255 hectares of notified forests under the control of Bangladesh Forest Department, out of which 104,616 hectares (87%) are located in the central region and 15,639 hectares (13%) in the northern region.

Most of the Sal forests are now severely degraded and poorly stocked. These are, in fact, the worst hit of all the forests in the country and the last National Forest Resources Assessment reported that the Sal forests areas of Bangladesh is now only 34,000 hectares (Altrell et al., 2007). Madhupur National Park is one of the last remaining patches of old-growth Sal forest left in the country. The associates of Sal include *Mallotus philippensis*, *Schleichera oleosa*, *Protium serratum* and *Dillenia pentagyna*. About 7,314 acres of Madhupur Sal forests areas were converted to rubber gardens, e.g. Pirgacha rubber garden, Chandpur rubber garden, Sontoshpur rubber garden and Kamalapur rubber garden. Besides, there are a number of exotic species planted in the national park area, for example *Acacia auriculiformis*, *Acacia mangium*, *Eucalyptus camaldulensis* and *Tectona grandis*. At present, most of the forest land in Madhupur has been denuded, degraded or encroached upon or taken over for the

commercial production of pineapples, bananas, the industrial plantation of rubber and exotic fuel-wood species (Gain, 2004, in Hossain *et al.*, 2013). Changes in soil properties due to deforestation have been reported in the Sal forests (Hossain *et al.*, 2010)

B. Agro-Ecosystem

Farming practices in Bangladesh are complex and diverse and are largely controlled by physical, biological, climatological and socioeconomic factors. These different environments are suitable for different crops and cropping patterns under irrigated and non-irrigated conditions. In Bangladesh, more than 300 different crops are presently cultivated many of which are endemic.

Bangladesh has been divided as thirty agro-ecological zones and 88 subzones on the basis of physiography, soil properties, soil salinity, depth and duration of flooding which are relevant for land use and for the assessment of agricultural potential. The general agroecological variations of Bangladesh range from below sea level-basins to small hills. People of this land have come from various socio-ecological positions of the sub- continent as well as from other continents of the world. People over the centuries have been cultivating, preserving, and using more than 1,364 plant species coming from both endemic and exotic origins, for about 85 diverse uses.

Farming practices largely depend on the cropping seasons in Bangladesh. There are two distinct cropping seasons in a year: Kharif (monsoon) and Rabi (winter). The major crop of Kharif season is paddy and jute, while crops grown in Rabi season are much more diverse and comprise of paddy, vegetables, wheat, pulses, oilseeds, spices, potatoes and others. Among all the crops, rice is the most dominant because of its adaptability in diverse ecological conditions prevailing in the country.

There are about 1,000 species of medicinal herbs. Ethnic groups distributed in different areas have been involved, over centuries, in collecting and preserving the highly rich biodiversity to meet their regular needs. Many varieties of rice, jute, sugarcane, cotton, linseed, mustard, cucumber, beans, gourds have also been selected and raised by the people who have been living in this area for about 8-10 thousand years. Women cultivate a fairly large number of flora in their homesteads and cultivated lands to meet family needs

C. Homestead Ecosystem

Most of the homestead ecosystems in the floodplains consist of a small pond, backyard jungles, bushes and kitchen gardens. Homesteads in the hilly terrain are usually tiny hillocks with its valley and hilly streams. Homestead ecosystems in the coastal zone having backyard mangroves with inter-tidal canals and ditches. Despite the conversion of natural features in the homestead ecosystems, a wide range of wild flora and fauna are still occurring in good abundance. In addition, in most of the villages there are common property resources, like fallow land, lakes and *bee/s*. Notable among these, Ram Sagar, Nil Sagar, Durga Sagar and Alta Dighee are good examples of community-based freshwater reservoir with high abundance of aquatic biodiversity.



Homestead at Ruma, Bandarban by Hossain Sohel

Homesteads of Bangladesh have a long heritage of growing timber and fruit trees, along with other perennial shrubs and herbs. Species composition and number of species in the homesteads of Bangladesh are variable. Abedin and Quddus (1990, in Islam *et al.*, 2013) reported that the number of plant species (excluding vegetable species) in the coastal areas was higher (70 species) than those found in the homesteads of Tangail (52 species), Ishurdi (34 species), Jessore (28 species), Patuakhali (20 species), Rajshahi (28 species) and Rangpur (21 species) districts. Homestead gardens are significant sources of fruits, timber, fuelwood, swan, veneer logs and bamboo of Bangladesh. In this way, the homesteads of the country are vital sources of livelihood for many farmers and serve as the safety net during the time of hardship and natural disasters.

CASE BOX 3- One Home One Farm Activities and Investment

The Government of Bangladesh has taken a project titled *Ektee Bari Ektee Khamar* or One House One Farm (OHOF) to ensure agro livelihood and family farming through e-financial inclusion and empowerment of the smallholders and under privileged (Table 6). The project started in fiscal year 2010-2011 with BDT 11970 million i.e US\$ 153 million for 9,640 villages that scaled up to 17,300 villages with BDT 14920 million i.e US\$ 191 million and finally the project has revised on July 30, 2013 with BDT 31630 million i.e US\$ 400 million for 40,527 villages. This programme has been contributing largely to increase homestead vegetation through nursery and kitchen gardening and also to the increase animal stocks through fisheries, poultry and livestock and hence contributing to conservation of local varieties of plants and animal genetic resources.

Table 6 Activities and Investment of the Project *EKTEE BARI EKTEE KHAMAR*.

Sl. No.	Small Farm	Number of Farms	Investment (BDT Million)
1	Fisheries	92,100	1290
2	Poultry	182,800	1830
3	Livestock	186,600	3350
4	Nursery	43,600	440
5	Kitchen gardening	48,400	580
6	Others	126,500	1510
Total		680,000	9000

Source: *EKTEE BARI EKTEE KHAMAR PROJECT*, Rural Development and Cooperative Division, Ministry of Local Government, Rural Development and Cooperatives

1.2.1.2 Inland Water Ecosystem

Bangladesh is a land of water bodies. Wetlands constitute more than 50% territory of the country and play important role in social and economic livelihood of the population. The wetlands in Bangladesh encompass a wide variety of ecosystems including: the main rivers (the Ganges, the Brahmaputra and the Meghna) and their 700-plus tributaries and distributaries; about 6,300 *beels* (permanent and seasonal shallow lakes in floodplain depressions); at least 47 major *haors* (deeply flooded depressions in the north-east), *baors* (oxbow lakes); vast areas of seasonally flooded land; and fish ponds and tanks. The inland water ecosystems of Bangladesh are categorized as follows:

Floodplain

Floodplain occupies a greater part of the landscape and offers important habitats of species of wild flora and fauna. The total area of floodplain of Bangladesh is 28,26,792 ha (DoF, 2015). The country has taken a number of initiatives to conserve floodplain biodiversity. Mentionworthy some of them are Padma-Jaumuna floodplain at Manikganj district; Surma-Kushiyara Floodplain at Sunamganj district; Madhumati Floodplain at Goplaganj district (IUCN, 2005); and Jamuna floodplain at Pabna district (Aziz *et al.*, 2014). In all these areas the 'community-based wetlands conservation model was replicated creatively and are success cases of conservation and wise-use of wetlands biodiversity. At these sites, hreatened species of flora and fauna were conserved successfully and the common species having economic value were used sustainably with a tremendous improvement of livelihoods of the local communities.

Rivers

Bangladesh is a riverine country criss-crossed with numerous rivers and their tributaries. Three mighty rivers: the Ganges, the Brahmaputra and the Meghna along with their innumerable tributaries form one of the richest habitats of fishes in the Indian Subcontinent. The other main rivers are the Karnafuli, the Matamuhuri, the Halda and the Sangu rivers in the southern Chittagong sub-region, the Surma, the Kushiara, the Kangsha and the Someshwari in the north-east region and the Tista, the Korotoa, the Atrai, the Bangalee, the Mohananda in the north-west. Annual flooding of these rivers inundates about 70% of the total land surface. The total annual discharge passing through this river system into the Bay of Bengal reaches up to 1,174 billion cubic metres (Banglapedia, 2004). According to BWDB (2005), 57 of the rivers are trans-boundary - 54 originate from India and 3 from Myanmar. The river system of Bangladesh is divided into six hydrological regions as shown in Table 7.

Table 7 Hydrological Regions of River System in Bangladesh

Hydrological region	Number of rivers	Length (kilometre)	Catchment area (square kilometre)
North West Region	96	4,908	63,718
North Central Region	20	1,311	18,404
North East Region	55	3,250	47,616
South East Region	24	1,320	10,068
Eastern Hilly Region	17	1,131	6,253
South West Region	98	4,969	35,576
Total	310	16,889	181,635

Source: BWDB, 2005

The rivers of Bangladesh have a great importance in respect of fisheries and other hydrological and navigation benefits. Rivers are the migratory routes of fishes with adjacent

floodplains and vice-versa. Many riverine fishes migrate to upstream (floodplain) in order to spawn in nutrient-rich water.

Beels

The *beel* is a static waterbody that accumulates surface run-off water through an internal drainage channel (Banglapedia, 2004). This type of shallow, seasonal waterbody is common in low-lying floodplain areas throughout Bangladesh. The total area of *beel* in Bangladesh was estimated to be 114,161 hectares, occupying 27% of the inland freshwater (Ahmed *et al.*, 2007).

The most famous *beel* in the country is Chalan Beel located in the north-west region. The other major *beels* in this region are Hilna, Kosba, Uthrail, Manda, Sobna and *Beel* Mansur. In the central region, *Arial Beel* and *Balai Beel* now lost their importance as natural fish habitat. Other important *beels* in this region are Chanda, Boro, Mollar and Tungipara Beels. There are many beels in the south and south-west and the notable are Chapaigachi, Garalia, Panjiapatra, Chenchuri and Dakatia *Beels*.

Haors

The *haors* are back swamps or bowl-shaped depressions between the natural levees of rivers, or in some cases, much larger areas incorporating a succession of these depressions. The *haors* vary in size from as little as a few hectares to thousands of hectares. There are altogether 411 *haors* (47 major and large sized) comprising an area of about 8,000 square kilometres dispersed in the north-eastern Sylhet and Mymensingh districts. In greater Sylhet, the most prominent *haors* are Shonir, Hail, Hakaluki, Dekar, Maker, Chayer, Tanguar and Kawadighi Haors. In consideration of the environmental importance and heritage, the Government of Bangladesh has decided to conserve Tanguar Haor (9,500 hectares) by symbolizing it as an Ecologically Critical Area (ECA) under the Environment Conservation Act 1995 and registered as a wetland of international importance (Ramsar site, site no. 1031, declared in 2000) under the Ramsar Convention. Hakaluki Haor is also declared and managed as an ECA.

Baors

In the southwest region of Bangladesh there are a number of meandering rivers changed their courses, part of the old course got silted up and cut-off from the main course. As a result horse-shoe shaped oxbow lakes, known as *baor*, were created. A *baor* apparently looks like a lake, but unlike lakes, it remains connected with original river through channels during monsoon. This way, the *baors* annually receive fresh supply of riverine water carrying fry, fingerlings and adult fishes and other aquatic animals. *Baors* are very important wetlands of Bangladesh and support a wide range of aquatic flora and fauna. There are more than 87 *baors* in Bangladesh covering an area of 5,488 hectares (DoF, 2008). Most of the larger *baors* are in the south-western Jessore region. The important *baors* of the country are *Arial*, Bahadurpur Baluhar, Bookbhara, Harina, Habullah, Rustampur, Ichhamati, Jaleshwar, Jogini Bhagini, Joydia, Kannadah, Kathgara, Khedapara, Marjat, Pathanpara, Rampur, Sagarkhali, Sirisdia and Sonadia *Baors*.

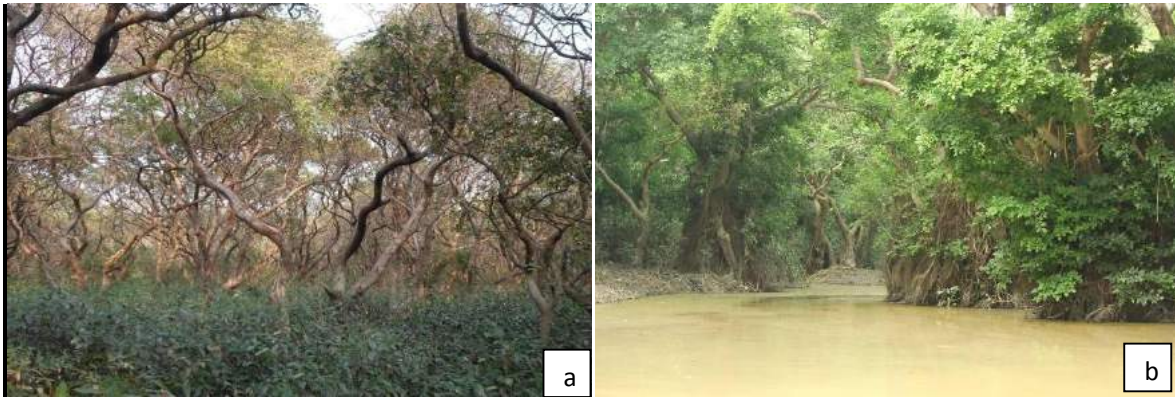
In addition to above inland wetlands ecosystems, five important freshwater ecosystems of Bangladesh are briefly described below to showcase their importance in terms of biodiversity of the country and beyond.

Ratargul Swamp Forest

Ratargul is a small freshwater swamp in the *haor* basin of north-east region of Bangladesh. It is the last stronghold and refuge of fresh water swamp forest biodiversity in the country. The forest is situated in the broad zone of Surma-Kushiyara Floodplain of the Bio-ecological Zone

(Nishat *et al.*, 2002). The ecosystem is a typical freshwater wetland forest that remains dry in winter, but inundated to a depth of about 8 feet during monsoon. Chowdhury *et al.* (2004) reported 73 species of flora and 230 species of fauna from Ratargul.

It is a two-storied forest of which the top story is mostly *Pongamia pinnata* (Koroj), sporadically mixed with *Barringtonia acutangula* (Hijol), *Ficus religiosa* (Ashwathwa) and *Syzygium fruticosum* (Jam). In the past, these areas used to be managed through 'pollarding' wherein the branches and a few tops used to be cut as harvest at 4-year cycle to yield *katha* (structures made of bamboo and tree branches to provide protection for fish in the sancturay). The local fishermen use these *kathas* to create a micro-habitat by plunging them into the water to attract fishes and harvest them later. The bottom story is composed mostly of *Schumannianthus dichotomus* (Patipata or Murta). Its height is from 2 to 2.5 metres. The cover of patipata is quite dense.



Ratargul Swamp Forest by M.Z. Hossain (a) and M.M. Feeroz (b)

Species diversity is very rich in this swamp. Mentionworthy flora of the swamp are : *Barringtonia acutangula*,, *Pongamia pinnata*, *Crateva religiosa*, *Salix tetrasperma*, *Schumannianthus dichotomus*, *Phragmites karka*, *Rosa clinophylla*, *Saccharam spontaneum*, *Phyllanthus reticulatus*,, *Ficus religiosa*, *Ficus benghalensis*, *Asclepias curassavica*, *Oryza latifolia*, *Oryza rufipogon*, *Cyperus iria*, *Cyperus malaccensis*, *Nymphaea rubra*, *Nymphaea pubescens*, *Euryale ferox*, *Trapa bispinosa*, *Monochoria hastata* *Hemarthria protensa*, *Hygrophiza aristata*, *Vallisneria spiralis*, *Echinochloa colona*, *Echinochloa stagnina* and *Polygonum plebeium*. This forest also carries a number of medicinal plants such as *Asparagus racemosus*, *Centella asiatica*, *Crataeva magna*, *Hemidesmus indicus* and *Mimosa pudica*. *Calamus guruba* (Rattan) plantations have been raised at suitable locations of this forest. Indian strawberry (*Duchesnea indica*), the wild rose of Bengal (*Rosa clinophylla*) and Jhara Dhan (*Oryza rufipogon*) are three threatened species (as cited by Sobhan *et. al* 2012) of the country are still available in the area.

Ratargul is rich in faunal diversity as well. Nine amphibians (1 bufonid, 2 microhylid, 4 ranid and 2 rhacophorid), 20 reptiles, 4 snakes (*Bungarus caeruleus*, *Bungarus fasciatus*, *Naja kaouthia* and *Naja naja*), 175 species of birds and 26 species of mammals are found in this forest. Important wild fauna are: Swamp butterflies, Spiders, Honey Bees, Leech, Swamp frogs, Tree frogs, Cricket Frogs, Microhyla, Lizards, Vine Snake, Golden Flying Snake, Water Snake, Rat Snake, Cobras, Green Pit Viper, Spotted Pond Turtle, Indian Roofed Turtle, Shikra, Fish Eagle, Brahminy Kite, Black Kite, Peregrine Falcon, Spotted Greater Whistling Teal, Northern Shoveller, Northern Pin-tail, Green-winged Teal, Red-crested Pochard, Eurasian Wigeon, Great Egret, Little Egret, Pond Heron, Night Heron, Marsh Warbler, Watercock, Water Hen, Pheasant-tailed Jacana, Common Moorhen, Purple Moorhen, Whiskered Tern, Painted Snipe, Little Cormorant, Oriental Darter, *Rhesus macaque*, Bengal

Fox, Flying Fox, Vampire, Smooth-coated Otter, field rats, and shrews. The site is also important feeding and breeding grounds of several rare fish and mollusk species.

Tanguar Haor

Tanguar Haor has outstanding conservation value, being natural fresh water wetlands in the north-eastern region, seasonally harboring more than 60,000 individuals of migratory water birds belonging to 60 species. This wetland is an important fish habitat comprising about 140 species. In 2000, Tanguar Haor became the 2nd Ramsar site of the country. It is currently managed by the MoEF. Since December 2006, the MoEF is implementing a community-based management project in Tanguar Haor through IUCN with support from the Swiss Agency for Development and Cooperation.



Freshwater swamp, Tanguar Haor by ABM Sarowar Alam

The biodiversity of Tanguar Haor has recently been documented in several compilations covering amphibians, reptiles, birds and mammals and swamp flora (Sobhan *et al.*, 2012). Table 8 compares species diversity of Tanguar Haor in 20 years interval.

Table 8 Changing Trend of Species Diversity in Tanguar Haor, Sunamganj

Groups	In 1990s	In 2010-11
Fauna		
Mammals	34 ^a	19 ^a
Birds	219 ^a	167 ^a (84 migratory, 83 resident)
Reptiles	34 ^a	27 ^a
Amphibians	11 ^a	11 ^a
Fish	141 ^a	No updated data
Flora		
Ferns	2 ^b	4 ^a
Monocots	29 ^b	32 ^a
Dicots	49 ^b	68 ^a

Sources: ^aSobhan *et al.*, 2012; ^b MoEF, 2001

Hakaluki Haor

Hakaluki Haor is one of the major wetlands of Bangladesh. With a land area of 18,386 hectares, it supports a rich biodiversity and provides direct and indirect livelihood benefits to nearly 190,000 people. In Hakaluki Haor, there are 289 interconnecting *beels*, 387 canals, 24 rivers, and a huge area of floodplains. Miah (2010) observed that the 83% of *beels*, 94.45% of rivers and 97% of canals became degraded at



Fishing in Chokya Beel, Hakaluki Haor by Mahbulul Alam Miah
different levels. A total of 115 fish were documented under 72 genera and 27 families of which 107 were indigenous and eight exotics. Number of Critically Endangered species was 8, Endangered 21, Vulnerable 13, Not Threatened 50, Data Deficient 13, and Not Evaluated species 10. Among the small fishes *Gudusia chapra* was the most dominant species (43.93%), whereas *Glossogobius giuris* was the lowest (1.37%) by weight. Among the major carps, *Labeo rohita* was the most dominant species (28.75%) and the lowest was the *Labeo calbasu* (16.69%). Fish production was found maximum in floodplain (5,590.44 metric tons) followed by *beels* (1,603.04 metric tons) and rivers and *khals* (282.94 metric tons), and the total fish production was 7,476.42 metric tons during study period in Hakaluki Haor (Miah, 2010).

Chalan Beel

Chalan Beel is the largest and most important watershed in the north-central Bangladesh. It comprises of a series of depressions interconnected by numerous channels to form more or less one continuous sheet of water during monsoon covering an area of about 375 square kilometres. The watershed serves about five million people predominantly through fisheries and agriculture. Though far from its past glory, Chalan Beel is still an abode of large variety of fish with a huge importance in local economy and people's livelihood. During the dry season, the water area decreases down to 52-78 square kilometres and looks like a cluster of small *beels* of different sizes. Besides being a giant junction of a number of water ways, the *beel* also served a springboard where many rivers flowed further south and east to meet finally with the River Padma and the Brahmaputra (Iqbal, 2006).

Most of the rivers and small *beels* of Chalan Beel are at the risk of partial or total degradation due to manifold reasons like agricultural encroachment, siltation along with other anthropogenic activities. The critical dry out condition (0-5% of the monsoon size) was observed in 83% of the rivers and 68% of the *beels* in the lean season (Hossain *et al.* 2009). Recently, 114 fin fish species belonging to 29 families were recorded from Chalan *Beel* (Hossain *et al.*, 2009).

Kaptai Lake

There are three true natural lakes in Bangladesh; Rainkhyongkine and Bogakine located in the CHT and Ashuhila Beel, tremendously disturbed and deteriorated by human activities, in the north-west part of Dhaka. The largest man-made lake in South Asia is Kaptai Lake of 68,800 hectares (surface area - 58,300 hectares). The H-shaped Kaptai Lake, the only major reservoir in Bangladesh was created from the construction of dam across the river Karnafuli near Kaptai town in 1961. It has drowned almost the whole of the middle-Karnafuli valley and the lower reaches of the Chengi, the Kasalong and the Rinkhyong Rivers. Shoreline and the

basin of Kaptai Lake are very irregular. The volume of the lake is 524,700 cubic metres with a mean depth 9 metres (maximum depth is 32 metres and mean water level fluctuation is 8.14 metres). Although the lake was created primarily with a vision to generate hydroelectric power, it substantially contributes to the national economy through freshwater fish production, navigation, flood control and agriculture. The lake is confined within the hill district of Rangamati and embraces sub-districts of Rangamati Sadar, Kaptai, Nannerchar, Langadu, Baghaichhari, Barkal, Juraichhari and Belaichhari.

In 2007-08 fish production in Kaptai Lake was 8,248 metric tons with an average of 120 kilograms per hectare. At the early stage of the creation of lake, Indian major carps were the dominant species of about 60% of total catch, which is reduced to 5.69% in 2007-08. Presently

the major catches in the Kaptai lake are kachki (*Corica soborna*) and chapila (*Gudusia chapra*), both contributing equally to 60% of the total catch. Halder *et al.* (2002) recorded 66 species of indigenous fish in the lake. The major Cypriniforms available in the lake are *Catla catla*, *Cirrhinus mrigala*, *Labeo rohita*, *L. calbasu*, *L. goinus* and *Puntius sarana*.



Fishing in Chokya Beel, Hakaluki Haor by Mahbulul Alam Miah

1.2.1.3 Coastal and Marine Ecosystem

Bangladesh coastline extends 710 kilometres starting from St. Martin’s Island in the south-east to the Sundarban mangroves in the south-west. The coastline consists of three major divisions - the eastern, central and western. Bangladesh’s maritime boundary has been extended by 118,813 square kilometres comprising 12 nautical miles of territorial sea and an exclusive economic zone (EEZ) extending up to 200 nautical miles into the high seas (Case Box 4).

Bangladesh is a part of the Bay of Bengal Large Marine Ecosystem (BOBLME) which is one of world’s 64 large marine ecosystems. It comprises the coastal waters of the Maldives, Sri Lanka, India, Bangladesh, Myanmar, Thailand, Malaysia and Indonesia. It is reported that more than 400 million people in this region depend upon the 6.2 million square kilometres marine ecosystem for their foods, livelihoods and security (Christie and Ole-Moiyoi, 2011). Therefore, the conservation imperative is very high in this region in terms of the marine resources.

The eastern coast of Bangladesh is comparatively stable whereas the central coast is very dynamic with highest rate of accretion and erosion. The western coast is dominated by mangrove forest system. The status and trends of the mangroves is detailed out under the sub-section 1.2.1.1 (Terrestrial Ecosystem).

The central coast has been identified as the stepping stone, staging ground and wintering ground of more than 100 species of migratory shore birds belonging to East Asia-Australasian and Central Asian flyways. Bangladesh coast supports more than 10 globally threatened

migratory shorebirds, including Spoon-billed Sandpiper, Asian Dowitcher, Spotted Redshank, Nordman's Greenshank, Goliath Heron and Indian Skimmers.

The east coast of Bangladesh is an important breeding ground for three species of marine turtles (Rashid and Islam 2005). The only coral community is located on the east coast in association with high diversity and moderate density of marine algae and mollusks. The west coast, on the other hand, supports breeding ground for *Batagur baska*, Masked finfoot, the Bengal Tiger, Saltwater Crocodile, King Cobra, White bellied Sea Eagle, and Ganges River Dolphin to name a few.



Batagur (River Terrapin) captive breeding and re-introduction in the coast of Bangladesh by ABM Sarwar Alam

The main ecosystems of the coastal zone are: (a) Coral-associated Island, (b) Sandy beach, (c) Small islets, (d) Sand dunes, (e) Inter-tidal mudflats, (f) Grasslands, (g) Reed lands, and (h) Mangrove forest. Bangladesh coastal zone is well-connected with a vast network of estuaries of the Ganges-Brahmaputra-Meghna river systems.

The Department of Fisheries declared a marine reserve in the year 2000 under section 28 of the *Marine Fisheries Ordinance, 1983* (Ordinance No. 35 of 1983). The area of the reserve is estimated to be 69,800 hectares (or 698 square kilometres) (Figure 4).

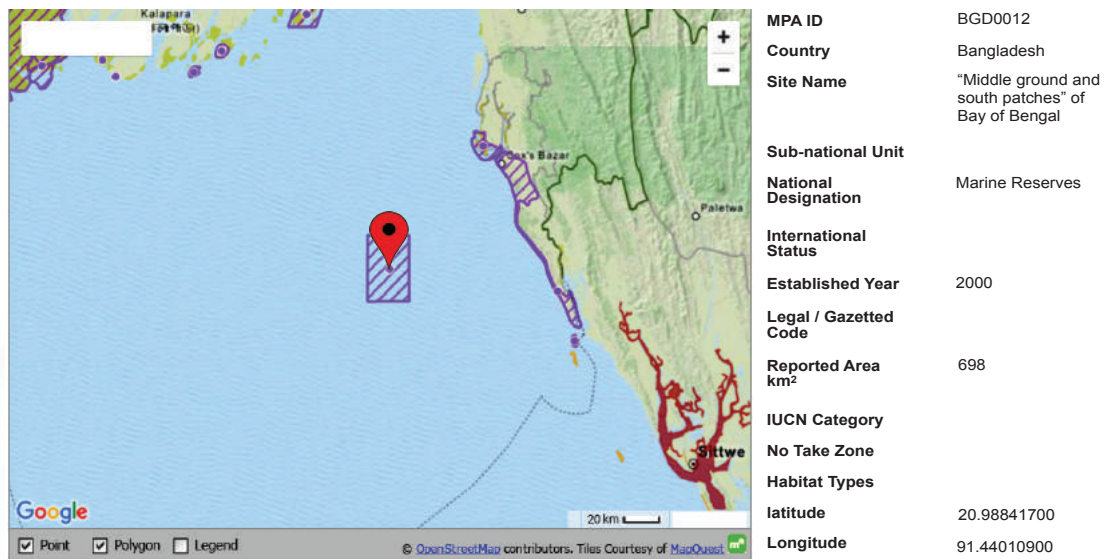


Figure 4 Marine Reserve of Bangladesh (area surrounding red pin in the centre)

CASE BOX 4 - Maritime Boundaries in Bangladesh

On 14 March 2012, the International Tribunal for the Law of the Sea (ITLOS) delimited the maritime boundary of Bangladesh in the Bay of Bengal with Myanmar in an equitable manner (MoFA, 2012). Before this verdict, undisputed sea area of Bangladesh was around 50,000 square kilometres. That has been increased by another 50,000-60,000 square kilometres along with the maritime resources.

Two years later, on 7 July 2014, the Arbitral Tribunal at the Permanent Court of Arbitration, The Hague, declared its verdict on the matter of the Bay of Bengal maritime boundary between Bangladesh and India. On the basis of the Tribunal's delimitation line, an adjustment was made to the provisional equidistance line (The Arbitral Tribunal, 2014). This adjustment increased Bangladesh's maritime area by 19,467 square kilometres. As a result the area appertaining to Bangladesh east of the delimitation line stands 118,813 sq. km (Bhuiyan et al. 2015).

Both verdicts have now settled long-pending maritime boundary disputes between Bangladesh and its two neighbours. It also opened up the opportunity to explore marine resources in and under the water in a planned way, including marine biodiversity.

CASE BOX 5-Newly Accreted Area – Riverine Estuary



According to a newspaper report (Newage, 13 April 2014), there had been no assessment of land accre, inland and/or coastal since the independence of the country. That report summarized several expert opinions and published a map originally prepared by the Institute of Water Modeling, Bangladesh (IWM) (Figure 5).

The map shows the locations of cross-dams studies suggested along Sandwip, Urirchar and Jahajer Char in the Bay that could reclaim about 1,000 square kilometres of land in 30–35 years; the report suggests. It was also reported that according to experts the gross gain of land in the Meghna estuary and the sea was bigger in size than the gross land loss had been taking place over the last 50 years.

Figure 5 Possible Land Accretion Sites at the Meghna Estuary (Source: IWM, collected from Newage website, accessed on 25 July 2015)

The marine biome in the Bay of Bengal bordering maritime boundary with Myanmar, Sri Lanka and India is an important biodiversity area as far as the cetaceans and shorebirds are concerned. Whale, dolphin and porpoises species are recorded recently from the Swatch of no-Ground numbering over 15,000 individuals. Government of Bangladesh has declared the Swatch of no-Ground of the Bay of Bengal as marine protected area on 27 October 2014 (Table 30).

The newly accreted low-lying inter tidal islands in the estuary, coast and at Bay are very rich ecosystem in terms of its biomass productivity. In addition to having the mudflats as the wintering ground of migratory shorebirds, the channels in the central coast are plentiful in

macro-benthos and other invertebrates. Among them crustaceans, nematodes and helminthes are found in super-abundance. Inter tidal creeks having luxuriant growth of different types of algae which are the major food source of wild ducks and geese that used to visit the area in large numbers. The islands and its surroundings are also comprised of various types of habitats, such as network of inter tidal creeks inside mangroves, massive mudflats, grassland, reed land, sand flats, sand beaches, sand dunes and deeper channels. This area also shows abundance in crustaceans and estuarine fish populations. The channels around the newly accreted lands are good abode of River Terrapin, Marine Turtles, Ganges River Dolphin and Irrawaddy Dolphin. Several kilometers of inter tidal sand flats at the southern tip of Nijhum Dweep facing the Bay of Bengal is the most high-ranking staging ground of 10,000 to 20,000 migratory birds during winter quarter (Khan, 2012).

1.2.2 Species Diversity

Bangladesh is rich in species diversity of the flora and fauna. The unique geo-physical location, tropical climate and fertile landmass are the underlying factors to support such diverse communities.

1.2.2.1 Floral Diversity

The Encyclopedia of Flora and Fauna of Bangladesh (2007-2009) contains a comprehensive list of plant species of Bangladesh. It recorded 3,611 taxa of angiosperms from the Bangladesh territory. It has recently been noted that, between June 2009 and June 2013, 64 angiosperm species were recorded from Bangladesh and 8 were described as new to science (Irfanullah, 2013). In addition to that, very recently, Bangladesh National Herbarium has reported 50 angiosperm species as new records for the country (Ara and Khan, 2015). A comparison of compiled data between the World and Bangladesh is presented in Table 9.

In case of other plant groups, the Encyclopedia reported 3,002 algal taxa (including Cyanobacteria) under 424 genera and 127 families. Being microscopic, there exists tremendous possibility to discover new algal species in Bangladesh. For example, a four-season sampling of a couple of waterbodies in the tea gardens of Srimangal, Moulvi Bazar district revealed 421 algal taxa of which 130 were found for the first time in Bangladesh and 3 were new to the biologists (Irfanullah, 2013). Continuous new records of both macroscopic and microscopic flora justify the need for a complete inventory of Bangladesh flora in order to have a good understanding of the biodiversity trend.

Table 9 Floral Diversity in Bangladesh

Plant group	Number of species described	
	World (estimated)	Bangladesh (observed)
Virus/Bacteria	8,050	470
Algae	40,800	1988+
Fungi	90,000	275
Lichen	13,500	51*
Bryophytes	14,500	248
Pteridophytes	12,000	195
Gymnosperms	650	7
Angiosperms	250,000	3,733°

Sources: World - MoEF/Gol (2014); Bangladesh - updated MoEF (2010) through literature review and stakeholder consultations; *Aptroot and Iqbal (2011), °Based on Ara and Khan (2015)

Combined together, Rampahar-Sitapahar Reserved Forests (around 1000 hectares) harbour a total of 786 angiospermic species (595 dicots, 148 monocots, 1 gymnosperm and 42

pteridophytes). Similarly, Uddin and Hassan (2012b) also reported 41 pteridophyte species belonging to 26 genera under 13 families from the Rampahar-Sitapahar area. This exemplifies the richness of Bangladesh flora, especially in the CHTs. A summary of some noteworthy studies that collected information on forest species is provided in Annex: Table 3.

Additionally, major species that are used in plantations in Bangladesh are shown in the Table 10. In 1978 and onwards, extensive trials of *Eucalyptus* and *Acacia* species started to find out the very fast growing exotic species for some difficult sites. Later on, a trend of planting *Eucalyptus* and *Acacia* were getting preferences in plantation programmes. But a Government ban on *Eucalyptus* prevented its large scale plantation programmes. However, individual interest on *Eucalyptus* is still observed in planting around homesteads and marginal lands (Hossain and Hoque, 2013).

Table 10 Tree Species Mostly Used in Plantations in Bangladesh

Sl.No.	Scientific name	Common name
1.	<i>Acacia auriculiformis</i>	Akashmoni
2.	<i>Acacia nilotica</i>	Babla
3.	<i>Albizia lebbeck</i>	Kala koroï
4.	<i>Albizia procera</i>	Sada Koroï
5.	<i>Artocarpus chaplasha</i>	Chapalish
6.	<i>Chukrassia tabularis</i>	Chikrassy
7.	<i>Dalbergia sissoo</i>	Sissoo
8.	<i>Dipterocarpus turbinatus</i>	Tellya Garjan
9.	<i>Eucalyptus camaldulensis</i>	Eucalyptus
10.	<i>Gmelina arborea</i>	Gamar
11.	<i>Hevea brasiliensis</i>	Rubber
12.	<i>Hopea odorata</i>	Telsur
13.	<i>Lagerstroemia speciosa</i>	Jarul
14.	<i>Leucaena leucocephala</i>	Ipil-ipil
15.	<i>Michelia champaca</i>	Champa
16.	<i>Neolamarckia cadamba</i>	Kadam
17.	<i>Falcataria moluccana</i>	Malakana koroï
18.	<i>Pinus caribaea, P. oocarpa</i>	Pine
19.	<i>Senna siamea</i>	Minjiri
20.	<i>Swietenia macrophylla</i>	Mahogany
21.	<i>Syzygium grande</i>	Dhaki jam
22.	<i>Tectona grandis</i>	Teak
23.	<i>Toona ciliata</i>	Toon
24.	<i>Xylia xylocarpa</i>	Lohakat

Source: Hossain, 2014

Marine plant diversity is yet to be exhaustively explored in Bangladesh. Limited explorations have been done by far on the open sea waters. The Bay of Bengal Programme under its regional initiative carried out studies on fisheries resources of the Bay of Bengal and prepared a preliminary checklist of fish and other marine organisms. According to *Encyclopedia of Flora and Fauna of Bangladesh* (Volume 3 & 4), there are 50 species of brown algae (Order: Laminariales, also known as kelp), 82 species of red algae (Class: Rhodophyceae), and 26 species of green algae (Class: Chlorophyceae). Almost all seaweed species are found in St. Martin's Island. In Bangladesh, 5 seagrass species have so far been reported from

Bangladesh coast, namely *Halodule uninervis* (Forsskal) Ascherson, *Halophila beccarii* Ascherson, *Halophila decipiens* Ostenfeld, *Halophila pinifolia* (Miki) Den Hartog and *Ruppia maritima* L. (Kamal and Short, 2009). Seagrass beds are unique ecosystems harbouring marine biodiversity, providing significant ecosystem services. However, given sporadic and limited occurrence, studies on seagrass are limited in Bangladesh.

1.2.2.2 Faunal Diversity

Bangladesh harbours rich faunal diversity (Table 11) in its wide range of ecosystems. A comparison of faunal diversity of the world and Bangladesh showed tremendous diversity despite high human population density and small geographical area of the country. Moreover, as inventorying goes on, the list of species might continue to increase. For example, between 2009 and 2014, 22 amphibians and 27 reptiles have newly been recorded for Bangladesh (Feeroz *et al.*, 2014). A total of 706 bird species recorded in Bangladesh represent 7.2% of the world's total species. Of these, 383 are resident species, 218 winter visitors, 11 summer visitors and 94 vagrants. The mammal diversity on land and in the water is equally rich with 128 species (2.8% of the world's total species) found in Bangladesh, of which 7 are marine mammals (Hasan *et al.*, 2015, personal communication). Two species of mammals have newly been recorded from Bangladesh after 2010 (Feeroz *et al.*, 2011, 2012). In Bangladesh, so far 2,360 species of insects have been recorded (B.A. Bhuiya, 2015, personal communication). A stocktaking of country's insect richness based on secondary sources is given in Annex: Table 12.

Table 11 Faunal Diversity in Bangladesh

Taxonomic group	Number of species described	
	World	Bangladesh
Protozoa	31,250	175
Porifera	5,000	29
Cnidaria	10105	102
Ctenophora	100	10
Rotifera	2,500	76
Gastrotricha	3,000	4
Platyhelminthes	17,511	126
Nematoda	30,028	176
Mollusca	66,535	479
Echinodarmata	6600	46+
Arthropoda	1,181,398	5000+
Pisces (fish)	32,120	475 (marine) 267 (freshwater)
Amphibia	6,771	49
Reptilia (reptiles)	9,230	154
Aves (birds)	9,026	650
Mammalia (mammals)	5,416	128

Sources: World - MoEF/Gol (2014); Bangladesh - updated MoEF (2010) through literature review and stakeholder consultations; Islam (2003); Hasan *et al.* (2015, personal communication); Hossain *et al.* (2015, personal communication)

There is a positive change noticed in the protected areas in terms of increased diversity in species of wildlife and their population numbers. The avifauna species number, for example, which was 149 in 2000, had increased to 249 in 2003 and 270 in 2014 (SRCWP, 2014).

Several new mammalian and avian species were recorded in the protected areas after 2010 indicating proper management of these areas (Feeroz, 2013; Feeroz *et al.*, 2011, 2012).



Migratory ducks at Tanguar Haor by ABM Sarowar Alam

Bangladesh is a host of wide range of invertebrate diversity. Table 12 reflects a partial state of species diversity of invertebrate fauna and Table 12 in Annex shows the recorded species of insect fauna.

Table 12 List of Invertebrates so far Recorded from Bangladesh

Sl. no.	Phyla	No. of species recorded	References	
1	Protozoa	175	Kabir <i>et al.</i> , (eds.), 2008	
2	Prorifera	29	Kabir <i>et al.</i> , (eds.), 2008	
3	Cnidaria	102	NCS Report, 1997 Kabir <i>et al.</i> , (eds.), 2008	
4	Ctenophora	10	Kabir <i>et al.</i> , (eds.), 2008	
5	Rotifera	76	Kabir <i>et al.</i> , (eds.), 2008	
6	Gastrotricha	04	Kabir <i>et al.</i> , (eds.), 2008	
7	Platyhelminthes	126	Kabir <i>et al.</i> , (eds.), 2008	
8	Nematoda	176	Kabir <i>et al.</i> , (eds.), 2008	
9	Annelida	98	Kabir <i>et al.</i> , 2009	
10	Echinodermata	46	NCS Report 1997 Kabir <i>et al.</i> , 2009	
11	Acanthocephala	28	Kabir <i>et al.</i> , 2009	
12	Bryozoa (Minor Phyla)	07	Kabir <i>et al.</i> , 2009	
13	Kinorhyncha (Minor Phyla)	02	Kabir <i>et al.</i> , 2009	
14	Chaetognatha (Minor Phyla)	03	Kabir <i>et al.</i> , 2009	
15	Mollusca	470	Siddiqui <i>et al.</i> , (eds.), 2007	
16	Arthropoda	Crustacea (Zooplankton)	164	Bhouyain and Asmat (1992); Ahmed <i>et al.</i> (2008)
17		Crustacea (Crabs)	39	Shafi and Quddus, 1982; Chowdhury and Hafizuddin, 1991; Ameen, 2001; Siddiqui and Zafar, 2002; Ahmed <i>et al.</i> , 2008
18		Crustacea (Shrimps & Prawns)	62	Ahmed <i>et al.</i> , 2008; Hossain, 2013
19		Insecta	2360	Bhuiya, 2015 (personal communication)
20		Arachnida (Scorpion & spiders)	431	Ahmed <i>et al.</i> , 2009
Total		4408		

Source: Bhuiya, 2015 (personal communication)

Among the fauna, insects play a vital role in regulating the ecosystem and contribute to sustainability of the biodiversity. Feeroz *et al.* (2011) recorded 43 butterfly species and 11 species of other groups of insects from Rema-Kalenga Wildlife Sanctuary in Shatchari, Sylhet. Forty-four species of butterflies were recorded from Butterfly Research Park in Bhawal National Park in 2012 (Bashar, 2014). In the same year, researchers reported more than 100 species of insects of various groups including butterflies, dragonflies, damselflies, bees, wasps, beetles, mantids, grasshoppers and others from Dudpukuria-Dhopachari Wildlife Sanctuary of Bandarban. They also listed 70 butterflies, 25 dragonflies & damselflies, and 10 species of grasshoppers from Teknaf Wildlife Sanctuary in 2013. Bhuiya (1983-2014) recorded nearly 450 species of parasitic Hymenoptera from Bangladesh. In 2004, a total of 311 butterfly species was recorded from Bangladesh; Larsen (2004) reported 236 species, whereas another 75 species were recorded by previous researchers (Alam, 1962a, 1962b; Ameen and Chowdhury, 1968; Begum and Begum, 1986; Alam and Ullah, 1995, in IUCN 2014). Another 12 species were reported in 2013 and 2014 making the total 323 species (Khandaker *et al.*, 2013; Neogi *et al.*, 2014; Shahadat *et al.*, 2014). Four new species of butterflies were recorded from Kaptati National Park (Case Box 6).

CASE BOX 6– Four New Species of Butterflies Recorded from Kaptai National Park



a. Dark Pierrot



b. Banded Ace



c. Indian Ace



d. Short-horn Ace

Newly recorded butterfly species of Bangladesh by Tahsinur Rahman Shihan

Four new species of butterflies were recorded from the Kaptai National Park during a recent survey in October 2013 to November 2014 by the research team of Monitoring and Conservation of Wildlife in Kaptai National Park of Bangladesh project under the SRCWP Project supported by Bangladesh Forest Department and the World Bank. These four species are Dark Pierrot, Banded Ace, Indian Ace and Short-horn Ace. Three of them belong to family Hesperidae and one to family Lycaenidae (Khan, 2014, personal communication).

Marine fauna in Bangladesh includes prawn, shrimp, crab, lobster, mollusks, turtles and zooplankton. Brief description of these groups is given as follows. Hossain (2013) updated the checklist and documented 62 prawn and shrimp in Bangladesh territory. Under the on-going Updating Redlist of Bangladesh Project of IUCN, a total of 125 prawn, shrimp, crab, and lobster species and 37 zooplankton species (Table 13) have been listed for assessing the current conservation status. There are about 336 molluscs and 3 starfish/echinoderms have also been reported from the Bangladesh territory (Hossain *et al.*, 2014).

Table 13 Zooplanktons Reported from Freshwater and Marine Environment of Bangladesh

Sl.No	Scientific name (Reference)	Family	Phylum/Sub-phylum
1	<i>Eubosmina coregoni</i> (Baird, 1857)	Bosminidae	Crustacea
2	<i>Brachionus angularis</i> (Gosse, 1851)	Brachionidae	Rotifera
3	<i>Brachionus calyciflorus</i> (Pallas, 1766)	Brachionidae	Rotifera
4	<i>Brachionus caudatus</i> (Barrois and Daday, 1894)	Brachionidae	Rotifera
5	<i>Brachionus bidentata</i> (Anderson, 1889)	Brachionidae	Rotifera
6	<i>Brachionus havanaensis</i> (Rousselet, 1913)	Brachionidae	Rotifera
7	<i>Brachionus plicatilis</i> (Mueller, 1786)	Brachionidae	Rotifera
8	<i>Brachionus rubens</i> (Ehrenberg, 1838)	Brachionidae	Rotifera
9	<i>Ceriodaphnia reticulata</i> (Jurine, 1820)	Daphniidae	Crustacea
10	<i>Cryptocyclops bicolor</i> (Sars, 1863)	Cyclopidae	Crustacea
11	<i>Diacyclops nanus</i> (Sars, 1863)	Cyclopidae	Crustacea
12	<i>Cyprois occidentalis</i> (Sars, 1926)	Cyclopidae	Crustacea
13	<i>Daphnia lumholtzi</i> (Sars, 1885)	Daphniidae	Crustacea
14	<i>Daphnia magna</i> (Straus, 1820)	Daphniidae	Crustacea
15	<i>Diaptomus gracilis</i> (Sars, 1862)	Diaptomidae	Crustacea
16	<i>Diaptomus pygmaeus</i> (Pearse, 1906)	Diaptomidae	Crustacea
17	<i>Filinia longiseta</i> (Ehrenberg, 1834)	Filiniidae	Rotifera
18	<i>Filinia terminalis</i> (Plate, 1886)	Filiniidae	Rotifera
19	<i>Hexarthra mira</i> (Hudson, 1871)	Hexarthridae	Rotifera
20	<i>Keratella cochlearis</i> (Gosse, 1851)	Brachionidae	Rotifera
21	<i>Keratella quadrata</i> (Muller, 1786)	Brachionidae	Rotifera
22	<i>Keratella tropica</i> (Apstein, 1907)	Brachionidae	Rotifera
23	<i>Lepadella imbricata</i> (Harring, 1916)	Lepadellidae	Rotifera
24	<i>Macrocyclus distinctus</i> (Richard, 1887)	Cyclopidae	Crustacea
25	<i>Macrothrix laticornis</i> (Jurine, 1820)	Macrothricidae	Crustacea
26	<i>Mesocyclops dybowskii</i> (Lande, 1890)	Cyclopidae	Crustacea
27	<i>Thermocyclops inversus</i> (Kiefer, 1936)	Cyclopidae	Crustacea
28	<i>Moina brachiata</i> (Jurine, 1820)	Moinidae	Crustacea
29	<i>Moina macrocopa</i> (Straus, 1820)	Moinidae	Crustacea
30	<i>Moina reticulata</i> (Daday, 1905)	Moinidae	Crustacea
31	<i>Monostyla lunaris</i> (Ehrenberg, 1832)	Lecanidae	Rotifera
32	<i>Paracyclops fimbriatus</i> (Fischer, 1853)	Cyclopidae	Crustacea
33	<i>Platylas patulus</i> (Mueller, 1786)	Brachionidae	Rotifera
34	<i>Polyarthra vulgaris</i> (Carlin, 1943)	Synchaetidae	Rotifera
35	<i>Trichocerca cylindrica</i> (Imhof, 1891)	Trichocercidae	Rotifera
36	<i>Trichocerca similis</i> (Wierzejski, 1893)	Trichocercidae	Rotifera
37	<i>Trichotria tetractis</i> (Ehrenberg, 1830)	Trichotriidae	Rotifera

Source: Updating Red List Project of IUCN Bangladesh, 2015



Shrimps and crabs - (Clock-wise) - Nymph Snapping Shrimp, Mud Spiny Lobster, Mangrove Horseshoe crab, Blue swimming crab, Field crab, Ghost crab and Common Squillid Mantis Shrimp (photo by Mostafa A R Hossain, M. Enamul Hoq and Mohammed Noman)

Molluscs are the single largest marine animal group (phylum), making up almost one-fourth of all known species (Benkendorff, 2010, in Hossain *et al.*, 2014). Although studies on marine molluscs started in the Bangladesh territory in the early 1940s (Commans, 1940, in Hossain *et al.*, 2014), comprehensive studies on these groups had always been limited. In 1990, an extended list was produced by Ahmed (1990, in Hossain *et al.*, 2014) containing 301 species from the Bangladesh coast.



Marine Molluscs of Bangladesh (Source: Hossain *et al.*, 2014)

Hossain *et al.* (2014) recorded 317 molluscs' species from Kutubdia, Moheshkhali and Sonadia off-shore islands. Out of these species, 141 belonged to gastropods (including 20 identified up to genus level) and 176 were bivalves (including 51 identified up to genus level). A total of 181 (57% of 317 species) were recorded for the first time from Bangladesh. In

another study (2013-2014) on the molluscs of St. Martin's Island, 41 species were recorded for the first time from St. Martin's (Sarker *et al.*, 2014). Nevertheless, the total number of mollusc species recorded in this study was 70, much less than previous two studies 113 (Ahmed, 1990) and 132 (MoEF, 2001) (in Sarker *et al.*, 2014). Both studies show that much of Bangladesh's marine mollusc diversity remains unexplored and the coastal ecosystems are changing rapidly.

Table 14 summarizes marine faunal species number. There is an overall reduction in the number of bony fish species over a period of 12 years since 2001, whereas the shrimp species number doubled. Also, lobster count decreased and molluscs increased considerably. In addition to habitat change, study methods used may also have influenced these numbers.

Table 14 Marine Fauna Present in Bangladesh

Group of organism	Number of species		
	Hossain (2001)	Islam (2003)	Ahamed <i>et al.</i> (2012)
Bony fish	475	475	442
Cartilaginous (soft-boned) fish	50	–	–
Shrimp	25	24	56
Crab	15	50	16
Lobster	5	–	3
Mollusc	301 (6)	301 (3)	336
Starfish/Echinoderms	3	–	4
Marine Turtles	5	5	5
Whale/Dolphin	11	–	–

The coastal and marine waters of Bangladesh supports five species of sea turtles - Olive Ridley Turtle, Green Turtle, Hawksbill Turtle, Loggerhead Turtle and Leatherback Turtle. Olive Ridley and Green turtles are common while Hawksbill, Loggerhead and Leatherback turtles are rare. Due to



Marine Turtle by Sayam U. Chowdhury

serious degradation and manifold threats in off-shore and in-shore areas over the last three decades, turtle nesting is now confined only to some undisturbed sandy beaches in St. Martin Island, long sandy beach from Sahporirdwip to Cox's Bazar Sahporirdwip including Teknaf Bordal Kochopia, Inani Monkhali, Sonadia Island, Kutubdia Island, Sandwip, Egg Island, Mandarbaria, Dubla Island and sandy beaches of Sundarban area (Rashid and Islam, 2005).

Out of five sea turtles, only three species have been found to nest, including Hawksbill Turtle in St. Martin's and other nesting rookery only supported Olive Ridley and Green Turtles in some areas (Rashid 1997). The nesting populations are extremely small comparing the size of rookeries resulted by the indiscriminate loss of nesting ground through development and disturbance, mortality of population stock in the sea by commercial shrimp trawl net and gill-net (Sea Turtle Project, Bangladesh).

1.2.2.3 Status and Trends of Threatened Species

A. Flora

It has been widely recognized long since that many plant species are threatened in Bangladesh. Lists of threatened plants have been produced since early 1990s (Irfanullah, 2011). Khan *et al.* (2001) published the first volume of *Red Data Book of Vascular Plants of Bangladesh* apparently following IUCN Red List categories. Although this book listed 106 species, only four can be identified as threatened as per the IUCN Red List categories: *Aldrovanda vesiculosa* (Malacca jhangi), *Corypha taliera* (Talipalm), *Knema bengalensis* (Khude Barala) and *Licuala peltata* (Chata Pat/Kurud) (Irfanullah, 2011).

According to the *Encyclopedia of Flora and Fauna of Bangladesh* (2007-2009; Volumes 5-12), 486 vascular plants are threatened in Bangladesh (Irfanullah, 2011) (Table 15). The second volume of *Red Data Book of Vascular Plants of Bangladesh* includes 120 species as threatened following IUCN's latest Red List categories and assessment process (Ara *et al.*, 2013) (Table 8 in Annex). M.A. Rahman (2013, personal communication) also assessed 13 angiosperm families containing 520 species and categorized 235 species into different threatened categories. Challenge remains to have a clear, acceptable and comprehensive evaluation of the flora of Bangladesh following latest guidelines of the IUCN Red List.

Table 15 Number of Threatened Species in Major Vascular Plant Groups According to the *Encyclopedia of Flora and Fauna of Bangladesh*

Vascular plant groups	Total no. of species	Critically Endangered (CR)	Endangered (EN)	Vulnerable (VU)	Total no. of threatened species (% of total species)
Pteridophytes	195	0	0	36	36 (18.46)
Gymnosperms	7	0	1	0	1 (14.29)
Angiosperms	3,611	30	126	293	449 (12.43)
Dicotyledons	2,623	8	80	179	267 (10.18)
Monocotyledons	988	22	46	114	182 (18.42)
Total	3,813	30	127	329	486 (12.75)

Source: Irfanullah, 2011

A1. Boilam

Boilam (*Anisoptera scaphula* (Roxb.) Kurz) is a very tall resinous tree with a straight bole attaining a height of 30-45 metres and a girth of 3.0-4.5 metres. Deforestation and overexploitation significantly reduced the species in natural forests and at present at the highest risk of extinction. The species is native to Bangladesh and occurs sporadically in the high forests of Chittagong, Chittagong Hill Tract and Cox's Bazar forest areas. However, currently few individuals of the species is only found in Saplapur, Silkhali and Swankhali beats of the Cox's Bazar South Forest Division; Bengdepha and Bhomarioghona of Cox's Bazar North Forest Division; Hazarikhil of Chittagong North Forest Division; Dudpukuria-Dopachari Wildlife Sanctuary and Tonkabati Forest Beat of Chittagong South Forest Division. In natural forests, the scattered populations are either in lone individuals or as stands of 2 or 3 boilam trees in some pockets of the forests. Small scale plantations of young boilam are also established in some forests areas.

A2. Civit

Civit (*Swintonia floribunda*) is one of the threatened tree species once found abundant in the hill forests of Bangladesh. Once the species was considered as D-class (not good timber) and available in association with some other hardwood tree species in hill forests. But now this species is becoming rare because of indiscriminate felling and use by the plywood industries. It is commonly used for veneer, plywood and boat making. It also yields a high quality pulp and fibre.

The individuals of this species are disappearing due to forest fragmentation, deforestation, illegal felling, jhum, clearing of land for agriculture and so on. However, very few planted trees are also found in Satgaon Tea Estate in Sri Mongal, Hyanko Rubber Estate and Sitakunda Eco-Park. Inadequate natural regeneration has been observed in the Satgaon Tea Estate and natural stands of Tankawati and the recruitment is also very poor. Pablakhali of Bagaichari once was famous for both the civit and White Wing Wood Duck (Bhadi Hans) nesting in the trees those are now not available. White Wing Wood Duck, an indicator species, has disappeared due to loss of habitat and nesting places indicating the importance of conserving the native flora before complete extinction.

Except the Rajghat and Bhomorioghona Forest Beats of Cox's Bazar North Forest Division, civit is found scattered in single to a few individuals. According to the Forest Officials, Sangu Reserve supposed to have some good stock of civit along with some other native hardwood tree species.

A3. Talipalm

Talipam (*Corypha taliera* Roxb) under Arecaceae is a tall monocarpic palm with a straight bole attaining a height of 25 metres and a girth of 1 metre. It was assessed as Critically Endangered plant by Khan *et al.* (2001).



William Roxburgh was the man who found the plant in 1919 from Bengal. It is endemic to Bengal, however, not found in wild at present. One record of this palm growing in a village near Shantiniketan in Birbhum district in West Bengal, India, was cut down in 1979. Another plant in wild was reported to grow in Birganj Upazila in Dinajpur district about 35 years ago and was also cut down immediately after flowering. The last known individual of the species in the Dhaka University campus between the Jagannath Hall and Isa Khan Staff quarters was discovered in the early 1950s in a scrub Jungle. The plant produced flowers in September 2008 and died in 2010 after ripening numerous fruits.

Tali palm by Akhtaruzzaman Chowdhury

At present no known mature individual exists either in the wild or under cultivation in the world. However, a number of person and institutions collected ripen fruits from that plant for raising seedlings. Department of Botany of the University of Dhaka and Endangered Plants and Animals Conservation Foundation, Bangladesh have raised more than a thousand of seedlings and planted in different places/ institutions/ botanic gardens/ parks of 64 districts of the country. Those seedlings seemed to be growing successfully.

A4. Banspata

Banspata (*Podocarpus neriifolius*) is a large, glabrous evergreen tree with whorled branches. It is a medium large canopy tree (up to 30 metres high) with cylindrical straight bole (60-100 centimetres girth) or sometimes markedly fluted. This species belongs to the family Podocarpaceae. Banspata, a native gymnosperm of Bangladesh once naturally occurred in the forests of Chittagong Hill Tracts (Publakhali) and Cox's Bazar (Ukhia), Lawachara Forest of Sreemongal, Kassalong and Massalong Reserve in Bagaichari. Coppicing of this gymnosperm were found in the Ukhia natural forest of Cox's Bazar South Forest Division. However, due to deforestation of the natural forests, this species has become endangered in its natural habitat.

A total of 111 Banspata trees/ saplings were explored through an extensive field visit from the forests and botanical gardens of the country (Table 7 in Annex). Of them, only 10 trees were found in the natural forests and the remaining 101 trees/ saplings are planted for research or aesthetic purposes (Bhuiyan *et al.*, 2014).

B. Fauna

Bangladesh has already lost at least 13 wildlife species, most of which are large mammals. Many of the wildlife species have been facing continuous threat of extinction. Bengal tiger (*Panthera tigris*) once found all over the country, but now restricted to the Sundarban. Wild Asian Elephants of the country are also facing threat of extinction due to habitat loss and increased human-elephant conflicts. No confirmed record of Eurasian Otter (*Lutra lutra*) is in the country for the last two decades. Primates of the country are also facing different level of threats. Apart from natural habitat some of the primate species are also found in and around human settlements which is causing increased interaction between human and primates and ultimately increasing risk of bidirectional disease transmission (Feeroz, 2013, personal communication).

The *Red List of Threatened Animals of Bangladesh* remains the only published document on threatened animals of the country (IUCN Bangladesh, 2000). This important document is now being updated (Case Box 7). Status of inland and resident vertebrates of Bangladesh according to Bangladesh National Criteria has been unchanged to a total of 201 of threatened and 323 data deficient species (IUCN Bangladesh, 2000, in MoEF, 2010).

Besides, some studies are being conducted on threatened species of Bangladesh in collaboration with the BFD. For example, in 2013, radio-telemetry study of Burmese python (*Python bivittatus*) and Elongated Tortoise (*Indotestudo elongata*), both endangered species, was initiated in Lawachara National Park in Moulovi Bazar (Rahman *et al.*, 2014).

CASE BOX 7– Red List of Animals in Bangladesh

In 2013, Bangladesh Forest Department took a project named SRCWP in collaboration with IUCN Bangladesh with the financial support from the World Bank to update the Red List of Animals of Bangladesh. A rigorous assessment process has been developed in consultation with experts from Bangladesh and around the globe. A total of 1,608 species of different animal groups are now being assessed since 2014 as per the assessment guidelines of IUCN (Table 16).

Crustaceans and butterflies have been included in the assessment for the first time in Bangladesh. After the assessment and review, assessed species will be gradually uploaded on the website of IUCN Bangladesh's Red List seeking public validation and feedback. Once the validation process is completed, the updated Red List is expected to be published by the end of 2015. The project aims at publishing six volumes on mammals, birds, amphibians & reptiles and fishes (in English) and an introductory volume both in English and Bangla.

Table 16 Group-Wise Distribution of Species Recorded and to be Assessed

Group	No. of species recorded	No. of species to be assessed
Crustaceans	185	141
Butterflies	323	302
Fishes	653	255
Amphibians	34	49
Reptiles	154	173
Birds	650	566
Mammals	121	122
Total		1,608

Source: Updating Red List project of IUCN Bangladesh, 2015

Bangladesh has a number of species that has been iconic to the species' biodiversity globally as well as bearing cultural values and traditions. Some of these represent the so called flagship species, keystone species and bio-indicator species. However, these species are all threatened; as their common attribute. The following section will give a snapshot of the status and trends of a number of such faunal species.

B1. Fish Species

The open water fish diversity of Bangladesh has been negatively impacted by a series of natural and anthropogenic actions. These range from siltation of waterbodies to over-exploitation of natural fisheries to changing the habitats from small- to large-scale development interventions. As a result, many fish species, like *Hemibagrus menoda*, *Barilius barila*, *Botia dayi*, *Raiamas bola*, *Psylorhynchus sucatio*, *Scistura corica*, *Labeo pangusia*, *Labeo angra*, *Botia lohachata*, *Barilius barila*, *Chagunius chagunio*, *Gogangra viridescenes*, *Silonia silondia*, *Setipinna phasa*, *Laguvia shawi* and *Crossocheilus latius* have become locally endangered.

According to the *Red Book of Threatened Fishes of Bangladesh* (IUCN Bangladesh, 2000), 54 indigenous riverine fishes of Bangladesh are threatened at various degrees. However, there have been massive changes in riverine fish diversity in the first decade of this century. According to a survey conducted by the Fish Museum & Biodiversity Centre (FMBC) of Bangladesh Agricultural University during 2000-13, more than 100 riverine fishes are presently under threat and 25 fish (Table 17) were not observed in Bangladesh for more than last 20 years, thus could be extinct from Bangladesh waters (FMBC, 2013).

Table 17 Possibly Nationally Extinct Riverine Fishes of Bangladesh

No.	Family	Scientific name	Common English name	Bangla name	Habitat*
Cypriniformes					
1	Balitoridae	<i>Balitora brucei</i>	Grays Stone Loach		R
2		<i>Schistura dayi</i>			R
3	Cobitidae	<i>Neoeucirrhichthys maydelli</i>	Goalpara Loach		R
4		<i>Pangio oblonga</i>	Java Loach	Panga	R
5	Cyprinidae	<i>Salmostoma acinaces</i>	Silver Razorbelly Minnow	Chela	R
6		<i>Danio dangila</i>	Moustached Danio	Nipati	R
7		<i>Esomus lineatus</i>	Striped Flying Barb	Darkina	R-E
8		<i>Garra annandalei</i>	Annandale Garra	Ghorpoiya	R
9		<i>Labeo dero</i>	Kalabans	Kursa	R
10		<i>Labeo nandina</i>	<i>Kulta Labeo</i>	Nandina	R
11		<i>Osteochilus hasseltii</i>	Silver Sharkminnow		R
12		<i>Raiamas guttatus</i>	Burmese Trout	Bhol	R
Siluriformes					
13	Amblycipitidae	<i>Amblyceps laticeps</i>	Indian Torrent Catfish		R
14	Erethistidae	<i>Laguvia shawi</i>		Kani Tengra	R
15		<i>Laguvia ribeiroi</i>	Painted Catfish	Kani Tengra	R
16	Schilbeidae	<i>Ailia punctata</i>	Jamuna Ailia	Kajoli	R-E
17	Siluridae	<i>Pterocryptis gangelica</i>			R
18	Sisoridae	<i>Nangra bucculenta</i>		Gang Tengra	R
19		<i>Nangra nangra</i>		Gang Tengra	R
20		<i>Nangra ornata</i>		Gang Tengra	R
21		<i>Pseudecheneis sulcata</i>	Sucker Throat Catfish		R
Perciformes					
22	Ambassidae	<i>Ambassis nalua</i>	Scalloped Perchlet	Nalua Chanda	R-E
23	Channidae	<i>Channa barca</i>	Barca Snakehead	Pipla	R
24	Osphronemidae	<i>Pseudosphromenus cupanus</i>	Spiketail Paradisefish	Koi	R-E
Beloniformes					
25	Hemiramphidae	<i>Dermogenys brachynotopterus</i>	Gangetic Halfbeak	Ekthuita	E-R

Source: FMBC, 2013; *R-Riverine and E-Estuarine

Cryogenic Gene Banking of Fish

The sperm cryopreservation (preservation of fish sperm in liquid Nitrogen at -196 °C) protocol for different fish species seems variable and species-specific. Although fish is the main protein source in Bangladesh and the fish biodiversity and production from open water are declining, little attention has been paid to cryopreservation of fish sperm. In Bangladesh, research on fish sperm cryopreservation started in early 2004. The studies have focused on aquacultured or commercial species and so far none of the threatened species have been considered (Table 18). Cryogenic sperm banks for more fish need to be established as means of germplasm conservation in Bangladesh.

Table 18 Cryopreservation of Sperm of Some Indigenous Fish Species in Bangladesh	
Local name	Scientific name
Cypriniformes (Carp)	
Catla	<i>Catla catla</i>
Rohu	<i>Labeo rohita</i>
Calibaus	<i>Labeo calbasu</i>
Mrigel	<i>Cirrhinus mrigala</i>
Sarpunti	<i>Puntius sarana</i>
Siluriformes (Catfish)	
Boali pabda	<i>Ompok bimaculatus</i>
Baim	<i>Mastacembelus armatus</i>
Rita	<i>Rita rita</i>
Perciformes (Snakehead)	
Shol	<i>Channa striatus</i>

Source: Hossain et al., 2011

B2. Tiger

Bengal Tiger (*Panthera tigris tigris*) is listed as Critically Endangered in Bangladesh (IUCN Bangladesh, 2000). These were once widespread in Bangladesh. There were reports of tigers in the mixed evergreen Chittagong Hill Tracts, namely valleys of Kassalong-Sajek and Sangu-Matamuhuri both fall within the Tiger Restoration Landscape, (Sanderson *et al.*, 2006, in Ahmed *et al.*, 2009). Currently, the largest remaining population of tigers is in the Sundarban - the largest mangrove forest in the world (Ahmad *et al.*, 2009).

Although some noteworthy works have been published on the Sundarban tigers since the 1970s, relatively little is known about their status and ecology compared with other populations worldwide (Ahmad *et al.*, 2009). Barlow *et al.* (2008, in Ahmad *et al.*, 2009) found higher concentrations of tigers in the south and west of the Sundarban compared to the north and east (Figure 6). A recent study, by using GPS collars, determined the home ranges of two female tigers in the south-east of the Sundarban. The small home ranges (<20

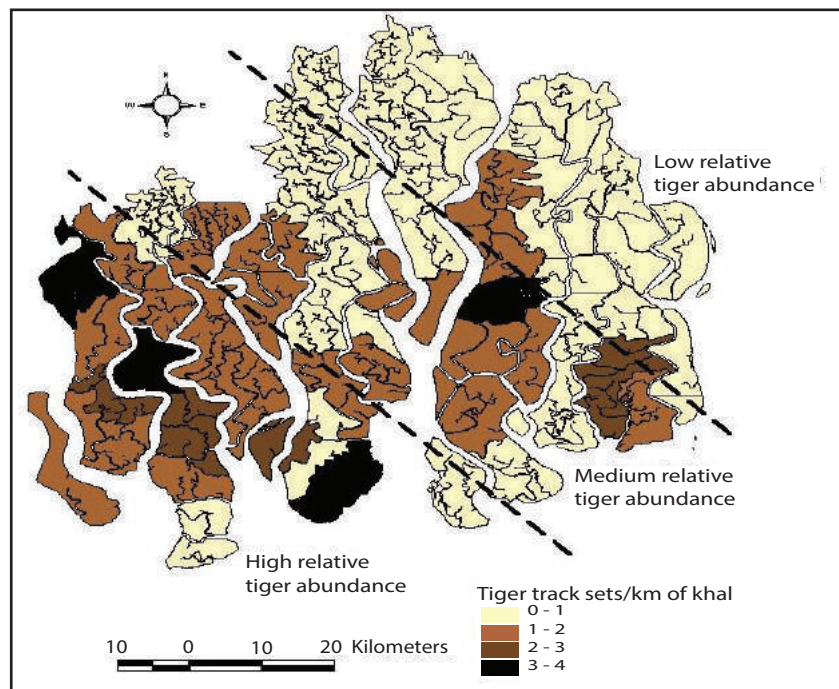


Figure 6 Relative Abundance of Tigers in the Sundarbans of Bangladesh (reproduced from Barlow *et al.*, 2008; in Ahmad *et al.*, 2009)

kilometre squares) of those two tigers indicated a very high tiger density compared to other tiger habitats. Even if tiger home ranges were twice this size in other areas of the forest, the Bangladesh Sundarban could still support 100-150 breeding females or 300-500 tigers (Barlow, 2009; in Ahmad *et al.*, 2009). Other methods tried to determine minimum population size of the tiger. During 2005-2007, camera traps were used to estimate the minimum population size of the Bengal Tiger for the Bangladesh Sundarban (Khan, 2012). The results were extrapolated from the core study area (Katka-Kochikhali, southeastern Sundarbans) to five additional sites using indices of abundance. Tiger density in the core study area was estimated 4.8 tigers per 100 kilometres square. By combining the estimates of this absolute density with indices of abundance, the average tiger density for the Sundarban was estimated 3.7 tigers per 100 kilometre squares. Bangladesh Sundarban (5,770 square kilometres), therefore, harbours at least 200 tigers. In a recent assessment taken by BFD through camera traps came out that tiger population in the Sundarban is 83-130 (BFD, 2015).

B3. Asian Elephant

Asian elephant (*Elephas maximus*), listed as 'Endangered' globally, is categorized as a critically endangered species for Bangladesh (IUCN Bangladesh, 2000). In Bangladesh, elephants were once distributed in the moist deciduous forest of Mymensingh Forest Division, semi-evergreen forests of Sylhet, and evergreen forests of Chittagong and the CHT. Currently, elephant populations are highly fragmented inhabiting within small isolated pockets of south-eastern part of Bangladesh. More specifically under the Forest Divisions of Chittagong South, Cox's Bazar North and South, Rangamati North and South, Rangamati pulpwood, Lama, Bandarban central, Bandarban pulpwood, Sylhet and Mymensingh (IUCN Bangladesh, 2004). However, the elephants of Mymensingh Forest Division are transboundary migrating herds moving seasonally from Meghalaya and Assam states of India in search of food (Motaleb *et al.*, 2011).



Elephant roaming in Himchari National Park in Cox's Bazar by Sultan Ahmed/IUCN Bangladesh

Population of Asian Elephant in Bangladesh never exceeded a thousand. On average 500 elephants roamed in the country through the last decades. But day-after-day, the number is decreasing with an alarming rate mainly due to habitat loss and fragmentation, landuse change and human persecution (IUCN Bangladesh, 2000).

Different researchers and organizations conducted sporadic research by using various methods to find out the number of elephants in Bangladesh. Ranjitsingh (1978) found the number 150, whereas in the same year Olivier (1978) recorded 250. Khan (1985) projected this number at about 200. Gittins and Akanda (1982) estimated the number between 281 and 348. Feeroz *et al.* (2004) projected the number between 151 and 344. In 2004, IUCN Bangladesh conducted elephant population survey and found 178 wild elephants by dung count method and between 196 and 227 by group count method (IUCN Bangladesh, 2004). Currently, an elephant survey is on-going by IUCN Bangladesh under the SRCWP project of the Bangladesh Forest Department. This survey is expected to give an updated estimation of elephant populations of Bangladesh in 2016.

B4. Primates

Bangladesh is the home of 10 species of primates of which eight species are threatened in different categories and remaining two are data deficient (IUCN Bangladesh, 2000). Some of the research on primate distribution, population structure, home ranges, human primate interaction, and human-primate disease transmission have been conducted in the last five years (Hasan *et al.*, 2011, 2013, 2014; Feeroz *et al.*, 2012, Feeroz, 2013, personal

communication). Recent studies focused on morphological studies of *Rhesus macaques* of Bangladesh and found a different lineage from its other geographical population (Feeroz, 2010, personal communication).



Phayre's Langur, Source: Feeroz et al., 2011

B5. Cetaceans: Dolphins, Porpoises and Whales

Bangladesh supports rich cetacean diversity in its fresh and marine waters. The early studies on cetaceans were on the Ganges River Dolphins (*Platanista gangetica gangetica*) in the 1970s (Haque, 1976). Several post-graduate level researches on this species were conducted at the University of Dhaka and Jahangirnagar University. Under the Sustainable Environment Management Programme of the MoEF (1998-2005), IUCN and BCAS worked on dolphin of Chandar beel area.



Ganges River Dolphin by ABM Sarowar Alam

In a survey conducted at eight sites over 79 km in the Padma, Jamuna and Hurashagar-Baral rivers of Pabna district during February to August 2011, a total of 174 dolphins were reported from the land in 72 hours (Rashid et al., 2015). They also reported an average sightseeing rate of 2.68 dolphins per hour from the land. Since 2014, IUCN has been monitoring the post-project impact on the biodiversity, including dolphins, of these habitats. In December 2013, BFD has declared three dolphin sanctuaries in the River Jamuna in the district of Pabna for conservation purposes. Earlier, in 2012, the Government of Bangladesh declared Dhangmari, Chandpai and Dudhmukhi areas of eastern Sundarbans as dolphin sanctuaries.

Wildlife Conservation Society, in 2009, reported nine species of cetaceans from Bangladesh, of them seven are dolphins (Pan Tropical Spotted Dolphin, Irrawaddy Dolphin (*Orcaella brevirostris*), Indo-pacific Bottlenose Dolphin, Indo-pacific Humpback Dolphin, Spinner Dolphin, Rough-toothed Dolphin and False Killer Whale), one is porpoise (Finless Porpoise), and one species of whales (Bryde's Whale). In terms of population size, Bangladesh has the largest population of Irrawaddy dolphins (Smith *et al.*, 2006) - a globally vulnerable cetacean.



The Irrawaddy Dolphin, Source: Bangkok Day Tour

The Government has established the country's first marine protected area 'the Swatch of No Ground Marine Protected Area' on 27 October 2014 that may safeguard whales, dolphins, sea turtles, sharks, and other oceanic species. As a result, it is expected that in future there will be a better understanding of the trend of biodiversity of cetaceans where population distribution and territorial spread could be better identified.



Gangetic Dolphin, Source: Udayan Borthakur

B6. Masked Finfoot

In Bangladesh, Masked Finfoot (*Heliopais personatus*) was recorded only from the Sundarbans. It appears to have declined dramatically and is now known from few sites, occurring at low densities everywhere. Globally, the population may now number as low as 1,000 individuals. It is a nationally (IUCN Bangladesh, 2000) and globally Endangered species. In Bangladesh, the systematic research was initiated in early 2000s (Khan, 2005). Neumann-Denzau *et al.* (2008) later studied the breeding behaviour of the species. In 2011-12, a project entitled 'Ecology, Breeding Behaviour and Conservation of the Endangered Masked Finfoot in Bangladesh' was supported by The Rufford Small Grants Foundation.



Masked Finfoot by Sayam U Chowdhury

B7. Spoon-billed Sandpipers

The Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*) is a globally Critically Endangered migrant shorebird species. First reported in 1987 that this species winters in Bangladesh coasts (Rashid and Scott 1989). The species breeds in the Russian Arctic centre on the coast of the Chukotsk Peninsula known to winter in intertidal habitats in South-East and South Asia, including Bangladesh. A rapid deterioration in the conservation status of the Spoon-billed Sandpiper was first detected in 2000 when breeding-season surveys of sites monitored during the 1970s indicated that a marked decline in the population had taken place (Bird *et al.*, 2010). No further statistics on trends were published. However, there are projects operational since 2014 from which positive trend results are expected in near future. The Government of Bangladesh is protecting the population at its wintering ground in the coastal wetlands and monitoring their migration pattern through using modern radio telemetry devices.



Spoon-billed Sandpiper by Sayam U Chowdhury

1.2.3 Genetic Diversity

Bangladesh is rich in genetic diversity of flora and fauna. Various institutes namely Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Bangladesh Jute Research Institute (BJRI), Bangladesh Tea Research Institute (BTRI), Bangladesh Livestock Research Institute (BLRI), Bangladesh Institute of Nuclear Agriculture (BINA) and public universities have been conducting studies on respective aspects of genetic diversity of flora and fauna of Bangladesh. Some noteworthy work to give a snapshot of the status and trends of genetic biodiversity is described below.

1.2.3.1 Crop Diversity

Agricultural crops show large diversity within species. This diversity present in a species indicates the potentials of crop improvement. The agro-ecological zones (AEZs) of Bangladesh possess diverse germplasm of cultivated plants, their wild relatives and naturally occurring species. Plant Genetic Resources Centre (PGRC) of the BARI acts as a national repository for the BARI-mandate crops, namely cereals (except rice), pulses, oilseeds, vegetables, fruits, spices, tuber crops, flower and ornamentals, medicinal and aromatic plants.

Historically Bangladesh is a unique habitat of rice and considered as center of origin of *indica* rice probably due to its geographical position, diverse land type, topography, rainfall, solar radiation, day-length and temperature variation leading to seasonal disparity that contributed to huge variation in rice biodiversity. Worldwide, 27 rice species have been recognized of which 5 are domesticated in Bangladesh with dominant of *Oryza sativa*. Various types of land races has been adopted across the country those are unique for inheriting one or more special characters such as pest resistance, nutrient efficient, tolerance to drought, stagnant, salinity, heat and cold, high yielding, photoperiod sensitivity, floating ability and so on (Table 19).

Since its establishment, BRRI scientists started collection, preservation and characterizations of germplasms from various parts of the country. About 4600 germplasms are native and others from different sources and/or advanced lines. Total collections of germplasms are shown season and ecosystem wise (Table 20).

So far, BRRI developed 74 modern rice varieties of which 8 are Aus, 34 are T. Aman, 30 are Boro season inbred variety and 4 are hybrid for Boro and T. Aman varieties. A significant number of these varieties has been developed by using native germplasms such as Latisail, Badshahbhog, Zirakatari, Khaskani, Swarnalata, etc. All of these varieties have unique features regarding growth duration, yield, seasonal adaptability, stress tolerance and quality characteristics. BRRI has also identified rice varieties/germplasms for pharmaceuticals perspectives such as

Table 19 Rice Genetic Resources in the BRRI Gene Bank

Variety/Line	Registered in accession
<i>Indigenous indica</i>	
Local landraces	5202
Pure line selection	1030
Exotic indica landraces (IRRI, China, USA, Turkey etc)	790
<i>Exotic/breeding lines</i>	
Wild Rice of Bangladesh (<i>Oryza rufipogon</i> , <i>O. officinalis</i> , <i>O. nivara</i> and <i>Oryza sativa f. spontanea</i>)	42
Wild rice from IRRI	12
Total	8044

Source: BRRI, 2015

Table 20 Ecosystem-wise Genetic Diversity of Rice Germplasm

Season / Ecosystem	Accession in BRRI Gene Bank
Aus (upland ecosystem)	1049
Wet season T. Aman (rainfed lowland ecosystem)	4802
Dry season Boro (favorable ecosystem)	1667
Rice suitable for all season	60
Hill Rice/Jhum rice	277
Deep Water Rice	42
Total	8044

Source: BRRI, 2015

low GI rice (BR16, BR25 and BRR1 dhan46), GABA rice (BRR1 dhan31), anti-oxidant rich rice (BR5).



Rice diversity in Bangladesh, Source: BRR1, 2015

The PGRC currently maintains 10,085 accessions of 137 different agri-horticultural crops in the gene bank and in the field gene bank. Among them, 1,727 accessions are cereals, 3,460 pulses, 455 oilseeds, 3,902 vegetables, 199 spices, 170 fruits, 92 roots and tuber crops, and 60 fibre, narcotic and other crops. The centre also maintains 20 medicinal and aromatic plants at the field gene bank.

In addition, 9,975 accessions of cereals, pulses, oilseeds, tuber crops, vegetables, fruit plants, spices are maintained at five crop research centres, namely the Pulses Research Centre (PRC), the Oilseed Research Centre (ORC), the Horticulture Research Centre (HRC), the Tuber Crops Research Centre (TCRC) and the Spices Research Centre (SRC) of the BARI. A good number of cereal crops germplasm are maintained at the Wheat Research Centre (WRC) and the Plant Breeding Division of the BARI. The accessions contain landraces (traditional varieties), primitive cultivars, breeding lines, and wild and weedy relatives. The BARI so far released 446 high-yielding varieties: 67 varieties are cereals, 32 pulses, 43 oilseeds, 90 vegetables, 73 fruits, 25 spices, 93 tuber crops, 16 flowers, 6 fibres and 1 narcotic. A good number of wheat, maize, potato, pulses, oil seeds, and vegetable varieties have been developed from exotic germplasm, which enriched the agro-biodiversity.

The agro-biodiversity of 281 crops are maintained as *ex situ* or *in situ* conservation in seven crop research centres, six regional agricultural research stations and 30 sub-stations of BARI located all over Bangladesh. In general, the diversity of landraces for almost all crops is decreasing with the increase of modern varieties. Data reveal that there is decreasing trend of diversity in most landraces. Based on collections of different crop accessions, the status and trends of diversity of BARI mandate crops are shown in (Annex Table 13).



Hyacinth bean diversity in Bangladesh, Source: PGRC, BARI, 2015

There are 46 under-utilized native and naturalized fruit tree species which may be used for food, fibre, animal fodder, oil, medicine and many other potential purposes have been documented at the Bangladesh Agricultural University (Rahim *et al.*, 2011).

Jute is a tropical bast fibre crop, next to cotton in use, with high socio-economic importance in Bangladesh. It is now in great threat of genetic erosion and replacement by modern agricultural system. Therefore, emphasis has been given since 1970 with an approach to collect and conserve the genetic resources of jute (*Corchorus* species), kenaf (*Hibiscus cannabinus*) and mesta (*H. sabdariffa*) germplasm including their wild relatives for utilization in genetic improvement programme. Thus, the activities of collection, conservation, characterization, evaluation and documentation have been started since the establishment of the gene bank at BJRI in 1982. Initially, it started with an old stock of 1,662 accessions of land races, obsolete cultivars, genetic stocks and mutants which are being maintained in the gene bank.

At present, a total of 6,012 accessions comprising 4,180 accessions of *Corchorus* (15 species), 1,461 accessions of *Hibiscus* (22 species), 252 accessions of 15 allied genera and 119 accessions of interspecific hybrid derivatives have been conserved in the gene bank of BJRI (Table 21). Out of 15 *Corchorus* species only two species, namely *C. capsularis* (deshi jute) and *C. olitorius* (tossa jute) are cultivated in this country and the rest 13 species are in wild forms. These are *C. aestuans*, *C. asplenifolius*, *C. baldaccii*, *C. brevicornutus*, *C. fascicularis*, *C. hirtus*, *C. pinnatipartitus*, *C. pseudo-capsularis*, *C. pseudo-olitorius*, *C. siliquosus*, *C. tridens*, *C. trilocularis*, and *C. urticifolius*. In case of *Hibiscus*, two species, viz., *H. cannabinus* and *H. sabdariffa* (mesta/rosette) are cultivated in Bangladesh and the remaining 20 species are in wild forms. These are *H. acetosella*, *H. caesius*, *H. calyphyllus*, *H. diversifolius*, *H. flavifolius*, *H. fuscus*, *H. greenwayi*, *H. herbacium*, *H. ludwigii*, *H. lunarifolius*, *H. lunariformis*, *H. micranthus*, *H. panduriformis*, *H. physaloides*, *H. radiatus*, *H. solandra*, *H. surattensis*, *H. tiliaceus*, *H. trionum* and *H. vitifolius*. There are 15 allied genera, viz. *Cortalaris*, *Abutilon*, *Abelmoschus*, *Cassia*, *Leptadinia*, *Linum*, *Pavonia*, *Sida*, *Sparmannia*, *Triumfetta*, *Urena* (*U. lobata*), *Waltharia*, *Melhanian*, *Pentapetes* (*P. phoenicea*) and *Solanum*.

However, a wide gap has been observed between the conserved germplasm of jute and allied fibres and the existing global diversity. There is an urgent need of collection of these invaluable resources occurring in wild conditions which are facing continuous threat of extinction.

Table 21 Jute and Allied Fibre Germplasm Stored in the Gene Bank

Species name	Initial stock (1982)		Present stock (2014)	
	Number of species	Number of accession	Number of species	Number of accession
Deshi Jute (<i>C. capsularis</i>)	01	1025	01	2400
Tossa Jute (<i>C. olitorius</i>)	01	460	01	1498
Wild <i>Corchorus</i>	04	-	13	282
Total <i>Corchorus</i>	06	1485	15	4180
kenaf (<i>H. cannabinus</i>)	01	98	01	675
Mesta (<i>H. sabdariffa</i>)	01	79	01	476
Wild <i>Hibiscus</i>	-	-	20	310
Total <i>Hibiscus</i>	02	177	22	1461
Allied genera	-	-	15	252
Interspecific hybrid derivatives	-	-	-	119
Grand Total	08	1662	52	6012

Source: BJRI, 2014

The BJRI along with the earlier scientists engaged in jute agricultural research since 1904 have released 44 varieties of jute, kenaf and mesta. Out of these, 20 varieties, namely nine of *C. capsularis* (White), six of *C. olitorius* (Tossa), three of *H. cannabinus* and two of *H. sabdariffa* are now under commercial cultivation. Most of the varieties were developed through pure line selection and some of them were developed through hybridization followed by pedigree selection. Three varieties of *C. capsularis*, namely Atom Pat-38, BINA Deshi Pat-2 and BINA Pat Shak-1 were developed through mutation breeding by the BINA.

Bangladesh has a long history of cultivating sugarcane (*Saccharum officinarum*). Both local and exotic varieties are cultivated in the country. As per the Bangladesh Sugarcane Research Institute (BSRI), a total of 1,132 varieties are reported in Bangladesh indicating rich diversity of the species in the country (Table 22).

Table 22 Status and Trends of Genetic Diversity of Sugarcane

Species	Number	Trend	Present status
<i>Saccharum officinarum</i>			Field Gene Bank
Exotic	321	Gradually Deteriorating	Field Gene Bank
Indigenous	177	Gradually Deteriorating	Field Gene Bank
Institute Bred	591	Gradually increasing	Field Gene Bank
<i>S. spontaneum</i> (Wild)	43	Slowly increasing	Field Gene Bank
Total	1132		

Source: Bangladesh Sugarcane Research Institute (2015)

Tea (*Camellia sinensis*) is a popular drink in Bangladesh. A brief description on the genetic diversity of this crop is given in Case Box 8.

CASE BOX 8 – Status of Tea Cultivars

Tea (*Camellia sinensis*) predominantly a self-sterile and out-bred crop with a wide range of variations exists in present day seedling population. Therefore, Bangladesh tea cultivars can be categorized in seven agrotypes, such as China type (*Camellia sinensis* var. *sinensis*), Assam type (*C. sinensis* var. *assamica*), Burma or Cambod type (*C. sinensis* subsp. *lasiocalyx*), Manipuri type (indigenous variety of *C. sinensis*), Hybrid I (more akin to China type), Hybrid II (leaves are slightly bigger than Hybrid I, but smaller than Hybrid III), and Hybrid III (more resemble to Assam type). However, a total of 516 tea germplasm have been collected and maintained (ex situ conservation) in the Bangladesh Tea Research Institute (BTRI) gene bank. Diversity is increasing with new collections and release of new clones and improved seed varieties.

1.2.3.2 Wildlife and Fish Diversity

Studies on genetic diversity in wild fauna are limited in Bangladesh. One of the early studies was on Hilsa Shad (*Tenuolosa ilisha*) identifying two gene pools such as marine population and inland and estuarine population (Rahman and Nævdal, 2000). Hasan *et al.*, (2012) studied genetic diversity in frog (*Anura*) in Bangladesh. In Bangladesh, 35 frog species are currently recognized (Kabir *et al.*, 2009; Howlader, 2011; in Hasan *et al.*, 2012). An analysis of mitochondrial 16S rRNA collected from 107 frog samples revealed the presence of at least eight undescribed frog taxa in Bangladesh. This number is very high for a plain country like Bangladesh. The results also suggest that the number of frog species has so far been underestimated. Study on *Rhesus macaques* of Bangladesh (Feeroz *et al.*, 2008, personal communication) observed unique polymorphisms. In other study, it was evident that the movement of monkeys and associated simian foamy virus involved with human-aided movement throughout the country (Feeroz, 2013, personal communication). In a detail study on mitochondrial DNA of *R. macaques* in its geographic range including Bangladesh found that *Rhesus macaques* of the country are different from Indian and Chinese counterparts, and they dispersed to India from southeastern part of Bangladesh (Hasan, 2014, personal communication). It was also evident from the genetic study that monkey performers collect their monkey from 13 monkey habitats of the country (Hasan, 2015, personal communication). Findings of those studies could contribute to the management of this species.

CASE BOX 9– The River Halda

The River Halda is famous for being the spawning ground of natural carps like Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus mrigala*) and Kalibaush (*Labeo calbasu*) in Bangladesh. As a tidal river, it is one and only natural carp breeding ground in the world from where fertilized carp fish's eggs are collected by local fishermen and egg collectors during April to June almost every year from time immemorial. Torrential rains with thunderstorm, regular ebb and tide, and strong sediment-laden current from upper hilly terrain make the river a unique environment for the carps to release eggs.

The River Halda originates from the Haldachhara of Patachhara Hill Ranges (GPS: 22°55'39.98" north & 91°46'16.92" east, Patachhara union) in Ramgarh upazila under Khagrachhari district, flows through Manikchhari, Fatikchhari, Bhujpur, Hathazari, Raozan upazilas and Chandgaon thana of the Chittagong Metropolitan City, and falls into the River Karnaphuli near the Kalurghat Bridge. A total of 19 main canals and 17 hilly streams (chhara) flowing down into the River Halda from the CHT. Its total length is about 98 kilometres, of which 29 km up to Nazirhat are navigable by big boats throughout the year; small country boats can ply further up for 16 to 24 kilometres to Narayanhat.

Currently, the River Halda has been adversely affected by different anthropogenic and natural factors like construction of rubber dam and sluice gates on feeder canals, illegal dredging, encroachment

and brood fish killing, water pollution, river bank erosion, loop cutting, and saline water intrusion. The Government has acknowledged the value of ecosystem services; habitat protection and rehabilitation; nutrient cycling; and the interactions of aquatic organisms – in maintaining the productivity of Halda fisheries. The Government thus recognizes the need to conserve and rehabilitate habitats cost-effectively through an ecosystem approach and is trying to reverse these longstanding negative impacts through rehabilitation of riverine habitats.

1.2.3.3 Domesticated Biodiversity

Fish

Domestication of wild fishes in most cases benefits both the farmer and the environment. In Bangladesh, to date, about 20 fish species have been domesticated and their breeding and rearing protocols have been developed. Around 50% of the domesticated fishes are cypriniforms and now under nation-wide aquaculture (Table 23). Though there is high possibility of working with reduced gene pool, it is optimistically believed that the biodiversity of the domesticated fish are well-preserved.

Table 23 The Domesticated Indigenous Fishes of Bangladesh

Local name	Scientific name	Culture status
Cypriniformes (Carps, barbs and loaches)		
Catla	<i>Catla catla</i>	Country-wide commercial
Rohu	<i>Labeo rohita</i>	Country-wide commercial
Gonia	<i>Labeo gonius</i>	Country-wide commercial
Bata	<i>Labeo bata</i>	Country-wide commercial
Calibaus	<i>Labeo calbasu</i>	Small scale, sporadic
Mrigel	<i>Cirrhinus mrigala</i>	Country-wide commercial
Raek	<i>Cirrhinus reba</i>	Small scale, sporadic
Mohashol	<i>Tor putitora</i>	Breeding protocol developed
Sarpunti	<i>Puntius sarana</i>	Breeding protocol developed
Gutum	<i>Lepidocephalichthys guntea</i>	Breeding protocol developed
Bou	<i>Botia dario</i>	Breeding protocol developed
Osteoglossiformes (Featherbacks)		
Chitol	<i>Chitala chitala</i>	Small scale, sporadic
Foli	<i>Notopterus notopterus</i>	Small scale, sporadic
Siluriformes (Catfishes)		
Boali pabda	<i>Ompok bimaculatus</i>	Small scale, sporadic
Modhu pabda	<i>Ompok pabda</i>	Small scale, sporadic
Gulsha	<i>Mystus vittatus</i>	Small scale, sporadic
Nuna tengra	<i>Mystus gulio</i>	Breeding protocol developed
Guzi air	<i>Sperata seenghala</i>	
Synbranchiformes (Freshwater eels)		
Baim	<i>Mastacembelus armatus</i>	Breeding protocol developed
Tara baim	<i>Macrogathus aculeatus</i>	Small scale, sporadic
Cuchia	<i>Monopterusuchia</i>	Breeding protocol developed
Perciformes (Perches)		
Koi	<i>Anabas testudineus</i>	Breeding protocol developed
Boro kholisa	<i>Colisa fasciata</i>	Breeding protocol developed

Source: Hossain et al., 2014

Livestock

Bangladesh is rich in farm animal genetic resources (FAnGR). The common FAnGR are cattle, buffalo, goat, sheep, horse, chicken, duck, geese, pigeon and pigs. Some wild relatives of FAnGR, like wild pig, Red Jungle Fowl, wild quail and Goyal (*Bos frontalis*) live in specific forest areas. Most of these species are indigenous, except some exotic breeds of cattle, buffalo, goat, sheep and chicken and their crossbred progenies. Livestock population of

Bangladesh consists of 24.688 million of large ruminants, 28.332 million of small ruminants, 293.235 millions of chicken and duck (MoF, 2013). The following Tables (24 to 28) described the present status of species, types, breeds and varieties of animal genetic resources at present.

Table 24 Different Genotypes of Indigenous Farm Animal Genetic Resources

Species	Breed name / local name	Type/breed/ variety	Distribution	Utility	Population status
Cattle	Red Chittagong	Variety	Chittagong District in the south east	Dairy	Endangered
	North Bengal grey	Variety	In the districts of western part	Dairy	Normal
	Pabna	Variety	Pabna and Sirajgong District in the western part	Dairy and Beef	Endangered
	Deshi	Non-descriptive	All over the country	Dairy and draft	Normal
Buffalo	Indigenous buffaloes	River type	Coastal area in the south	Dairy and draft	Normal
		Swamp type	North eastern part	Draft	Normal
Goat	Black Bengal	Breed	All over the country	Meat	Normal
Sheep	Garole	Breed	Satkhira district in the south west	Meat	Normal
	Deshi	Non-descriptive	All over the country	Meat	Normal
Pig	Deshi	Non-descriptive	All over the country	Meat	Normal
Horse	Deshi	Non-descriptive	In Tangail in the central part	Draft	Endangered
	Pony	Variety	In western part	Draft	Endangered
Chicken	Asil	Breed	In Brahmanbaria district in the eastern part	Game and recreation	Endangered
	Hilly	Variety	In the hilly region of south east	Egg and meat	Normal
	Deshi	Non-descriptive	All over the country	Egg and meat	Normal
Duck	Muscovy	Breed	In the wet land all over the country	Meat	Normal
	Nageshwari	Variety	In Sylhet district in the south east	Meat and egg	Normal
	Sylhet Mete	Variety	In Sylhet district in the south east	Meat and egg	Normal
	Deshi	Non-descriptive	All over the country	Meat and egg	Normal
Geese	Deshi	Non-descriptive	All over the country	Meat	Normal
Pigeon	Jalali	Breed	All over the country	Meat	Normal
	Siraji	Breed	All over the country	Meat	Normal
	Giribuj	Breed	All over the country	Recreation	Normal
	Loton	Breed	All over the country	Recreation	Normal
	Indigenous	Non-descriptive	All over the country	Meat	Normal
Dog	Sarail	Breed	In Brahmanbaria district in the eastern part	Pet and security	Endangered
	Deshi	Non-descriptive	All over the country	Pet and security	Normal

Source: FAnGRBD, BLRI, 2015

Table 25 Exotic Species, Type and Breed of Farm Animal Genetic Resources

Species	Breed name / local name	Type/breed/ variety	Distribution	Utility
Cattle	Holstein Friesian	Breed	Government Farm	For crossbreeding
	Jersey	Breed	Government Farm & BMPCUL	For crossbreeding
	Sahiwal	Breed	Government Farm	For crossbreeding
Buffalo	Nili-Ravi	Breed	Government Farm	For crossbreeding
	Migrated Indian buffaloes	River type	Central part	Dairy
Goat	Jamnapari	Breed	Western part	For crossbreeding
	Beetal	Breed	Western part	For crossbreeding
	Sirohi	Breed	Western part	For crossbreeding
Sheep	Muzaffarbadi	Breed	Western part	For crossbreeding
Chicken	Broiler	Strain	All over the country	Meat Production
	Layer	Strain	All over the country	Egg production
	Fayoumi	Breed	All over the country	Egg production
	RIR	Breed	Government Farms	For crossbreeding
	White Leghorn (WL)	Breed	Government Farms	For crossbreeding
Duck	Indian Runner	Breed	In the wetlands	Egg production
	Khaki Campbell	Breed	In the wetlands	Egg production
	Jending	Breed	In the wetlands	Egg production
Quail	Japanese	Breed	In the suburb area	Egg and meat
Rabbit	New Zealand white, black	Breed	In some part of central and western part	Meat production

Source: FAnGRBD, BLRI, 2015

Table 26 Different Crossbred Genotypes of Livestocks

Species	Breed name / local name	Distribution	Utility
Cattle	Holstein Friesian cross	All over the country	Dairy
	Jersey cross	Only in the milk pocket in the western part	Dairy
	Sahiwal cross	All over the country	Dairy
Buffalo	Nili-Ravi cross	In the coastal area in the south	Dairy
Goat	Jamnapari cross	In the western part	Meat production
	Beetal cross	In the western part	Meat production
	Sirohi cross	In the western part	Meat production
Sheep	Muzaffarabadi cross	In the western part	Meat production
Chicken	Fayoumi X RIR	In the western part	Meat production
	Commercial layer hybrids	All over the country	Egg production
	Commercial broiler hybrids	All over the country	Meat production

Source: FAnGRBD, BLRI, 2015

Table 27 Wild Relatives of Farm Animal Genetic Resources in Bangladesh

Species	Local name	Distribution	Utility	Population status
<i>Bos frontalis</i>	Goyal	In the forest of Bandarban district in the south east	Meat production, Cultural and social ceremony	Endangered
<i>Sus scrofa scrofa</i>	Wild pig	In the forests in the south east and north east	Meat production	-
<i>Gallus domesticus murgi</i>	Red Jungle fowl	In the forests in the south east and north east and in Sundarban	Meat production	Normal
<i>Coturnix coromandelica</i>	Wild quail	In the forests in the south east and north east	-	-

Source: FAnGRBD, BLRI, 2015

BLRI has taken an initiative for conservation, multiplications and distribution of high yielding fodder germplasm to the farmers. There are several potential fodder germplasm which have been widely accepted by the farmers not only to feed their animals, but also to cultivate those species as agri-business. The highly potential fodder species are available in the BLRI. A list of fodder germplasm available with the BLRI is given in Table 29.

Table 28 Genotypes of Cow in Bangladesh

Genotypes	Number (x1000)
(a) Indigenous	
Common local	3584
Red Chittagong Cattle (RCC)	10
Pabna	94
Munshiganj	13
(b) Crossbred	
Local x Shahiwal	331
Local x Friesian	1659
Local x Shahiwal x Friesian	221
Total	5912

Source: BLRI, 2013

Table 29 List of Fodder Germplasms Available at BLRI Germplasm Bank

Name (Scientific name)	
1. BLRI- Napier-1 (<i>Pennisetum purpureum-Bajra</i>);	2. BLRI- Napier-2 (<i>Pennisetum purpureum var. L- Arusa</i>)
3. BLRI -Napier -3 (<i>Pennisetum purpureum var. L-hybrid</i>)	4. Napier Vietnam
5. Napier hybrid (Japan)	6. Wruk Wona
7. Merk Eron	8. Napier dwarf early
9. Napier dwarf late	10. Andropogon (<i>Andropogon gyanus</i>)
11. Pangola (<i>Digitaria decumbens</i>)	12. Para (<i>Brachiaria mutica</i>).
13. Splendida (<i>Setaria splendida</i>) –line 1, line -2, line-3	14. Ruzi (<i>Brachiaria ruzizensis</i>)
15. Jumbo (<i>Hybrid sorghum</i>)	16. Guinea (<i>Panicum maximum</i>)
a. Guinea -1	
b. Guinea-2 (Soft)	
c. Guinea -3 (Hard)	17. Signal (<i>Brachiaria decumbens</i>)
18. German (<i>Echinochloa crus-galli</i>)	19. Buffel (<i>Cenchrus ciliaris</i>)
20. Dal grass (<i>Hymenachne psedointerruta</i>)	21. Baksha
22. <i>Desmodium intortum</i>	23. Paspalum: <i>Paspalum plicatum cv paspalum</i>
24. Plicatum (<i>Paspalum plicatum</i>)	25. Orchard grass
26. Super Hayati	27. Tall fescue
28. Rhodes grass	-

Source: BLRI, 2011-12

1.3 Status of Conservation of Ecosystems

Bangladesh government has been declaring and conserving various areas of biodiversity importance as PAs, ECAs, Botanical Gardens, Safari Parks and Eco-Parks, Fish Sanctuaries. Status of such areas is described below:

Protected Areas (PAs)

Bangladesh currently has 40 PAs. Among the PAs, 6 were established before Bangladesh became party to the CBD, whereas the remaining was established after the signing of the Convention (Table 30). A total of 21 PAs (7 National Parks, 12 Wildlife Sanctuaries, 1 Marine PA and 1 Special Biodiversity Conservation Area) have been declared by the government to conserve wildlife and their habitats since 2010, after the submission of the Fourth National Report to the CBD. The total area of newly added 20 forest PA is 33,915.31 hectares. All 38 forest PAs now cover about 10.55% of total forest area which is 1.8% of the total area of the country. The forest PAs managed by Bangladesh Forest Department are shown in figure 7 (two-Marine Protected Areas are not shown on the map).

Marine Protected Areas (MPAs)

The two Marine Protected Areas (MPAs), one in 'Swatch of No-ground' of Bay of Bengal, declared under Bangladesh Wildlife (Conservation and Security) Act, 2012 and another in 'Middle Ground and South Patches' of Bay of Bengal, declared under the Marine Fisheries Ordinance 1983 together comprise 243,600 hectares (2436 sq. km) constituting 2.05% of the total marine area 11,881,300 hectares (118,813 sq. km) of Bangladesh (Table 30).

Table 30 Protected Areas (National Parks, Wildlife Sanctuaries, Special Biodiversity Conservation Area and Marine Protected Area) of Bangladesh

Sl. No.	National of Protected Areas	Location	Area (hectare)	Established
A) National Parks				
1	Bhawal National Park	Gazipur	5022.00	11-5-1982
2	Madhupur National Park	Tangail/ Mymensingh	8436.00	24-2-1982
3	Ramsagar National Park	Dinajpur	27.75	30-4-2001
4	Himchari National Park	Cox's Bazar	1729.00	15-2-1980
5	Lawachara National Park	Moulavibazar	1250.00	7-7-1996
6	Kaptai National Park	Chittagong Hill Tracts	5464.00	9-9-1999
7	Nijhum Dweep National Park	Noakhali	16352.23	8-4-2001
8	Medhakachhapia National Park	Cox's Bazar	395.92	8-8-2008
9	Satchari National Park	Habigonj	242.91	15-10-2005
10	Khadimnagar National Park	Sylhet	678.80	13-04-2006
11	Baroiyadhala National Park	Chittagong	2933.61	06-04-2010
12	Kuakata National Park	Patuakhali	1613.00	24-10-2010
13	Nababgonj National Park	Dinajpur	517.61	24-10-2010
14	Singra National Park	Dinajpur	305.69	24-10-2010
15	Kadigarh National Park	Mymensingh	344.13	24-10-2010
16	Altadighi National Park	Naogaon	264.12	24-12-2011
17	Birgonj National Park	Dinajpur	168.56	24-12-2011

Sl. No.	National of Protected Areas	Location	Area (hectare)	Established
B) Wildlife Sanctuaries				
18	Rema-Kalenga Wildlife Sanctuary	Hobigonj	1795.54	7-7-1996
19	Char Kukri-Mukri Wildlife Sanctuary	Bhola	40.00	19-12-1981
20	Sundarban (East) Wildlife Sanctuary	Bagerhat	31226.94	6-4-1996
21	Sundarban (West) Wildlife Sanctuary	Satkhira	71502.10	6-4-1996
22	Sundarban (South) Wildlife Sanctuary	Khulna	36970.45	6-4-1996
23	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	42087.00	20-9-1983
24	Chunati Wildlife Sanctuary	Chittagong	7763.97	18-3-1986
25	Fashiakhali Wildlife Sanctuary	Cox's Bazar	1302.43	11-4-2007
26	Dudpukuria-Dhopachari Wildlife Sanctuary	Chittagong	4716.57	6-4-2010
27	Hajarihil Wildlife Sanctuary	Chittagong	1177.53	6-4-2010
28	Sangu Wildlife Sanctuary	Bandarban	2331.98	6-4-2010
29	Teknaf Wildlife Sanctuary	Cox's Bazar	11615.00	24-03-2010
30	Tengragiri Wildlife Sanctuary	Barguna	4048.58	24-10-2010
31	Dudhmukhi Wildlife Sanctuary	Bagerhat	170.00	29-01-2012
32	Chadpai Wildlife Sanctuary	Bagerhat	560.00	29-01-2012
33	Dhangmari Wildlife Sanctuary	Bagerhat	340.00	29-01-2012
34	Sonarchar Wildlife Sanctuary	Patuakhali	2026.48	24-12-2011
35	Nazirganj Wildlife (Dolphin) Sanctuary	Pabna	146.00	01-12-2013
36	Shilanda-Nagdemra Wildlife (Dolphin) Sanctuary	Pabna	24.17	01-12-2013
37	Nagarbari-Mohanganj Dolphin Sanctuary	Pabna	408.11	01-12-2013
C) Marine Protected Area				
38	Swatch of No-Ground	Bay of Bengal	173,800	27-10-2014
39	Marine Reserve*	Bay of Bengal	69,800	2000
D) Special Biodiversity Conservation Area				
40	Ratargul Swamp Forest	Sylhet	204.25	31-05-2015

Source: * Marine Fisheries Ordinance No. 35 of 1983, DoF, 2000, Bangladesh Forest Department (<http://www.bforest.gov.bd/index.php/protected-areas>; accessed on 29 December 2014);
*<http://www.thedailystar.net/swatch-of-no-ground-declared-protected-zone-48550>

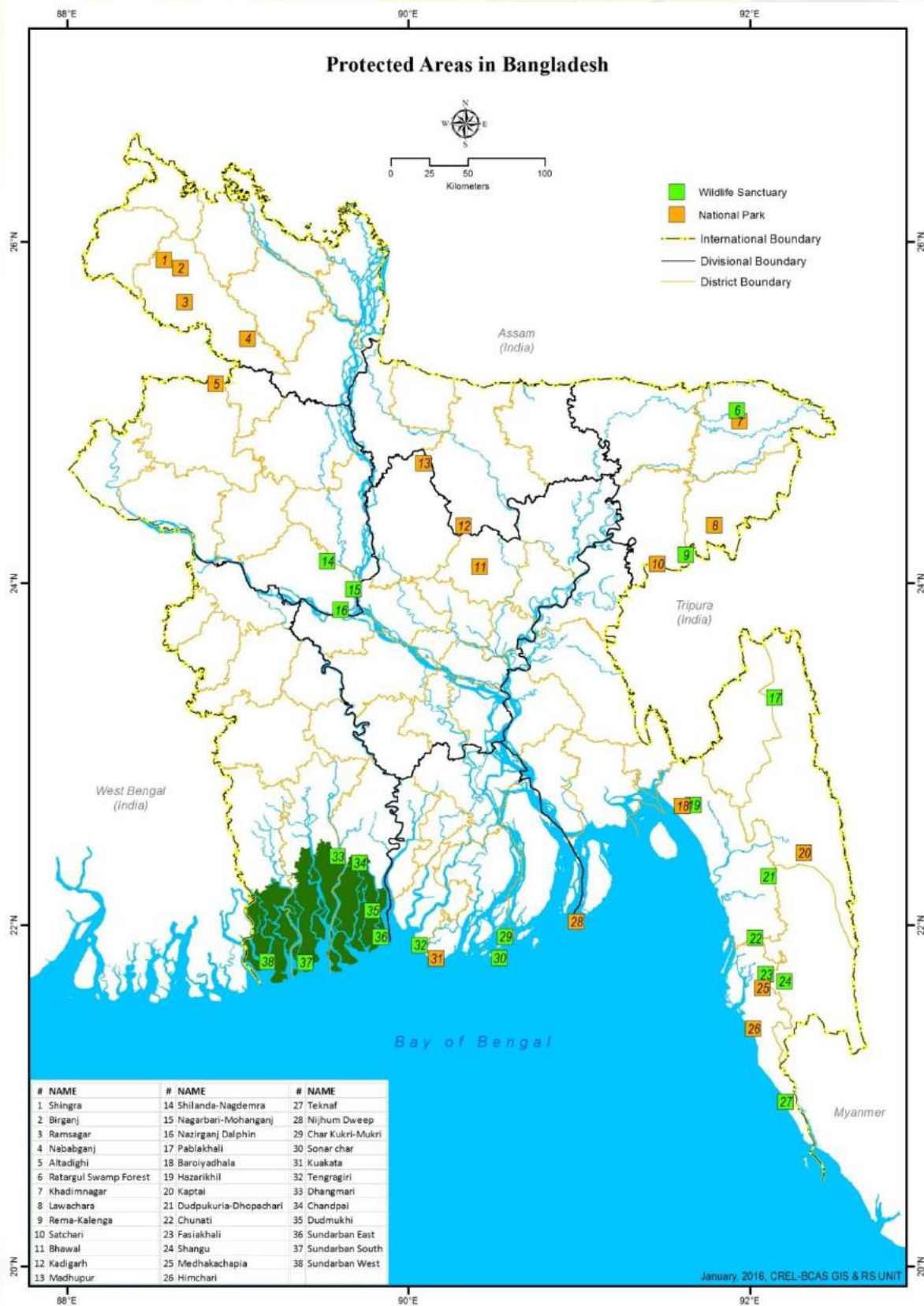


Figure 7 Protected Areas of Bangladesh (two MPAs are not shown) (Source: CREL - BCAS, 2015)

Ecologically Critical Areas (ECAs)

Bangladesh has declared 13 wetlands areas of biodiversity importance as ECAs under the section 5 of the *Bangladesh Environment Conservation Act, 1995*. Table 31 describes the ECAs and Figure 8 shows the location of ECAs in the country. The total area of ECAs managed by Department of Environment is 384,529 hectares or about 2.60% of the total country.

Table 31 Ecologically Critical Areas (ECAs) of Bangladesh

Sl. No.	Name of ECA	Type of Ecosystem	Location	Areas (hectare)	Year of Declaration
1	Cox's Bazaar-Teknaf Peninsula	Coastal-Marine	Cox's Bazar	20,373	1999
2	Sundarbans (10 km landward periphery)	Coastal-Marine	Bagerhat, Khulna & Satkhira	292,926	1999
3	St. Martin's Island	Marine Island with coral reefs	Teknaf upazila, Cox's Bazar	1,214	1999
4	Hakaluki Haor	Inland Frestwater Wetland	Sylhet and Moulvi Bazar	40,466	1999
5	Sonadia Island	Marine Island	Moheshkhali upazila, Cox's Bazar	10,298	1999
6	Tanguar Haor	Inland Frestwater Wetland	Moulvi Bazar	9,727	1999
7	Marjat Baor	Oxbow Lake	Kaliganj upazila of Jhenaidah & Chaugacha upazila of Jessore	325	1999
8	Gulshan-Baridhara Lake	Urban Wetland	Dhaka city	101	2001
9	Buriganga	River	Around Dhaka	1336	2009
10	Turag	River	Around Dhaka	1184	
11	Sitalakhya	River	Narayanganj, Dhaka, Gazipur	3771	
12	Balu including Tongi canal	River	Around Dhaka	1315	
13	Jaflong-Dawki	River	Jaflong, Sylhet	1493	2015
Total				3,84,529	

Source: DoE, 2015

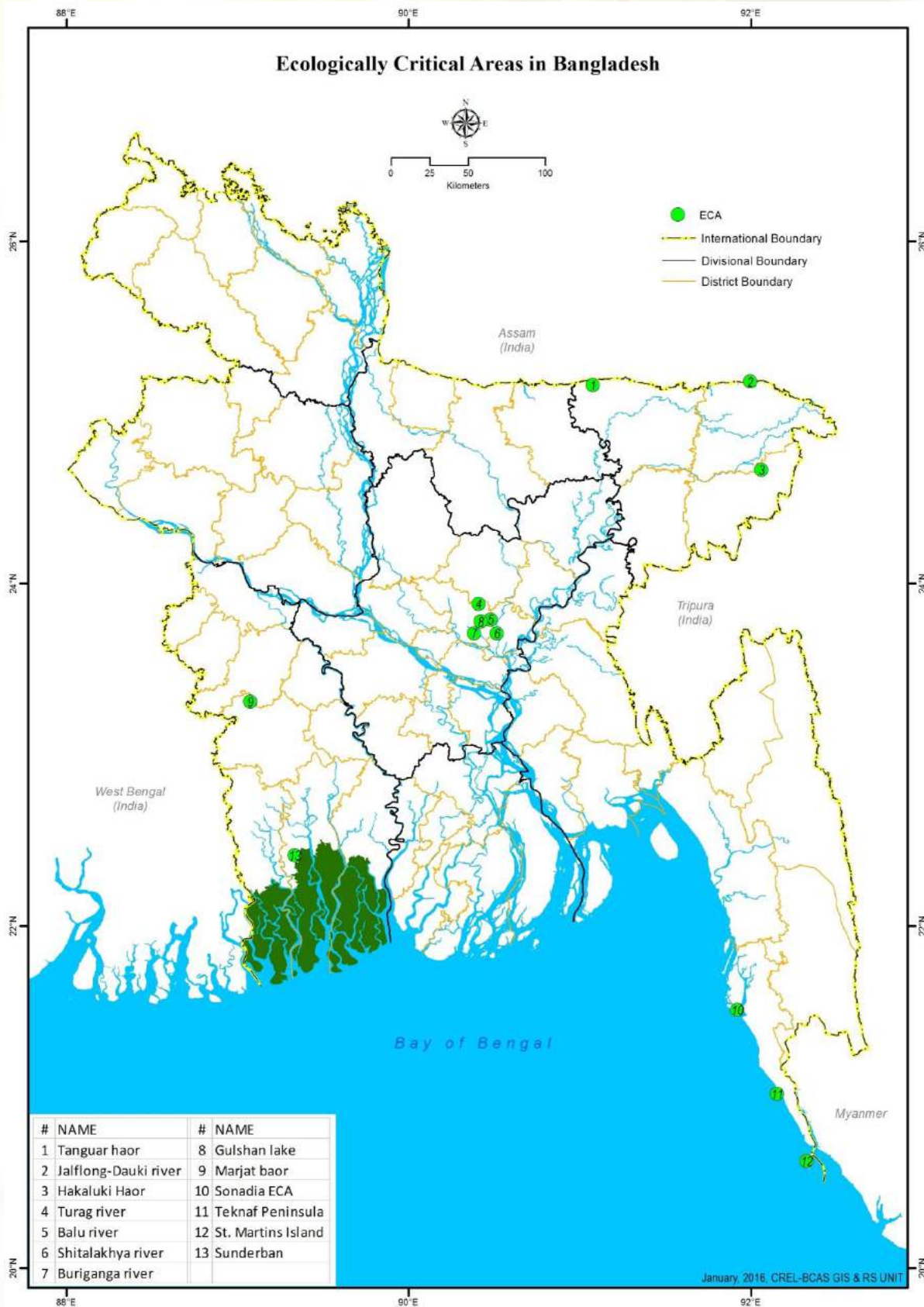


Figure 8 Ecologically Critical Areas of Bangladesh (Source: CREL - BCAS, 2015).

Botanical Gardens, Safari Parks and Eco-parks

The Bangladesh Forest Department administers a couple of botanical gardens, safari parks and several eco-parks in different parts of the country (Table 32). Although these sites are mostly used for recreational purposes, they also harbour a diverse community of flora and fauna. A numbers of captive breeding programme is being implemented in the Safari Parks, including threatened species like Crocodiles, Gharials, Batagur turtles, Vultures, Hog deer, Sambar, Goat antelope and Clouded leopard. The total area of Botanical gardens and eco-parks is 9,434.18 hectare which is 0.06% of the total country.

Table 32 Botanical Gardens, Safari Parks and Eco-Parks

Sl. No.	Name	Ecosystem	Conservation Focus	Location	Area (hectare)	Year of Declaration
1.	Balda Garden	Man made	Education, Plant species	Dhaka	1.37	1909
2.	National Botanical Garden	Man made	Plant species, education	Dhaka	84.21	1962
3.	Dulahazara Safari Parks	Mixed Evergreen	Wildlife species	Cox's Bazaar	600.00	1999
4.	Sitakunda Botanical Garden & Eco Park	Mixed Evergreen	Plant species	Chittagong	808.00	2000
5.	Madhabkunda Eco Park	Mixed Evergreen	Natural habitat, vegetation, wildlife	Moulvibazaar	265.68	2001
6.	Madhutila Eco Park	Deciduous Forest	Natural habitat, vegetation, wildlife	Sherpur	100.00	2001
7.	Banshkhali Eco-Park	Mixed Evergreen	Natural habitat, vegetation, wildlife	Chittagong	1,200.00	2003
8.	Kuakata Eco-Park		Natural habitat, vegetation, wildlife	Patuakhali	5,661.00	2005
9.	Tilagar Eco-Park	Mixed Evergreen	Natural habitat, vegetation, wildlife	Sylhet	45.34	2006
10.	Borshijora Eco-Park	Mixed Evergreen	Natural habitat, vegetation, wildlife	Moulavibazar	326.07	2006
11.	Bangabandhu Sheikh Mujib Safari Park	Deciduous Forest	Education, recreation, wildlife species	Gazipur	1,542.51	2014
Total					9,434.18	

Source: BFD, 2014

Fish Sanctuaries

There are five sites in the coastal areas of the country those are declared as hilsa fish sanctuaries under the **Protection and Conservation of Fish Act 1950**. The total hilsa sanctuary area is about 350 km long, covering 22 upazilas of five districts, namely, 100 kilometres of the lower Meghna estuary; 90 kilometres area of the Shahajpur River; nearly 100 kilometres of the Tetulia River; whole 40 kilometres of the Andharmanik River; and 20 kilometres stretch of the lower Padma. These sanctuaries are described in Table 33

Table 33 Hilsha (Fish) Sanctuaries in Bangladesh

Sl. No.	Hilsha sanctuary area	Ban period
01	Shatnal (Chandpur district) to Char Alexander (Laxmipur district) (100 km of lower Meghna estuary)	March to April
02	Madanpur/Char Ilisha to Char Pial (Bhola district) (90 km area of Shahbajpur river, a tributary of the Meghna river)	
03	Bheduria (Bhola district) to Char Rustam (Patuakhali district) (about 100 km area of Tetulia river)	
04	Andharmanik river (Kalapara Upazila, Patuakhali district) (Entire 40 km stretch of the river)	November to January
05	Lower Padma (Naria-Bhedarganj, Shariatpur) (Entire 20 km stretch of the river)	March to April

Source: Department Fisheries (2015)

Observation during the last couple of years indicates that the highest number of gravid hilsa are caught during 5 days before and 5 days after i.e., total 11 days of the first risen/appear moon in the *Bengali* month of *Ashwin* (September-October). To ensure uninterrupted spawning hilsa catch, transportation, marketing, selling and storage has been banned throughout the country during the highest breeding time. The shape of the banned area is tetragonal, which has been covered four major spawning grounds with an estimated area of 6.9 thousand square kilometer.

Other than the PAs and ECAs and Hilsha Sanctuaries, there are a number of Community Conserved Areas (CCAs) in Bangladesh those are managed locally by the ethnic community, mainly for conserving water. A list of such areas is given in Annex (Table 4).

CASE BOX 10- Nijhum Dweep National Park

Nijhum Dweep is located within Hatiya upazila in Noakhali district, at the confluence of the Meghna estuary on the Bay of Bengal. In 2001, Nijhum Dweep was declared as a National Park by the Government of Bangladesh.; especially for the migratory birds in Bangladesh. Nijhum Dweep National Park is the only habitat of the world's largest population of Indian Skimmer (Rynchops albicollis) along with 76 migratory bird species of the country (Feeroz and Uddin, 2015, personal communication). Nijhum Dweep is also located under Important Bird and Biodiversity Area (IBA 11) named as Ganges-Brahmaputra and Meghna delta. List of IBAs are shown in Annex (Table 5).

A total of 152 plant species representing 55 families have been recorded from Nijhum Dweep Island. Among the species, 66 are tree species, 15 are shrubs, 58 are herbs and 13 are climber species. The Island has been divided into several zones based on common vegetation types. Since 1971, trees such as Keora, Baen and Gewa have been planted in this island In a recent study, six species of amphibians and 22 species of reptiles (turtle: 5 species (3 sea turtle), lizard: 7 species, snake: 10 species) were recorded. A total of 193 species of birds (76 migratory species) and 17 species of mammals were also recorded. Apart from these species, a total of 61 species of invertebrates and 14 fish samples were collected from this island. The current estimation of the spotted deer population in Nijhum Dweep was less than 2,000 (Feeroz and Uddin, 2015, personal communication)., Nijhum Dweep, on the central coast of the Bay of Bengal, is the cross-road of two global migratory birds' flyways: the East-Asia-Australasia and the Central Asia. More than half a dozen of globally threatened migratory bird's winter in Nijhum Dweep, including Spoon-billed Sandpiper, Asian Dowitcher, Nordman's Greenshank, Spotted Redshank, Goliath Heron, Grey Lag Geese and Bar-headed Geese.

CASE BOX 11 - Floral Diversity of the Selected Protected Areas of Bangladesh

Floral study in Bangladesh is often sporadic and in most cases is purpose oriented. However, initiatives have been taken recently by the BFD, development agencies and academics for the indepth assessment and monitoring of both flora in selected protected areas. As shown in Table 34, among the PAs, the Chunati Wildlife Sanctuary is found to show the highest floral diversity.

Table 34 Floral Diversity in Six Protected Areas

Categories of Flora	Rema-Kalenga Wildlife Sanctuary ¹	SitaKunda Eco-park ²	Dudhpukuria-Dopachari Wildlife Sanctuary ³	Fasiakhali Wildlife Sanctuary ⁴	Chunati Wildlife Sanctuary ⁵	Teknaf Wildlife Sanctuary ⁶
Trees	142	140	182	82	240	142
Shrubs	163	79	125	66	102	112
Herbs	190	54	200	88	211	184
Climbers	102	28	71	41	106	87
Epiphytes	16	2	7	8	19	10
Parasites	7	-	6	-	7	1
Ferns	-	9	17	-	6	-
Total	620	312	608	285	691	536

Source: ¹Feeroz et al., 2011; ²Dutta et al., 2014; ³Feeroz et al., 2012; ⁴Uddin et al., 2011; ⁵Hossain and Hossain, 2014; ⁶Feeroz, 2013

Other than the floral diversity in the protected areas (Case Box 17), there have been inventory of faunal (wildlife) diversity in seven PAs (Table 35).

Table 35 Number of Wildlife Species in Seven Protected Areas

Categories of Flora	Rema-Kalenga Wildlife Sanctuary ¹	SitaKunda Eco-park ²	Dudhpukuria - Dopachari Wildlife Sanctuary ³	Fasiakhali Wildlife Sanctuary ⁴	Chunati Wildlife Sanctuary ⁵	Teknaf Wildlife Sanctuary ⁶	Nijhum Dweep National Park ⁷
Amphibians	20	21	25	28	26	27	6
Reptiles	52	40	56	41	54	54	22
Birds	215	210	231	195	252	243	193
Mammals	44	28	50	32	40	43	17
Total	331	299	362	296	372	367	238

Source: Feeroz et al. (2011), Feeroz (2011, personal communication), Feeroz et al. (2012), Feeroz (2011), (unpublished project report, Arannayk Foundation), Feeroz et al 2014, Feeroz (2013)

1.4 Threats to Biodiversity

Biodiversity, in its all aspects, is under continuous threat of degradation. Direct threats to biodiversity include landuse change, habitat destruction, introduction of invasive alien species, and human-wildlife conflicts. On the other hand, indirect threats include economic system and policy of the state, unsustainable exploitation of resources and weak management system such as gaps in spatial information or lack of public awareness. In the following sections, the major threats to biodiversity in Bangladesh are listed based on Bangladesh's Fourth National Report to the CBD (MoEF, 2010). It first gives a brief update on the direct and indirect threats to overall biodiversity followed by direct and indirect threats to a few major ecosystems and species.

1.4.1 Main Threats to Biodiversity

A. Direct Threats

Habitat Degradation and Fragmentation

Expansion of human settlement and agriculture, shifting cultivation, habitat degradation and destruction are the major threats to biodiversity in Bangladesh. For example, establishment of human settlement in and around the forest areas, human causalities, and crop raiding by the wild elephants are frequently occurring phenomena in Bangladesh which have resulted adverse public reactions to this mega species (IUCN Bangladesh, 2004). Most of the routes and corridors of elephants have been obstructed because of development activities (Figure 9). Destruction of natural habitats has been putting these large mammals at risk (Motaleb *et al.*, 2011). Case Box 12 illustrates a brief account on the degree of pressure and threats on protected areas of Bangladesh.

Change in Landuse Pattern

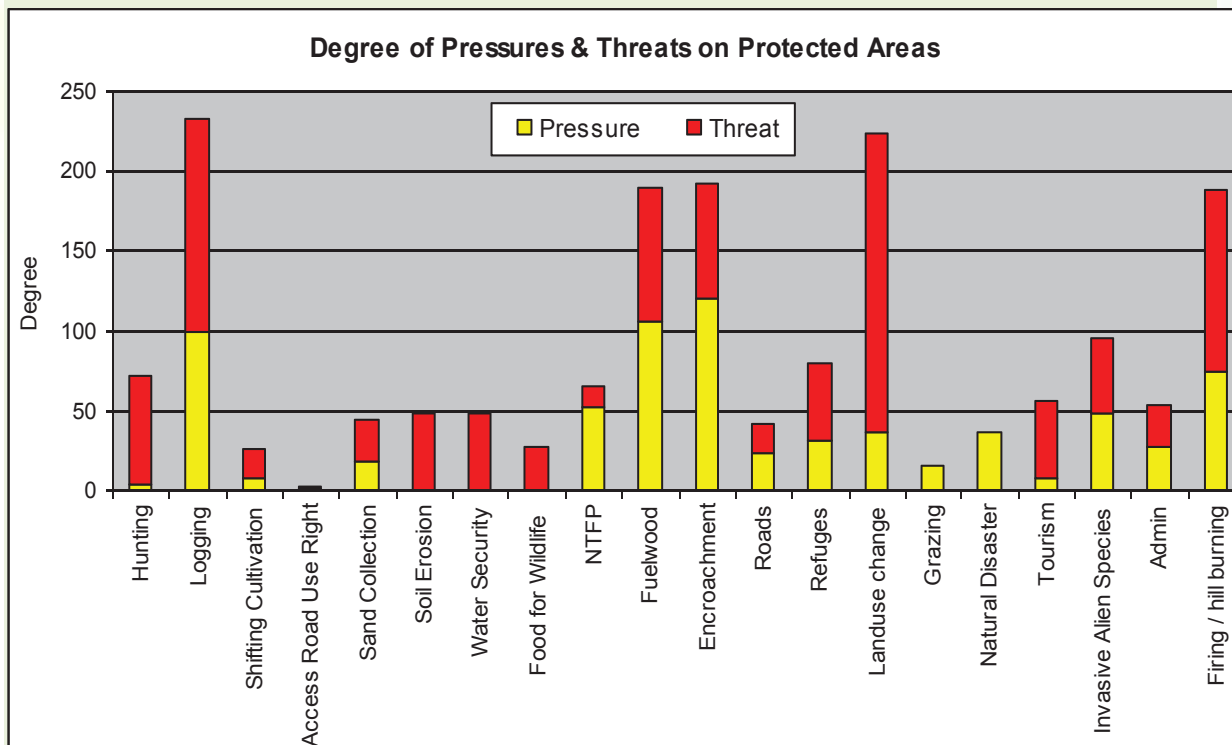
Population pressure and increased demand of food supply are causing conversion of natural ecosystems into other land covers. Unplanned urbanization, leading to rapid shrinkage in agricultural lands, is another major concern for Bangladesh. Infrastructure development, like road networks, and flood-control and irrigation structures, is also changing land use rapidly. Human population has become a threat to the PAs as well to other parts of the country.

Change in Hydrological Regime

Reduction in upstream flow of the rivers is one of the major concerns for the country. Changes in land use and construction of various flood management infrastructures have also changed the hydrological cycle. These changes in hydrological regime in the river floodplain are the threats not only to the fisheries resources but also to other aquatic lives through changing migration routes and breeding grounds.

CASE BOX 12 -Degree of Pressures and Threats to Protected Areas

The Integrated Protected Area Co-management (IPAC) Project carried out a rapid assessment in 19 Protected Areas (PAs) in 2010 (IPAC, 2012, personal communication). The assessment found that the PAs have been enduring a wide variety of pressure and threats. Amongst all, illegal logging, encroachment, fuelwood collection, landuse change, hill burning, and non-timber forest products collection were the most pressing issues concerning the PAs. It was also found that almost half of these PAs have very limited management capacity to tackle the pressure on the ground. The management effectiveness of all 19 PAs was not found satisfactory – most lacks limited budget, capacity, and infrastructure to carry out effective management.



Source: IPAC, 2012

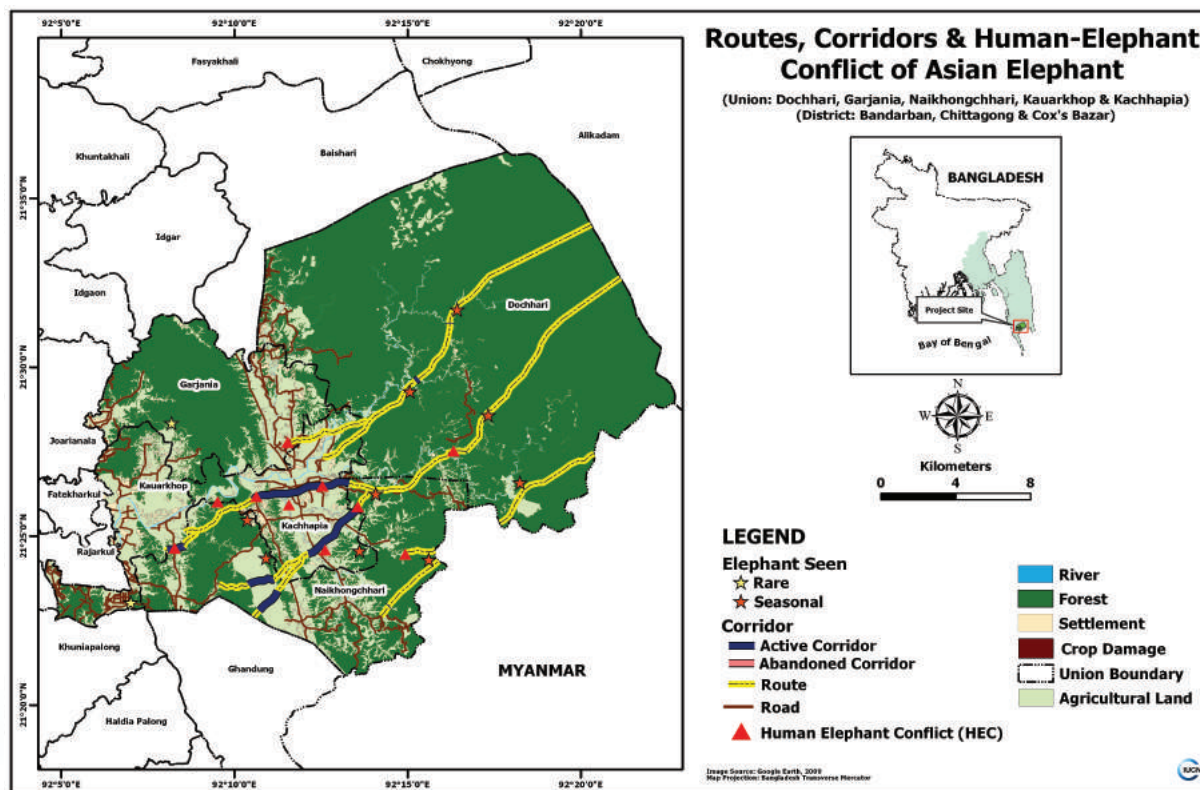


Figure 9 Map Showing the Routes, Corridors and Human-Elephant Conflict Areas in Chittagong Region (reproduced from Motaleb *et al.*, 2011)

Pollution

Terrestrial and aquatic ecosystems are polluted by discharges of untreated industrial effluents, domestic organic and inorganic wastes and agro-chemicals, i.e pesticides, insecticides, herbicides and organic fertilizers. Mechanized fishing boats, trawlers, goods and human carriers and ship breaking industries also release oil and other wastes into the rivers causing pollution. Air pollution due to unsuitable traffic and industrial machineries is a threat to plants and animals including insects responsible for pollination. Indiscriminate dumping of all forms of waste, both solid and liquid, is also a threat to aquatic and terrestrial habitats and organisms.

Over-exploitation

Over-exploitation of natural resources, like fishes, freshwater mollusks, corals, turtles, frogs, snakes, birds, and swans is also a threat to biodiversity.

Unplanned Tourism

Unplanned tourism is becoming a major threat to the biodiversity at hot spots. The biodiversity of St. Martin's Island, Lawachara National Park, Madhabkundu Ecopark and Sunderbans, for examples, have been facing continuous threat from unmanaged or poorly managed tourism industry.

Invasive Alien Species

As a country of rivers and wetlands, Bangladesh is very rich in fish diversity. Even then, over the last six decades, 24 fishes have been introduced (Table 36). The invasive species rapidly spread over the wetlands as biological explosives during the rainy seasons. Most of the introduced species were meant only for captive cultivation in closed pond systems, but nobody succeeded to maintain the fish in captivity. During monsoon and/or flood the escapees easily found their ways to the rivers and floodplains throughout the country. This posed one of the major threats to the biodiversity of many indigenous fishes in this country.

Table 36 Exotic Fish Species and the Countries they are Imported from

Common name	Scientific Name	Source	Year of introduction
Siamese gourami	<i>Trichogaster pectoralis</i>	Singapore	1952
Goldfish	<i>Carassius auratus</i>	Pakistan	1953
Tilapia	<i>Oreochromis mossambicus</i>	Thailand	1954
Guppy	<i>Poecilia reticulata</i>	Thailand	1957
Common carp	<i>Cyprinus carpio</i>	India, Nepal	1960
Mirror carp	<i>Cyprinus carpio var specularis</i>	India, Nepal	1979
Scale carp	<i>Cyprinus carpio var communis</i>	India, Nepal	1965
Leather carp	<i>Cyprinus carpio var nudus</i>	India, Nepal	-
Grass carp	<i>Ctenopharyngodon idella</i>	Hong Kong,	1966
Silver carp	<i>Hypophthalmichthys molitrix</i>	Hong Kong	1969
Nilotica	<i>Oreochromis niloticus</i>	Thailand	1974
Thai sarpunti	<i>Barbonymus gonionotus</i>	Thailand	1977
Bighead carp	<i>Hypophthalmichthys nobilis</i>	Nepal	1981
Black carp	<i>Mylopharyngodon piceus</i>	China	1983
African magur	<i>Clarias gariepinus</i>	Thailand	1990
GIFT (genetically improved farmed tilapia)	<i>Oreochromis niloticus</i>	Philippines	1994
Genetically improved scale carp	<i>Cyprinus carpio var communis</i>	Vietnam	1995
Thai pangas	<i>Pangasius hypophthalmus</i>	Thailand	1990
Giant pangas	<i>Pangasius gigus</i>	Thailand	-
Mosquito fish	<i>Gambusia affinis</i>	India	-
Sucker mouth catfish	<i>Hypostomus plecostomus</i>	Hong Kong, Singapore	-
Red piranha	<i>Pygocentrus nattereri</i>	do	2003
Pirapatinga	<i>Piaractus brachypomus</i>	do	2003

Source: Modified from Rahman (2005)

Several introduced species are highly carnivorous and predatory and eat other species including the small indigenous fish. Several exotic species also compete with the small indigenous species and gradually occupy their niches. The ecological, economic and biodiversity consequences of the introduction of exotic fish species have not been taken into consideration. Some of the negative impacts of exotic species on indigenous fishes are given in Table 37.

Table 37 Negative Impacts of Exotic Fishes on the Indigenous Fishes

Exotic fish	Impact
Tilapia	Their prolific breeding surpasses the carrying capacity of the waterbody leading to stunting of a number of small indigenous species – mola, dhela, anju, darkina, chela, punti, chapila, tengra, buguri, chanda, chikra etc.
Common carp	Destroy pond embankments and make water turbid by stirring up mud. Reduce the water transparency and dissolved O ₂ in water. Destroy habitat of small indigenous species living closed to the pond dyke and loaches in the bottom.
Grass carp	High feeding competition with many herbivorous small and large indigenous fishes.
Silver carp	Strong feeding and habitat competition with– catla in both captive condition and in the wild
Thai sarpunti	Compete with local sarpunti for foods and space
African magur	Predation and voracity of this catfish is legendary, predate on almost all small and medium fishes
Thai pangas	Natural diet is finfish, crustacean and insects, periphyton and benthos. This predatory fish is the major cause of disappearance of small indigenous species from the pond system
Mosquito fish	They live in the littoral zone of the waterbody and compete with small fishes for food and habitat
Suckermouth catfish	One of the dangerous catfish, now found in the floodplain all over the country, feed on small crustaceans and small fish, like loaches and freshwater eel
Red piranha	One of the most dangerous and aggressive species of piranha, feeds on insects, worms and small and large fish. The cultured fish in the pond system and escapees in the wild actively predate on the indigenous fishes. particularly small indigenous species
Pirapatinga	The natural diet is terrestrial plants, fruits, insects and crustaceans, however, in captivity where the natural food is scarce pirapatinga compete with small indigenous species. The fish has strong, human like teeth used to crush food items.

Source: Hossain et al., 2015

Climate Change

Bangladesh is one of the most vulnerable countries to global climate change. The consequences of the predicted climate change are likely to affect the coastal ecosystems including the Sundarbans as well as the agricultural lands adjacent to the coastal belts through increased sea level. Effects of global climate change are briefly described in Case Box 13.

CASE BOX 13 –Impacts of Climate Change on Bangladesh’s Biodiversity

Bangladesh is one of the most vulnerable countries to climate changes, variability and extreme climatic events. Survival, breeding and life cycle of many wildlife, fishes and invertebrates depends upon temperatures. On the other hand, flowering, pollination, seed formation, seed germination and plant growth depends on temperature. Changes in temperature and shifting or loss of seasons have, therefore, direct impact on the country’s biodiversity. Rainfall pattern is expected to change the water regime of the country under climate change regime. This will directly affect any life forms, virtually all, that directly or indirectly depend upon the timing, frequency and amount of rainfall. Being a sub-tropical country, temperature and rainfall plays a major role in making this country biologically diverse. Changes in climate will directly change the terrestrial and aquatic biodiversity alike over a shorter period of time, coupled with current anthropogenic interventions. It has been reported that climate change has already caused shifts in the distribution of some species, for example amphibians, grasses, migratory birds and butterflies.

Sea level rise is expected to push the Bangladesh’s coastline to the north, permanently flooding a good portion of the country. Effects of such inundation on coastal vegetations and wildlife have been much talked about, but without organized investigation. Higher water temperatures, loss of brackish waters and reduced flows from upstream could harm coastal fisheries.

Extreme weather events, like floods, cyclones and tidal surges, to which Bangladesh is already very vulnerable, are expected to increase in frequency and intensity under climate change regime. Cyclone Sidr has shown its devastation on Sundarbans. Salt-water intrusion after storm-surges damages coastal ecosystems and biodiversity drastically, which takes many years to revive. Under changing climate such revival may not be possible.

B. Indirect Threats

Economic Systems and Policies

With an average GDP of about 6.0 over the years and high population density (1,015 per square kilometer) (BBS, 2012), Bangladesh is experiencing rapid industrialization, urbanization, expansion and intensification of agricultural activities. These activities are creating pressures on the natural resources including forest, water bodies and agricultural lands through infrastructural development, transport and use of synthetic chemicals hazards to natural environment.

Legal and Institutional Systems

A number of laws have been formulated and come into force in relation to biodiversity conservation in the country. However, the organizations are not yet strengthened with adequate trained manpower and logistic supports for the proper management and conservation of biodiversity in Bangladesh.

Inequality in Ownership and Benefit Sharing

Since most of the natural resources are owned by the state, its management and benefits are also governed by various rules and policies of the state. The notion of resource and benefit sharing with the local communities is a fairly recent development and is still evolving. An absence of sufficient equity in resource sharing makes it difficult to motivate people for biodiversity conservation.

Erosion in Genetic Diversity

Genetic erosion in agricultural biodiversity is the result of introduction of High Yielding Varieties. Out of more than 10,000 local rice varieties once used to be cultivated in Bangladesh, only 22 are now mostly used. Increased use of agrochemicals is another potential cause of the loss of genetic diversity. Monoculture of few fast-growing exotics has accelerated the loss of native forest genetic resources. Akashmoni (*Acacia auriculiformis*) is getting priority

in forests plantations ($\approx 75\%$) that accelerates the loss of native forest plant diversity in an alarming rate (Hossain, 2014).

Lack of Knowledge and Awareness

Gaps in knowledge and awareness at various levels is heavily affecting conservation and sustainable use of biodiversity. People are yet to realize the value of ecosystem services that is responsible for the life and livelihoods and sustainability of the economy. Different types of Protected Areas exist in the country; but relevant stakeholders are not aware of the importance of management.

1.4.2 Threats to Major Ecosystems

A. Sundarban: Mangrove Ecosystem

The Sundarban Reserved Forest is internationally recognized as an important mangrove ecosystem of high biodiversity value. It is the most important remaining habitat, in the world, of the Critically Endangered Bengal Tiger (*Panthera tigris tigris*). A number of other large mammalians once abundant in Sundarban have already become extinct, including the swamp deer (*Cervus duvauceli*), one-horned rhinoceros (*Rhinoceros unicornis*) and wild water buffalo (*Bubalus arnee*). A recent study by IUCN found that currently 58 species of wildlife, indigenous to the Sundarban, are threatened, of which 36 are either Endangered or Critically Endangered.

The impact of enhanced shrimp farming along Bangladesh coast has induced a very high demand on natural shrimp fries that exhibit better performance over the hatchery fries. This in turn generated the tremendous pressure on shrimp fry collection from the Sundarban waters, which has become a major concern. A rough estimate indicated that these shrimp fry collectors alone chop off over one million saplings, mostly good and straight looking ones, annually from this forest.

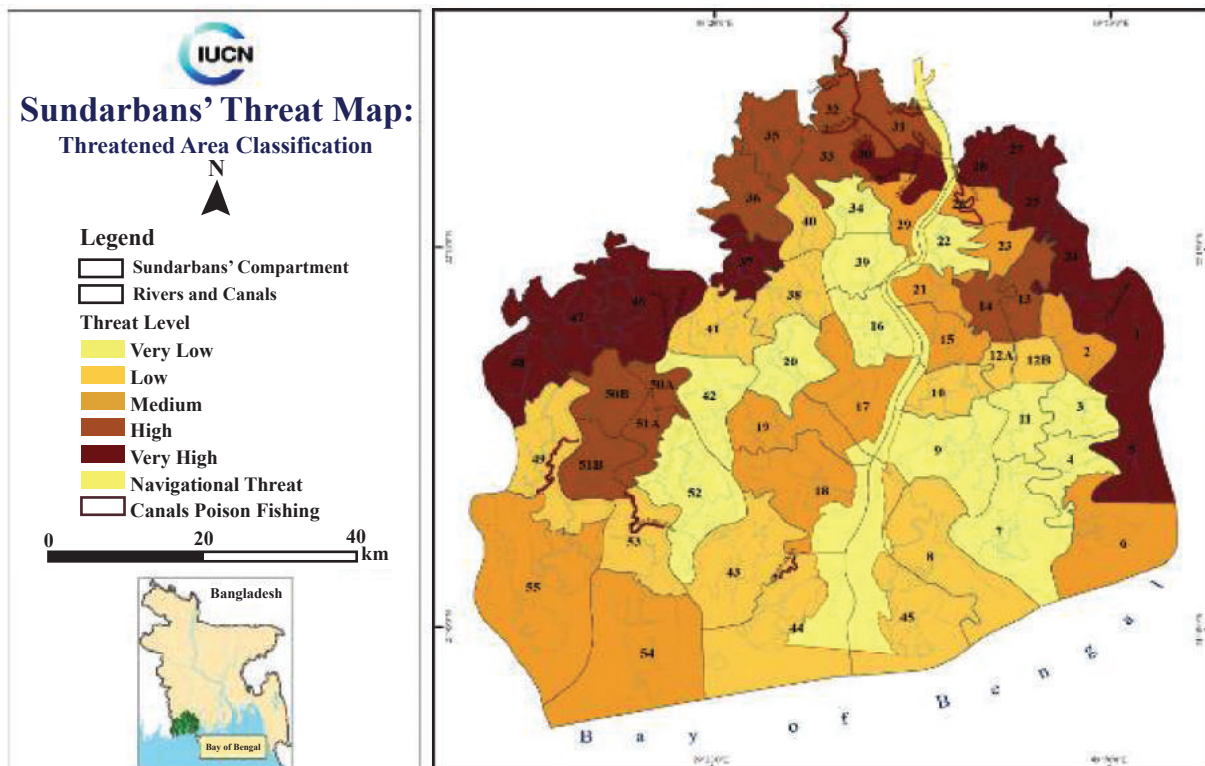


Figure 10 Degree of Threats in 55 Compartments of the Sundarban (Source: IUCN Bangladesh)

Based on the ecological similarities and dissimilarities, the whole Sundarban has been divided into 55 compartments (Figure 10). Number of discussions with communities and government officials at various locations around Sundarban and large number of focused group discussions that were held by IUCN Bangladesh on the periphery or buffer zone of the Sundarban surfaced a long list of compartment-wise threats to the Sundarban. Some of the threats are given below.

Destruction of Habitats

There is a noticed trend that population pressure in the form of encroachment and greater dependency on the ecosystem goods and services has been occurring along the buffer zone. Along with demographic increase, further surplus labour from agriculture due to shrimp cultivation started becoming dependent on forest resources.

Over-exploitation of Resources

There has been change, especially depletion in quality of forest, with respect to density, especially number of stems per unit area. In general, the understanding with the common people is that the number of stems per unit area has declined by about 10% to 15% than what it was 15 to 20 years back. Over-exploitation, mostly illegal collection of timber from the Sundarban by the communities is the main cause of such depletion.

Extraction of Poles for Fixing Fishing Nets

Distribution of pole class saplings, especially of Sundri has seriously declined and conspicuously visible. This has occurred due to the collection of the poles by the fishermen at every trip. The fisherman goes to fish in the Sundarban twice a month during full-moon and new-moon, locally known as *GHONE*. During such trip every boat collects about 40 to 60 such poles. Such collection of poles by the fishing communities has caused this threat.

Poaching

Deer poaching is common and widespread in the Sundarban and there is a good demand of deer meat (venison) among the communities living around the forest. Besides deer poaching, hunting of tiger as a valuable trophy is also a threat to the Sundarban ecosystem. It has been reported by the Bangladesh Forst Department that 8 tigers were killed in the Sundarban during 2010 to 2015 for poaching purpose (BFD, 2015). However, experts believe that there is a higher chance of underestimation of reported numbers since many poaching and hunting cases go undetected.

Poison Fishing

In many of the small creeks and canals the fishermen pour in huge amount of poisons, particularly insecticides, to catch fishes. This is done mostly in areas wherein entries are prohibited, like the sanctuaries.

Invasive Alien Species

Altogether 23 plant species of two broad types' viz. aquatic weed and climbers were identified as invasive. Of these, 19 are native or naturalized to Sundarbans mangrove. Invasives' abundance, diversity and rate of invasion were highest at the riverbanks and gradually decreased with increased proximity to the forests.

Tourism Driven Pollution

In recent years, the influx of tourists in specific areas is causing damage to the forest ecosystems. Throwing of solid wastes, like cans, plastic bags and water bottles, are becoming threats to the Sundarban. Noise pollution from the mechanized vehicles is also causing problems for the wildlife in these forests.

Top-Dying of Sundri

Top-dying of Sundri (*Heritiera fomes*) trees has become a serious threat to the Sundarban ecosystem. Though the exact reason of this threat is yet to be pin pointed, siltation coupled with the reduced flow of freshwater from transboundary upstream rivers is thought to be one of the main causes of this situation.

Poor Regeneration

In many areas, regeneration in some plants has declined. There are various reasons for this. Climate change may be one of the causes associated with this threat along with other complex changes that is affected by human made shocks, like air and water pollutions.

B. Freshwater Wetland Ecosystem

Freshwater wetland ecosystems are under threats of a number of human activities including over-exploitation, destructive fishing practices, soil erosion, pollution and so on.

Over-exploitation

A very small areas of swamp forests are now present due to extensive exploitation over the past decades. Natural regeneration of the forest species is facing problem in the wetlands. The reed beds are significantly reduced from over-harvesting for fuel and converting land into agricultural fields.

Destructive Fishing Practices

Harvesting the last fish, dewatering of key areas and repeated fish harvesting on an annual basis are the most unsustainable fishing methods used in many wetlands. As a result, reduction of fish diversity has been happening in these once highly diverse wetlands. For example, in Tanguar Haor, once well-recognized for migratory waterbirds with an annual number 60,000-120,000, there is a decreasing trend owing to hunting, trapping and eventually killing. During the waterfowl survey in January 2012, for example, only 28,876 individuals of 47 species were observed in Tanguar Haor.

Soil Erosion

Soil and river bank erosion is a major concern in *haor* and riverine areas, respectively. Soil erosion is also causing degradation of soil quality in the agricultural field.

Water Pollution

Excess use of chemicals in agricultural fields is a major reason for water pollution, which in turn negatively affects the aquatic ecosystems. Fuel oil, released by the mechanized vehicles, is also responsible for water pollution.

Unplanned construction

Construction of unplanned dams, embankments, sluice gates, bridges, roads etc. is a major threat to aquatic lives and their natural habitats.

Although information on specific threat to the designated marine reserve is not available, however, threat like destructive fishing is common using set bag-nets in river mouths and estuaries and catch fry and juveniles of marine fauna resulting in restriction of growth of commercially important species (IUCN, 2012).

C. Hilly Forest Ecosystem

Although severely degraded, hill ecosystems still harbour patches of natural forests of the country. The major threats to the Chittagong Hill Tracts (Khan, 2013) and surrounding forests are given below.

Expansion of Monoculture Plantation

Plantations of exotic species, like acacia, eucalyptus and rubber, have been promoted in the recent decades on denuded forest land. This changed the total landscape and affected the wildlife and natural processes.

Horticultural Practices

In the hill ranges, cultivation of tuber crop like ginger and turmeric, is increasing, and causing destruction of natural forest and top-soil erosion. These practices are inviting chemical pesticides, insecticide, rodenticides and weedicides in the hills, valleys and the hilly streams (rivers and static waterbodies). Although there are policies and strategies, but implementation needs further initiatives.

Jhum Cultivation (Shifting Cultivation)

Unplanned expansion of this traditional agro-technique is degrading the hill ecosystem by allowing soil erosion, hindering forest regeneration.

Tobacco Cultivation

Recent introduction and expansion of profit-driven tobacco cultivation have direct and indirect effects on the remaining natural ecosystem and traditional knowledge systems (Motaleb and Irfanullah, 2011).

Mass Settlement

Increase in population and mass settlements by the non-tribal people in the hilly areas have changed the demography of the CHTs over the years. This change in demographic structure has affected the natural ecosystem to accommodate settlers from the plain land.

Weak Enforcement of Laws

Illegal timber trading and poaching of wildlife due to limited law enforcement are destroying the forests and its biodiversity.

Hill Cutting

Hill cutting causes landslide which in turn compromises the physical integrity of the hills, devastates housing infrastructures and often kills humans and livestock.

Construction of Infrastructures

Barrier to the free flow of water by construction of embankments, dams and over-withdrawal of surface water are responsible for the damage of the natural watersheds and habitats of aquatic biodiversity.

CASE BOX 14- Zoonotic Diseases

Bangladesh's rich biodiversity coupled with the country's dense human populations provide the ideal conditions for cross-species disease transmission. After 2010, several pathogens of public health and animal conservation significance have been reported in human and animal populations including: H5N1, H9N2, Newcastle virus, Dengue, Nipah virus, Simian Foamy Virus, diverse Picorna viruses and Mycobacterium tuberculosis (MTB).

Several infectious agents have already been detected in human and animal populations in Bangladesh, but most of these studies have failed to establish long term, longitudinal sampling and monitoring of the affected populations. The few notable programmes that have focused on longitudinal sampling are: (a) An ongoing project to monitor changes in the diversity and prevalence of Avian Influenza viruses in selected poultry markets; and (b) a study that characterized the genetic changes of simian viruses in zoonotically infected humans as well as changes of the virus in naturally infected monkey populations. These illustrate the importance of monitoring viruses over an extended period of time, as each has identified changes in the viral pathogen landscape.

Over the next five years Bangladesh need to focus on selected infectious agents and devote a concentrated effort to their detection, characterization and monitoring. Specific suggestions that came from the earlier mentioned reports are: (1) Avian influenza in local, wholesale and poultry breeding farms be continuously monitored. Additionally, during seasonal migrations wild birds from key locations around the country should be screened for Avian Influenza; (2) Bats have been identified as the reservoir for Nipah virus in Bangladesh and other countries in Asia, however, there have been no research programmes that have focused on long-term surveillance of the virus. It was suggested that multiple sites containing established roots both near date palms as well as in areas without date palms be identified and monitored; (3) New advances in the detection of MTB using non-invasively collected buccal swabs will allow for the screening of diverse animal populations including primates, cattle and elephants, all taxa that have been shown to be infected with MTB. It was suggested to identify key populations of these animals in areas with a high prevalence of MTB in the human population as well as populations with less contact in order to develop a comparative study on the transmission of MTB; and overall, (4) In order to detect and monitor disease transmission it is critical that programmes be established that focus on the human-animal interface and the pathogens that are moving across this boundary. Such programmes will require a collaboration between multiple disciplines including zoologists, epidemiologists, physicians, veterinarians, microbiologists, specialists in GIS, data management and bioinformatics in order to successfully collect and analyze the data. (M.M. Feeroz, 2015, personal communication)

D. Agro-Ecosystem

Loss of Agricultural Land

Bangladesh is mainly an agriculture-based country. Urbanization, industrialization and expansion of settlement are causing shrinking of agricultural land day after day. Every year, over 80,000 ha of agricultural land i.e. nearly 1% of the land is being converted into non-agricultural land (Planning Commission 2009).

Introduction of High Yield Varieties

Bangladesh is a densely populated country. To meet-up the demand of food, a large number of High Yield Varieties (HYVs) are introduced in the country. It is obviously true that, the country has attained self-reliance in food security (rice) due to production of HYVs. However, farmers are reducing use of local varieties that they used to plant for hundreds of years. As a result, impact of the introduction of modern HYVs, crop cultivars are becoming uniform and the genetic diversity of cultivars have decreased. For instance, out of more than 10,000 cultivars of rice that persisted once upon a time, only 22 are mostly used now.

Impact of Fertilizer and Pesticides

Due to excessive use of fertilizer, more than 65% of the total agricultural land is suffering from declining trend of soil fertility while it is also reported that almost 85% net area suitable for cultivation has a level of organic matter below the minimum requirement. As a side-effect of the application of pesticides and insecticides, beneficial organisms are killed breaking the complex interacting system between pests and active soil organisms and causing deterioration of soil fertility

Use of Top Soil in Brick Manufacturing

Use of top soil in brick manufacturing has emerged as a threat to the quality of agricultural soil in Bangladesh. Top soil of the agriculture land is used as raw material for brick making. It also caused loss of soil fertility (Khan *et al.*, 2007).

E. Homesteads Ecosystem

Population pressure

Population pressure is the main threat to the homestead ecosystems. Expansion of settlements through increased construction of houses is causing reduction in vegetation coverage and wetlands. Although many wildlife for instances fox and vultures were seen in the bush close to the households are rarely seen now a days.

Construction of Roads and Highways

Construction of roads and highways is also responsible for clear cutting of homestead vegetation in many rural areas.

Human Behaviour

Change in behaviour among the people even in the rural areas may also contribute to the degradation of homestead ecosystems. Clear cutting of vegetation, filling of ditches, ponds and canals are often seen in the rural villages. Wild animals like fox, snakes, lizards, etc. are often killed by the people considering them as enemies.

1.5 Importance of Biodiversity and its Implications for Human Well-being

Being a natural resources dependent economy, biodiversity plays very important role to the life and livelihoods of the people here in Bangladesh. The globally important ecosystems, such as the forests, freshwater wetlands, and marine fishing area indeed make up a significant portion of ecosystem services and national economy. Well-functioning ecosystems and human well-being are directly related, where biodiversity contributes significant value to services given by any ecosystem. This phenomenon is observable in many spheres of human-nature interactions. In the following sections, these interactions are briefly discussed in the context of agriculture, fisheries, livestock, forestry, water resources and tourism sectors of Bangladesh. Importance of biodiversity and ecosystems in disaster resilience is stated briefly in Case Box 15.



Mowal, indigenous fishing community, in Sundarbans Mangrove by ABM Sarwor Alam

CASE BOX 15 –Importance of Biodiversity and Ecosystems in Disaster Resilience

It has now become an established fact that the floral biodiversity enhances the climate resilience of the ecosystem and people live near the ecosystem. Since Bangladesh is highly vulnerable to the adverse impacts of climate change, biodiversity conservation is likely to keep it more adaptable to the anticipated adverse impact of climate change.

Wetland ecosystem (e.g. haor) play a significant role in reduction of flash flood. The haors are large subsided lands that can hold the water from the flash flood. This is a major support function from the ecosystem. Another major regulatory function is the replenishment of groundwater table through these large water bodies. As an impact, these wetlands are thought also to work as a natural defense against droughts.

It has been extensively suggested that the impact of Cyclone Sidr in 2007 would have been much devastating in terms of lives and asset loss if the Sundarban was not there to cushion the blow. It is notable that biodiversity remains as one of the major footholds for such complex ecosystems like the mangroves. This understanding has revitalized the afforestation programme on the coast of Bangladesh as a means of adaptation to climate change.

1.5.1 Agriculture

Agriculture is the single largest producing sector of the economy and it contributes about 17.22% of the total Gross Domestic Product (GDP) and 45.6% of labour force engaged in this sector (BBS, 2012) in Bangladesh. The agricultural sector is heavily dependent on soil fertility. However, the fertility is based on the diversity of microorganism present in the soil, among other factors. Biodiversity underpins the agriculture productivity. Agricultural biodiversity includes all components of biodiversity – at genetic, species and ecosystem levels – that are relevant to food and agriculture and that support the ecosystems in which agriculture occurs. Therefore, its maintenance is essential for the production of food and other agricultural goods and the benefits they provide to humanity, including food security, nutrition and livelihoods.

CASE BOX 16–Culture and Indigenous Knowledge-Based Technologies Practiced in Hill Farming Systems in Bandarban Hill District

Jhum, the shifting cultivation is the indigenous and major farming system practiced by hill communities in Bangladesh. The farmers have their own indigenous or traditional knowledge system for jhum cultivation and management. Mohiuddin et al. (2012) lists the major indigenous knowledge and cultural attributes followed by the Jhumians.

- *Indicators for jhum land selection: Traditionally give emphasis on slope, soil texture, vegetation cover & earthworm burrows.*
- *Fire management in jhum field preparation: Fire starts from the top of the hill.*
- *Three-phase seed sowing techniques in Jhum: First broadcast the small sized seeds (Ocimum, Capsicum), after one week sown the seeds of rice, cotton, maize, vegetable crops, and when the rice is about 10 centimetres in height they broadcast the seeds of sesame.*
- *Evil-spirit and insect repellency by planting colourful flower plants in Jhum: Pungent smell of ginger, onion, mint, and pepper and bright colour of flowers reduce insect attack.*
- *Slope differentiation of hills for crop selection: Farmers differentiate slopes for different crop cultivation.*
- *Local climate as an indicator for crop selection: Crop selection according to hill altitude.*
- *Seed collection and germplasm management: Use healthy and disease free plants for seed collection.*
- *Indigenous seed storage method: Different methods used for different seeds.*
- *Agro-biodiversity conservation through community based seed distribution: Community-based seed sharing system still exists among the Marma peasants for conserving and maintaining the indigenous rice varieties (more than 10 varieties in the CHT).*

An integrated approach that encodes the indigenous knowledge with scientific knowledge may be a sustainable solution of agriculture for the CHT area.

1.5.2 Fisheries

Many aspects of Bangladeshi culture, economy and tradition are based on fishing and fish culture activities. This sector, therefore, plays a vital role in the country's economy through employment generation, animal protein supply and foreign currency earning and eventually poverty alleviation. Fisheries, contributed nearly 3.30% to the GDP in 2013-2014 fiscal year in current prices and 3.69% in constant price (at 2005-2006 base year) in Bangladesh (BBS, 2014). Figure 11 shows contribution of fisheries sector to the GDP of Bangladesh over a period of 2006–2013. Trend of fish production during 1960-2013 is shown in Figure 12.

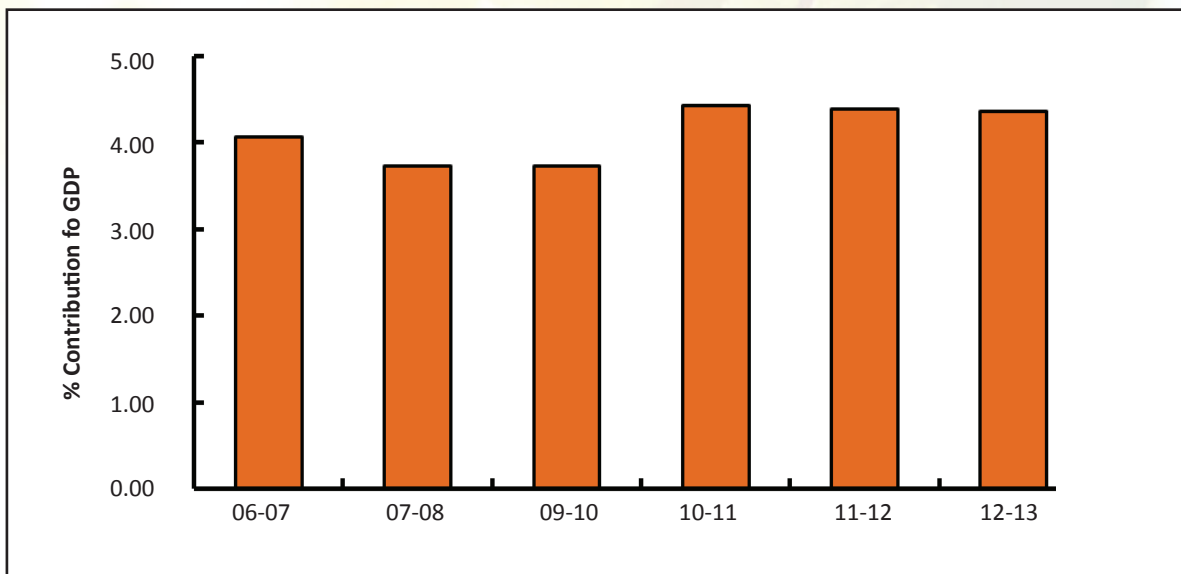


Figure 11 Contribution of Fisheries Sector to the GDP of Bangladesh during 2006–2013

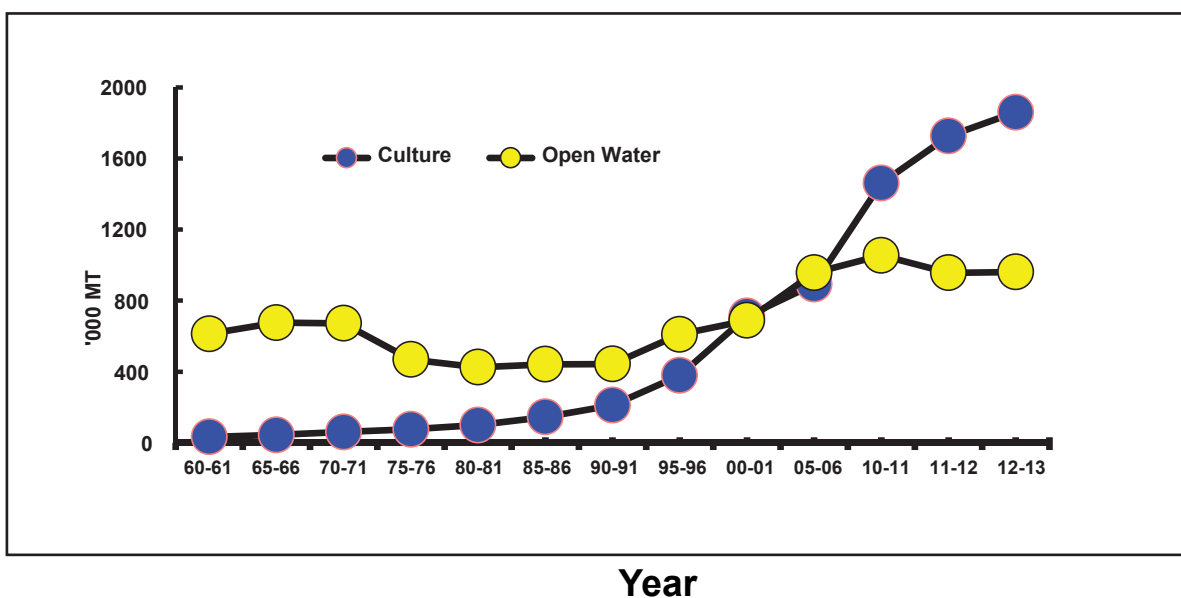


Figure 12 Fish Production (000 MT) During 1960-2013 from Culture and Open Water Sources (Source: DoF, 2014a)

However, the sub-sector contributes 23% of gross agriculture products and 5.71% to the total export earnings (DoF, 2008). It accounts for about 63% of animal protein intake in the diet of the people of Bangladesh (DoF, 2005). Table 38 summarises the production of fisheries in 2012-13 under different inland and marine ecosystems. Figure 12, on the other hand, highlights the production trends over the last more than five decades in culture and open water catches (Box 17). The fisheries sector provides full-time employment to an estimated 1.2 million fishermen and an additional 17.1 million people, i.e. more than 11% of total population directly or indirectly dependant on fisheries sub-sector (DoF, 2014b). Another 10% poor and middle class people are engaged in part-time fishing, aquaculture, fish seed production and collection of shrimp and prawn seed, fish handling, processing and marketing, net making, and input supply.



Estuarine Fishing by ABM Sarowar Alam

Table 38 Fisheries Production in Different Water Bodies (2012-13)

Water Resources	Water area (hectare)	Production (metric ton)	Production (kilogram/hectare)	% Total
Capture - Open Waters	3,916,828	961,458	-	28.19
River and Estuary	853,863	147,264	172	
Sundarban	177,700	15,945	90	
Beels (water body)	114,161	87,902	770	
Kaptai Lake	68,800	9,017	131	
Floodplain	2,702,304	701,330	260	
Culture - Closed waters	782,559	1,859,808	-	54.54
Ponds & Ditch	371,309	1,446,594	3,896	
Seasonally cultured waters	130,488	200,833	1,539	
Baor (Ox-bow lake)	5,488	6146	1,120	
Shrimp/Prawn Farm	275,274	206,235	749	
Trawler fishing	-	73,030	-	17.27
Aritasanal fishing	-	515,958	-	
Country Total		3,410,254		100

Source: DoF (2014b)

The wide variety of small indigenous species of fishes, such as *Amblypharyngodon mola*, *Aspidoparia jaya*, *Aspidoparia morar*, *Chela laubuca*, *Rohtee cotio* and others are the vital diet and source nutrition of poor people. In Bangladesh, some fish species are also used in traditional medicine.

CASE BOX 17 - Inland Fisheries in Bangladesh – Production and Demand Trend

From a global perspective, Bangladesh is ranked third largest in inland fisheries in Asia, behind China and India (Ghose, 2014). The rich aquatic biodiversity of the country with more than 650 fish species has been attributed to the world's one of the largest wetlands (Bengal Delta) and three large river systems (the Ganges, the Brahmaputra and the Meghna) that flow from the Himalayas into the Bay of Bengal. An analysis of the last 50 years showed that although open water fisheries increased significantly over that period, almost 10 times increase has been recorded in culture fisheries over the last two decades (Figure 11). This recent acceleration of production in culture fishery, however, has yet to ease fishing pressure on the wild fish diversity in large rivers and other water bodies.

Hilsa or Indian Shad (*Tenualosa ilisha*) is one of the most important commercial fish in the Indo-Pacific Region. In Bangladesh, it is regarded as national fish indicating its deep-rooted cultural value. Annual average Hilsa production in Bangladesh is 215,000 metric tons worth US\$ 380 million and contributing 1% to the national GDP (Ahsan *et al.*, 2014). Essentially a marine species, Hilsa migrates through three major river systems - the Ganges, the Brahmaputra and the Meghna - to breed. Trend of hilsha production over year is shown in figure 13.

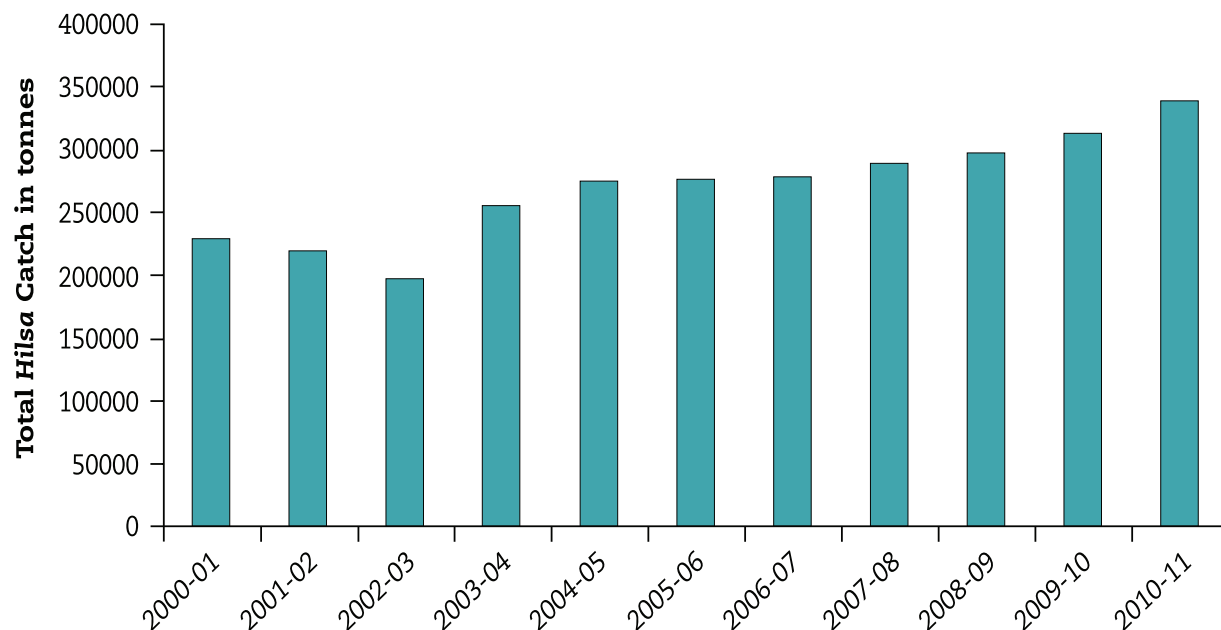


Figure 13 Total Inland and Marine Hilsa Catch of Bangladesh (2001-2011) (reproduced from Ahsan *et al.*)

Recently, a joint study was conducted by a group of experts from Bangladesh and India (Ahsan *et al.*, 2014). They studied the habitat quality along the migration path (Figure 14) and spawning grounds. Four suitable spawning grounds have been identified near the estuary near the north shore of the Bay of Bengal at Char Tojumuddin, Mirsorai, Kolapara and Kutubdyia. Hilsa catch is banned in these areas during the peak spawning period (15-24 October).

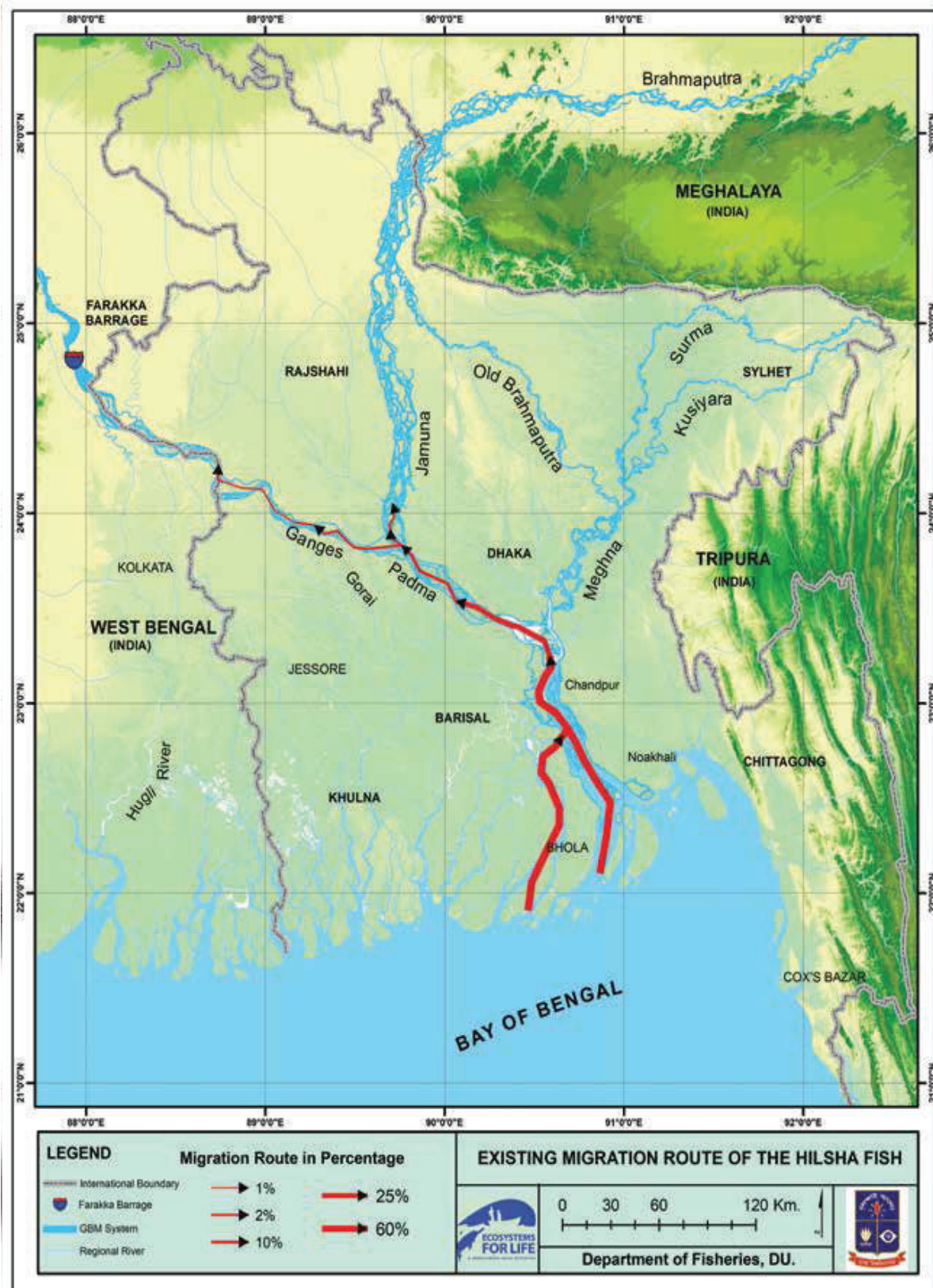


Figure 14 Hilsa Migration Route in Bangladesh (reproduced from Ahsan et al., 2014)

1.5.3 Livestock

Livestock plays an important role in the national economy of Bangladesh. The livestock sub-sector that includes poultry offers important employment and livelihood opportunities particularly for the rural poor, including the functionally landless, many of whom regard livestock as a main livelihood option. The contribution of livestock to GDP is 2.5% (Bangladesh Economic Review, 2013) and the overall trend of the livestock in Bangladesh has also been increasing (Table 39). Moreover, the products from livestock; like milk, meat and egg have also shown increasing trend of production (Table 40). The Figure 15 shows the trends of milk products. However, there is no data available indicating whether the genetic diversity itself has been increasing or decreasing.

Table 39 Number of Livestock and Poultry

Livestock and Poultry	Number of Livestock and Poultry (in hundred thousand)						
	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Cattle	228.7	229.0	229.76	230.51	231.21	231.95	232.41
Buffalo	12.1	12.6	13.04	13.49	13.94	14.43	14.47
Goat	207.5	215.6	224.01	232.75	241.49	251.16	252.12
Sheep	26.8	27.8	28.77	29.77	30.02	30.82	31.20
Fowl	2068.9	2124.7	2213.94	2280.35	2346.86	2428.66	2466.00
Duck	390.8	398.4	412.34	426.77	441.20	457.00	466.35

Source: MoF (2013)

Table 40 Production of Milk, Meat and Egg

Product	Production							
	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Milk*	22.7	22.8	26.50	22.86	23.65	18.91	34.63	34.63
Meat*	11.3	10.40	10.40	10.84	12.64	12.79	23.32	25.32
Egg**	54220	53690	56532	46920	57424	42110	73038	51347

Source: MoF (2013); * unit = in hundred thousand metric tons; ** unit = in hundred thousand number

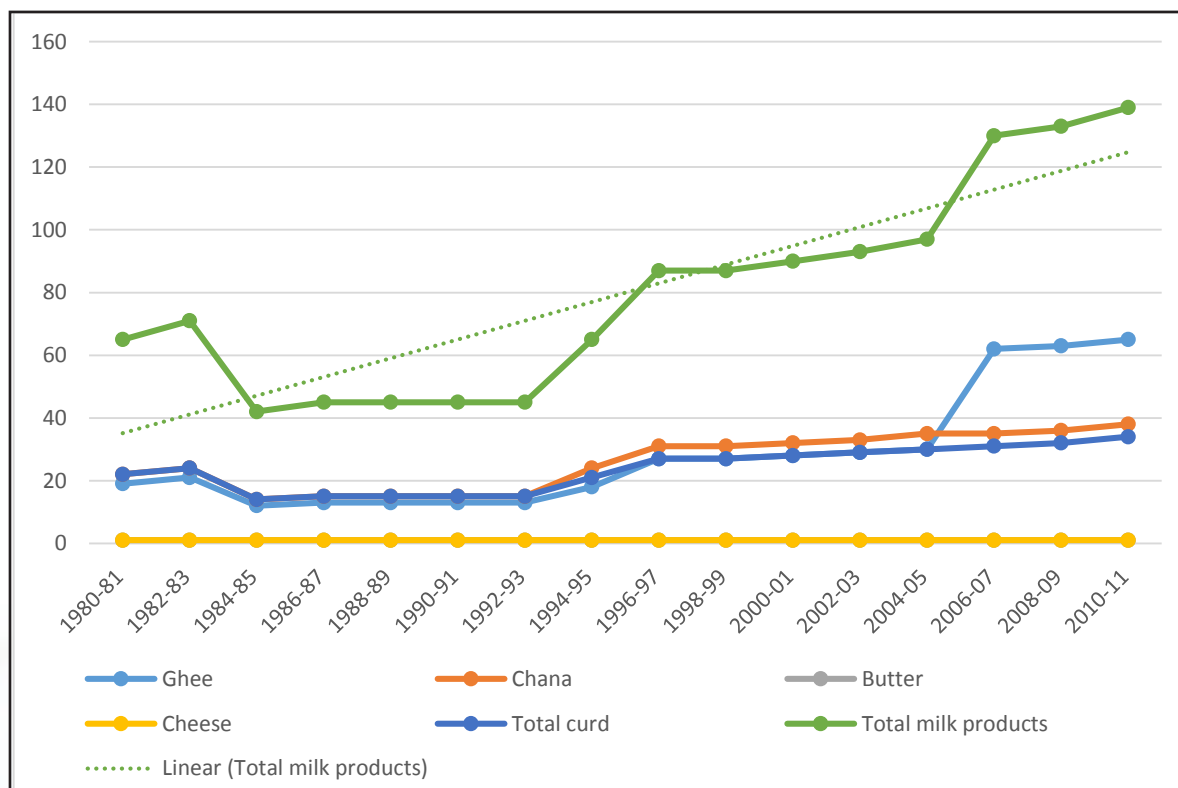


Figure 15 Trends in Production of Milk Products (BBS, 2011)

1.5.4 Forestry

Forests have a widely realized contribution to human well-being. Besides providing timber and other Non-Timber Forest Products (NTFPs) for human consumption, forests also provide cultural values, like education and aesthetic beauty, which are realized through research and tourism, respectively. It is comparatively easier to estimate the value of goods, for example, the worth of a forest in terms of total timber it has, but not the ecosystem services or cultural services it offers. Some attempts have, however, been made. The contribution of forest and related services to GDP is about 1.43% (BBS, 2014).

Reported in Haque and Aich (2014), Shah Uddin *et al.* estimated the value of provisioning and cultural services of the Sundarban US\$ 1.39 per hectare per year, whereas, the Net Present Value of the Sundarban is worth USD 9 billion (BFD, 2010) under the SEALS Project of the Bangladesh Forest Department (Table 1 in Annex). A recent valuation study concluded that the Sundarban generates a range of US\$ 456 to US\$ 1192 per hectare per year worth of ecosystem services (Haque and Aich, 2014). This means a US\$ 273 to US\$ 714 million per year for the entire Sundarban.

The value of a forest ecosystem is immense and only a handful of rigorous research has been done to realize the value of such ecosystems. It is imperative to argue that the biodiversity existing in these forests make it possible for the forest to be a functional and “alive” entity. Without the floral and faunal diversity, these forests would cease to exist and so would the different goods and services that we use for our well-being.

Medicinal plant is an important wealth in Bangladesh. A large number of people in the country are solely dependent on Ayurvedic treatment for maintaining their health. Medicinal plants are useful to human well-being and considered as a national wealth. About 747 plants with therapeutic value has been identified as reported by Yusuf *et al.* (2000; in Motaleb *et al.*, 2013). In Bangladesh, there are about 297 Unani, 204 Ayurvedic and 77 Homeopathic drug manufacturing industries where the medicinal plants are extensively used in both raw and semi-processed forms of medicine in various pharmaceutical dose formulations. These plants also serve as important raw materials for many modern medicinal preparations. The market value of drugs produced by these industries from medicinal plants is about BDT 3 billion. Besides, village Kobiraj, street vendors and indigenous people also use a large number of medicinal plants for the treatment of various diseases. Motaleb *et al.* (2013) reported that this practice reflects rich traditional heritage and that it plays a significant role in the general welfare of the upland communities of the CHT.

Acacia auriculiformis was used to be extensively planted by the Bangladesh Forest Department in agroforestry, community forestry, and fuelwood plantation programmes (Hossain, 2014). This trend has, however, been changed in recent years (Box 18).

CASE BOX 18- Use of Multiple Species in Plantation Programme

Till 2012, monoculture was very common while establishing forestry plantations. In the terrestrial areas, the use of Akashmoni (Acacia auriculiformis) was rampant. Everywhere, the Bangladesh Forest Department as well as the participants were planting Acacia auriculiformis (about 75% of all the plantations). At present, however, a change is being noticed. Since 2013, the Forest Department is implementing a US\$ 35 million project administered by the World Bank and funded from the Bangladesh Climate Change Resilient Fund. This project has started to go for multiple species plantation instead of monoculture. It has transpired that in many of the nursery locations the Bangladesh Forest Department has raised seedlings of over 20 different species and planting a large number of various indigenous species of seedlings in all the new plantation sites. This will help restoration of biodiversity and its enhancement in the country.

1.5.5 Nature-Based Tourism

The National Tourism Policy framed in 2010 emphasizes ecotourism development as well as preservation and conservation of natural and cultural products. In 2014, direct, indirect and induced contributions of tourism to GDP were 2.3%, 1.3% and 0.9%, respectively; whereas, generating 1.8% of total employment in the country. These figures remained more or less the same since 2010 (WTTC, 2014).

Around the country, the number of eco-tourists travelling to enjoy nature and various cultures are increasing. Cox's Bazaar, St. Martin's Island, the Chittagong Hill Tracts, the Sundarban and other protected areas are the prime sites visited by the tourists. Choudhury (2013) reported that, between 1 July 2010 and 30 June 2011, 207,930 tourists visited the Sundarban alone, whereby the Government earned revenue of Taka 8.622 million. According to the WTTC, Bangladesh's tourism industry directly contributed around Taka 2.23 trillion (2.1%) to the country's GDP in 2013 (WTTC, 2014), implying immense potential of ecotourism in Bangladesh.

However, in cross-country comparison, the WTTC reports that Bangladesh does poorly overall in the tourism sector. The total contribution to GDP (4.4%) compared to the Asia-Pacific is less than half in 2013 (8.9%) – and nearly 4 and 5 times less than Malaysia (16.1%) and Thailand (20.2%), respectively. The employment contribution is also in the same lines (WTTC, 2014).

Despite this limited performance, experts show a lot of hope in developing the sector. The strong backward and forward linkages are thought to be an underlying reason why, developing the eco-tourism sector with clear targets and medium and long term goals, will accelerate the sector to reach its foreseen potential and contribute significantly in livelihood options and human well-being.

2. National Biodiversity Strategy and Action Plan: Progress of Implementation and Mainstreaming

2.1 Introduction

With the development of the NBSAP (MoEF, 2006), Bangladesh has progressed remarkably towards fulfilling the global commitment of the country to the CBD. The Bangladesh NBSAP has identified 16 strategies, including 128 action programmes those are further categorized as short term (0-3 years), medium term (4-7 years) and long-term (8-10 years) programmes (Table 41). The following sections of this chapter also highlight some major achievements of implementing the NBSAP since its formulation. This chapter further summarizes the progress of NBSAP implementation during 2010-2015 by comparing with the original NBSAP actions and the progress reported in the Fourth National Report to the CBD (MoEF, 2010).

2.2 Implementation of NBSAP (2010-2015)

Since the submission of the Fourth National Report to the CBD in 2010 (MoEF, 2010), progress made during the period of 2010-2015 have been summarized in Table 41. This updated table has resulted from expert input, stakeholder consultations and literature review. For a comparative outlook, the accomplishments reported in the Fourth National Report have also been included alongside the new accomplishments.

Table 41 Progress of Implementing the National Biodiversity Strategy and Action Plan (2010-2015)

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
1. Recognize the value and importance of biodiversity for the Bangladesh people and document properly its components, distribution and value.	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Document existing ecosystems, species and genetic pools of Bangladesh, including their status and extension, with specific emphasis on ecosystems such as forests, coastal and marine environments, inland water, agriculture and fisheries; species including flora, fauna, microorganisms, underutilized species and insects. Determine values in economic terms of the different goods and services provided by the different biodiversity components to the benefits of the country's economy and its people. Support identification of the biodiversity services that contribute to reducing poverty and providing means for sustainable household economic securities. 	<ul style="list-style-type: none"> Encyclopaedia of Flora and Fauna of Bangladesh published by Asiatic Society of Bangladesh describing the current status of different taxonomic groups; Valuation of wetland ecosystem under CWBMP; MACH project in Hail Haor executed by Winrock international and CNRS to conserve biodiversity of the wetland; Scattered actions under various projects on livelihood/ Value Chain development in IPAC; Co-management project of Tanguar Haor, executing by IUCN Bangladesh concentrating of ecosystem based conservation resource management; 4th Fisheries Project (fish diversity assessment) ; 	<ul style="list-style-type: none"> Bangladesh National Herbarium has recently published the Volume 2 of <i>Red Data Book of Threatened Vascular Plants of Bangladesh</i> that include 120 threatened species (Ara <i>et al.</i>, 2013). IUCN is currently implementing a project to update the Red List of threatened animals of Bangladesh originally published in 2000 (IUCN Bangladesh, 2000). Details of this project can be found on www.iucnredlistbd.org Economic valuations of different ecosystems have been conducted sporadically, e.g., Sundarban (Haque and Aich, 2014) and Teesta River (2014) (unpublished). Values of Protected Areas (PAs) as well as the documentation of biodiversity of each PAs have been conducted by Arannayk Foundation since 2010. Four books have already been published, each focusing on biodiversity of a particular PA with their values and threats. Preparation of management plan with the approach of co-management is underway for various PAs and ECAs.

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Understand the economic values of biodiversity and empower local communities to achieve economic gains by developing suitable market linkages and strategies. Conduct village-based inventory of flora and fauna, including their traditional uses. <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> Develop a National Biodiversity Information System that acts as the National Clearing House Mechanism on biodiversity. 	<ul style="list-style-type: none"> Char livelihood program to promote and conserve biodiversity in Charlands funded by DFID; Wetland management initiative under SEMP executed by CNRS, BCAS and NACOM; CBRMP project of Local Government Engineering Department (LGED) is currently working for restoration and conservation of wetlands ecosystems; Various other institutions such as CEGIS/ SPARSSO/CDMP/BARC are working to develop databases on natural resources to assist conservation activities. 	
<p>2. Conserve ecosystems, species and genetic pool of the country to ensure that the present and future well-being of the country and its people are secure.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Develop action plans for protection and conservation of endangered native and endemic species of Bangladesh. Document and map existing community reserves in the hill ecosystems along with their management modes. Develop national systems and plans for conservation and management of Ecologically Critical Areas. Identify the impacts of climate change, desertification, floods and other processes on the integrity of ecosystems and species and develop suitable management plans. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Develop and implement actions to support management of soil biodiversity for enhancing productivity and implement options for conservation of pollinators. Support minimum nutritional standards for 	<ul style="list-style-type: none"> Wildlife Preservation Act of 1974 is in the process of being upgraded; ECA Rule is underway to be finalized; NAPA, BCCSAP, NAP have issues concerning biodiversity, but integration issues have not well taken care off in line with NBSAP; Community conserved areas have been established in different parts of the country; To identify impacts of climate change on Biodiversity long term monitoring has been suggested in National Adaptation Program of Actions; Ideas of establishing community seed banks have been initiated in grass root level. A book on the 'Red Data Book on Vascular plants of Bangladesh' has been published. That book includes 106 species of vascular plants of the country describing their conservation status. Recently another project has been launched by BNH aiming to publish Red Data Book of Vascular Plants of Bangladesh vol.-2. 	<ul style="list-style-type: none"> The Wildlife Act amended as <i>Wildlife (Conservation and Security) Act 2012</i>. Bangladesh Forest Department developed Bangladesh Tiger Action Plan (2009-2017). Under the SRCWP project of BFD, IUCN Bangladesh is facilitating the development of Bangladesh Elephant Action Plan for 2015-2024. Several Protected Area Management Plans have been developed by Bangladesh Forest Department under various projects (e.g. SRCWP). Community Reserves maps: Arannayk Foundation with the support from USAID, GIZ and Bangladesh Forest Department supporting community-based conservation practices in PAs of the country. Several programmes have been continued in Chunati Wildlife Sanctuary, Teknaf Wildlife Sanctuary and Inani Nature Reserve under these initiative since 2010. CREL and CBA-ECA projects: Village level plans are made, focusing on climate resilience and livelihood improvement. Activities have been undertaken around Marine Protected Area(MPA) under the BoBLME project supported by FAO. Turtle conservation has recently been taken under CWBMP and CBA-ECA projects.

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>the people by: promoting cultivation of nutritional crops and drought-resistant varieties; setting up community seed banks; provision of access to nutritious food; and raising awareness of addressing spells/cycles of hidden and transient hunger.</p> <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> • Support sustainable harvesting of biodiversity and management of biological resources. • Conserve the genetic pool of plants and animals, both in ex-situ and in-situ conditions, through appropriate local actions. • Promote indigenous methods of conservation and management of jhum agrobiodiversity with appropriate incentives. • Promote sustainable agriculture through diversification of crop production and introducing broader diversity in crops as well as innovative techniques such as participatory plant breeding. • Incorporate ecosystem conservation efforts into the national disaster management plan implementation. 		<ul style="list-style-type: none"> • Co-management has been initiated in various forest PAs, Wetlands ECAs through IPAC followed by CREL project. • Jaflong-Dawki River has been declared ECA by the DoE. Management initiatives have been taken in some ECAs through CWBMP and the CBA-ECA projects. Halda River is also in the process to be declared as ECA. • Under the SRCWP, some initiatives have been taken by the Bangladesh Forest Department to study spoonbill sandpiper and marine turtle monitoring in the coastal ECA of the country. • Bird colonies: In North Bengal, more than 40 colonies are being managed by different stakeholders along with the Bangladesh Forest Department. • Establishing assurance colonies of <i>Batagur baska</i> was initiated by CARINAM in 2009 with support from the BFD at Bhawal National Park, currently being managed by IUCN-Bangladesh • A good number of Community Conservation Areas have been established in the CHT under different initiatives.
<p>3. Restore ecosystems and rehabilitate endangered species.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Support rehabilitation of the rare, threatened and endangered native, wild and domesticated species. • Implement plans for management of species under the rare, threatened and endangered categories. • Develop action plans for reducing levels of pollution – both in rural and urban areas to support conservation efforts. • Support development of assessment, management and monitoring plans both at 	<ul style="list-style-type: none"> • Protected Area System (In last 5 years three new national parks and one new wildlife sanctuary have been designated); • River around Dhaka city have been declared as Ecologically Critical Area to safe guard its biodiversity; • CWBMP, IPAC and Tangua haor management plan have taken ecosystem approach to protect the habitat; • Tangua haor management plan and CBRMP have been working to restore wetland and swamp forest ecosystems. 	<ul style="list-style-type: none"> • IUCN Bangladesh is updating the animal Red List for Bangladesh. Details of this on-going project is available on www.iucnredlistbd.org • Two Vulture Safe Zones have been declared by the Forest Department in December 2014 in the Sylhet and Khulna regions (IUCN Bangladesh, 2015). • Captive breeding of globally Critically Endangered turtle <i>Batagur baska</i> is going on in Bhawal National Park since 2010. A new breeding center for this species has been established in the Sundarban in 2014. • Elephant habitat improvement: 240 ha (south-east of Bangladesh (SRCWP);

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>ecosystem and species levels.</p> <ul style="list-style-type: none"> • Create and launch initiatives for restoration of degraded ecosystems. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Develop mechanisms to halt degradation and restore ecosystems as much as possible. • Review and update Red Book lists of threatened and endangered species. <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> • Encourage afforestation and reforestation programmes with indigenous species. • Regulate shifting cultivation and introduce and extend, as appropriate, innovative farming practices developed and adopted by farmers. 		<p>Common Langur conservation (SRCWP); Crocodile breeding at Koromjal (Bangladesh Forest Department); and Olive Riddley Turtle: MarineLife (SRCWP).</p> <ul style="list-style-type: none"> • Bangladesh Forest Department established few Wildlife Rescue Centres in different regions of the country to rescue and for the protection of confiscated wildlife of the country. • Bangladesh National Herbarium is implementing a project to complete Red Book on vascular plants of Bangladesh. The Volume 2 was published in 2013 (describing 120 threatened species). The Volume 3 is expected to be published by 2015. • Afforestation and reforestation by the Bangladesh Forest Department includes indigenous species. • DoE has taken an ecosystem-based adaptation (EbA) project in Hakaluki Haor and Barind tract. • CBA-ECA project of DoE: restoration of beels and canals in the <i>haor</i>, 300-400 hectare mangrove plantation in the south-west area. • There has been some recent initiatives/innovations in the CHT by the Department of Agricultural Extension and the Soil Resource Development Institute and other projects on farming practice.
<p>4. Adopt national measures and standards to deal with invasive alien species and genetically modified organisms.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Develop national management plans for control and eradication of invasive alien species. • Support capacity building on identification of invasive species and genetically modified organisms. • Develop a national biosafety framework. • Locally monitor and prevent the release of IAS and hybrids in aquatic ecosystems. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Develop capacity building tools and methods for local communities to deal with identification, 	<ul style="list-style-type: none"> • Plant Quarantine system with limited capacity is in place to control IAS; • NBF has been developed in 2006 and biosafety rules have been drafted in compliance with Cartagena Protocol on Biosafety; • Biosafety Clearing House (BCH) has been established and got connected with central portal operated by SCBD; • Implementation project on NBF is underway to be initiated; • Bangladesh is participating in regional dialogue in managing IAS and GMOs 	<ul style="list-style-type: none"> • DoF has addressed the issues of invasive fishes like African Catfish and Piranha. • Implementation of Biosafety Framework: local, regional and international developments and cooperation/dialogues, initiatives have made slow progress. • Various committees are working at the check points.

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>management and control of invasive species and GMOs.</p> <ul style="list-style-type: none"> • Build awareness of biosafety and biopiracy issues among local communities and within the Customs Service. <p>Long term (8-10 years)</p> <ul style="list-style-type: none"> • Support establishment of monitoring systems for addressing issues of regional and international trade and their impact on movement and/or introduction of invasive species and genetically modified organisms. • Support economic and social impact studies on use of genetically modified organisms and alien species. • Encourage regional dialogue on sharing of expertise and resources in management of IAS and GMOs. 		
<p>5. Promote equitable sharing of biodiversity conservation costs and benefits among different sectors of the society.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Develop and implement national access and benefit sharing regime on genetic resources. • Identify impacts of trade and IPR regimes on national policies regarding access and benefit sharing. • Develop suitable national policies on patents and IPRs, which, in addition to being responsive to local needs, will also contribute to international cooperation in the use of biological resources. • Encourage documentation and protection of traditional knowledge associated with conservation and use. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Develop capacities for research and development on use of species and genetic resources. 	<ul style="list-style-type: none"> • Regulatory regime on ABS has yet to be established; • A detailed assessment on IPR is yet to be furnished; • Comprehensive documentation on indigenous and traditional knowledge is yet to be accomplished 	<ul style="list-style-type: none"> • Bangladesh Biological Diversity Act has been vetted and got final endorsement by the cabinet of the government. • Documentation of traditional knowledge is sporadically on-going by Arranyak Foundation and other research organizations. • Bangladesh Agricultural University: Documentation of 46 under-utilized native and naturalized fruit tree species which may be used for food, fibre, animal fodder, oil, medicine and many other undeveloped / untapped potential uses (Rahim <i>et al.</i>, 2011). • Institute of Forestry and Environmental Sciences (IFESCU), University of Chittagong: A recent study in Sitapahar forest reserve in Kaptai identified 31 under-utilized or lesser-known tree species with their distribution, growth and regeneration potential (M.K. Hossain, IFESCU, personal communication).

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> • Develop mechanisms for private sector investment into sustainable use of biodiversity by revision of appropriate policies and provision of incentives for such investments. • Promote development and commercialization of under-utilized crops and species. • Institute rewards and incentives for the conservation of indigenous crops, genetic materials, and best practices of resource use. 		
<p>6. Contribute to raising awareness and building capacity of biodiversity conservation among the different sectors of the society.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Ensure that all sectors of the Bangladesh society, including Government at different levels, are fully aware of both the need to conserve biodiversity and their personal and institutional responsibilities involved in this task. • Build taxonomic capacity for lower groups of plants, invertebrates, microorganisms and threatened/endangered species. • Promote understanding and awareness of the stakeholders of the importance and methods of conservation through developing appropriate communication tools, including materials in local language. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Develop the capacity of different sectors, including the Government, of implementing the necessary tasks in respect of biodiversity conservation, as appropriate. • Strengthen existing capacity of Department of Environment to address the 	<ul style="list-style-type: none"> • Efficiency in awarding Environmental Clearance Certificate has been enhanced by the Department of Environment through various legal and administrative measures; • Bangladesh National Herbarium and some universities have the Taxonomic Capacity. But the capacity in this regard has to be strengthened; • Environmental Curriculum on Environment has been developed by the Department of Environment for school level education awareness. 	<ul style="list-style-type: none"> • Under the SRCWP, higher study of Bangladesh Forest Department staff, and participation in international courses (Deradun, India) and exposure visits, and attaining MS degree have been supported. • CREL: Government officials' capacity has been developed through various training. • An analysis of plant taxonomy study in Bangladesh over last 40 years revealed a positive trend in the study of lower groups (Irfanullah, 2013). IUCN's on-going initiative on Red List updating has included invertebrates (crustaceans and butterflies). • It has been found that studies on higher vertebrates, especially wildlife studies increased several fold during last decade dramatically. Multi-dimensional studies on different aspects of wildlife ecology, management and conservation have been increasing during the last two decades. Several new dimension of wildlife studies started after 2010, viz human-wildlife conflicts, effect of climate change on wildlife and bidirectional pathogen transfer between wildlife and human. Data on status and distribution of wildlife regularly updated in the national list, not only by the wildlife experts, but also by a large group of enthusiastic amateurs/bird lovers (Divisional Forest Office, Rajshahi Wildlife). Similar systematic analysis on fishes is absent. • Homestead forestry: Biodiversity conservation through involvement of local people in Community Conserved Areas is a traditional management system in the

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>Environmental Clearance Certificate more efficiently.</p> <ul style="list-style-type: none"> • Provide institutional support for conserving homestead forestry. • Build capacity in local communities, especially those that live around the PAs to serve as tour guides where market research demonstrates a viable ecotourism potential. • Curriculum development and training of the trainers (ToT) on biodiversity. <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> • Build capacity of local communities to monitor and report on the status of biodiversity, threats, and underlying causes. • Integrate conservation and sustainable use into both formal and non-formal education programmes through the provision of education opportunities that particularly target the poor and natural resource dependent communities, e.g. those living in PAs. • Establish regional herbaria and botanical gardens and the Bangladesh Museum of Natural History. • Integrate biodiversity-based curricula into the formal education system and update regularly. 		<p>CHT. Arannayk Foundation is working involving local people of several areas of the CHT, viz Dighinala, Komolchari, Wagga, Rongchari, Lama and Kafrulpara for conserving biodiversity of these areas.</p> <ul style="list-style-type: none"> • The Government is implementing a project on Biodiversity Conservation and Eco-tourism Development in Bangladesh. • In 2014, a Committee was formed under the Ministry of Cultural Affairs to establish Bangladesh Natural History Museum. • Under Padma Bridge project, a biodiversity/natural resources museum is being established. • Establishment of Botanical Garden at Chittagong has been initiated by BFD. • Awareness programmes: Extensively going on elephant, tiger, hanuman, common lengur, vulture, migratory birds, etc through GO-NGO initiatives.
<p>7. Promote use of traditional knowledge for conservation, use and protection of the local communities' intellectual property rights.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Document and register the traditional knowledge developed over the centuries by the people. • Assess extent which the <i>sui generis</i> system of Bangladesh is able to protect the intellectual property rights of local communities. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Provide incentives to communities to conserve 	<ul style="list-style-type: none"> • No assessment done in true sense • Various NGOs have gathered data on the traditional knowledge regarding resource management and biodiversity conservation, however any national level initiative is still lacking. • A book on the 'Traditional uses of ethnomedicinal plants of the Chittagong Hill Tracts' has been published. That book includes the 	<ul style="list-style-type: none"> • On-going CREL (USAID-funded), SEALS project (EU-funded), GIZ – Arannayk funded and Mangrove for the Future (MFF) (SIDA-DANIDA-funded) projects have community-based approaches in biodiversity-rich ecosystems, sometimes in connection to resilience building and markets development.

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>indigenous food and other economic plants</p> <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> Promote forestry activities with a focus sustainable harvesting and management of fuel wood and Non-Timber Forest Products (NTFPs) by supporting activities such as Joint Forest Management and development of Community Wood lots etc. (creating equitable access among gender, class and caste to forest resources) Promote the adoption of People's Biodiversity Registers throughout the country Integrate traditional knowledge in local level planning 	<p>enumeration and photographs of 700 medicinal plant used by the different indigenous tribal communities live in the CHTs area and the total pharmacology of 301 diseases treated by tribal kabiraj/Boidhyas.</p> <ul style="list-style-type: none"> Under IPAC programme sustainable NTFPs management programme have been outlined 	
<p>8. Establish institutions for inter-sectoral implementing mechanism for the Bangladesh National Biodiversity Strategy and Action Plan.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Support establishment of an 'Apex Body' for biodiversity conservation for implementation of NBSAP with suitable support mechanism <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Develop capacities of the members of this proposed 'Apex Body' for better implementation of NBSAP <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> Support development of monitoring and evaluation tools for assessing the implementation of NBSAP besides addressing issues of opportunities and threats Enhance cooperation among agencies and ministries on issues of ownership of NBSA Support mainstreaming biodiversity conservation, issues and actions identified under NBSAP into other sectors, agencies and their action plans as well as into PRSPs and NAPA 	<ul style="list-style-type: none"> A national Technical Committee on Biodiversity has been formed headed by the Secretary, Ministry of Environment and Forest; This Committee is comprised of all the relevant institutions and government agencies relevant with Biodiversity Conservation. The Committee frequently meets to make policy decisions on biodiversity conservation in Bangladesh 	<ul style="list-style-type: none"> Tiger Conservation Committee: The Committee frequently meets to make policy decisions on tiger conservation in Bangladesh.

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
<p>9. Enhance Protected Area Management, recognizing the benefits of collaboration with local communities in their management (Co-management)</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Identify key habitats that ensure ecosystem integrity and connectivity (corridors, migratory flyways of birds, etc) and support actions to maintain and promote such connectivity between the earmarked critical and sensitive areas <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Develop suitable measures to promote co-management of PAs and designate community conservation areas Reorganize the structural pattern of the Forest Department and strengthen the capacity of personnel for PA management <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> Identify, create and manage National Biodiversity Conservation Areas, Protected Areas (PAs) and biodiversity hot spots and suggest appropriate actions to promote environmental sustainability Establish a well-managed and representative protected area system, which is responsive to the local needs of communities, in addition to supporting conservation of biodiversity Establish a biosphere reserve in the hilly parts of Chittagong and the CHTs 	<ul style="list-style-type: none"> Actions are underway through various project activates to establish PA system and integrating co-management approach in Biodiversity Conservation of the Ecologically Critical and Protected Areas. Bangladesh National Herbarium has identified a number of key habitats that ensure ecosystem integrity but the management of those habitats is not under BNH. In this case BNH can provide only technical supports. 	<ul style="list-style-type: none"> Assessments on elephant corridors have been done under IUCN's elephant projects under the SRCWP. Other projects include wildlife habitats are USAID's tiger conservation project by WildTeam, CREL project, and GIZ's projects. Bangladesh joined East Asian-Australasian Flyway (EAAF) partnership for protection of Wetlands and Migratory Water Birds. Five PA management plans are developed under the SRCWP and another five are on-going now. After successful implementation of Nishorgo and IPAC projects, CREL project is now being implemented since 2013 by taking climate-resilience building approach in biodiversity-rich areas. Village Conservation Group (VCG) and Village Conservation Areas (VCA) Committees are established in various PAs and ECAs. Infrastructures for Co-Management Committees (CMCs) progressed well.
<p>10. Ensure wise use of wetland resources.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Identify key habitats that ensure ecosystem integrity and connectivity (migratory flyways of birds, fish passes, etc) and support actions to maintain and promote such connectivity between the earmarked 	<ul style="list-style-type: none"> Except a few initiatives for the conservation of wetlands, the vast area in the country still deserve a huge attention in terms of sustainable use through provisioning of alternative livelihood and so many other measures to minimize resource exploitation. 	<ul style="list-style-type: none"> A good number of projects have been and are being implemented by different agencies, namely Tanguar Haor project of MoEF funded by SDC; CBA-ECA of DoE; Wetland Biodiversity Rehabilitation Project funded by GIZ and SRCWP of BFD and CREL project funded by USAID. Committees formed at different tiers in case of some ecosystems, e.g. Cox's

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>critical and sensitive areas.</p> <ul style="list-style-type: none"> Develop community-based wetland and aquatic resources management <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Promote and ensure income generation activities during the fish breeding season for people those are dependent on fishing only. <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> Promote conservation of biodiversity through ecosystem approach for watershed management in order to ensure adequate water supply, in terms of quality and quantity, for households by developing appropriate management plans for watersheds and their use. Establish and manage fish sanctuaries both in fresh water and marine ecosystem including 'brush piles' in fresh water ecosystem. Ensure the sectoral policies on fisheries, aquatic resources and water managements are in keeping with the NBSAP. 		<p>Bazaar-Teknaf Peninsula ECA, Hakaluki Haor ECA, and Tanguar Haor.</p> <ul style="list-style-type: none"> IUCN recently published a book on migration, breeding and conservation of Hilsa Shad in Bangladesh and India (Ahsan <i>et al.</i>, 2014). Valuation of ecosystem services of selected ecosystems (wetland, hills and coast) are underway under the updating and mainstreaming of NBSAP project (2015).
<p>11. Establish participatory mechanisms to receive and utilize the inputs from private sector, civil society and local communities about the different process leading to biodiversity conservation, use and sharing of benefits.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Ensure that appropriate participatory processes/ collaborative mechanisms are put in place in all activities related with biodiversity conservation, including the NBSAP implementation mechanisms. Identify and establish the mechanism of cooperation between related agencies for taking forward the actions identified under the NBSAP <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Support development of sectoral action plans, 	<ul style="list-style-type: none"> Government has adopted PPP approach in various environmental and resource management programmes. Department of Environment has established a partnership program to make combined effort on environment conservation in collaboration with relevant N/GOs 	<ul style="list-style-type: none"> Government introduced that 50% revenue generated from PA management (entry fee and other charges) to go to CMCs

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	<p>identifying the roles and responsibilities of government agencies and departments.</p> <ul style="list-style-type: none"> • Develop capacities as well as understanding on issues of conservation, management and use to relevant stakeholders • Further develop the finance strategy suggested under the NBSAP to include ways of cooperating with private sector and business community. <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> • Encourage budgetary allocations to implementation of NBSAPs by different agencies, including local government bodies, private sector and NGOs. 		
<p>12. Review and develop biodiversity related legislation(s) and establish a specific branch in the Judiciary to deal with biodiversity and environmental issues.</p>	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Review and strengthen the legal and policy regimes for conservation and, sustainable and equitable use of biological resources • Develop training modules for Judiciary on conservation and environment • Ensure that the proposed 'Biodiversity Act' is compatible to the NBSAP • Strengthen individual and institutional capacities on issues of trade and IPRs. WTO rules and Access and Benefit Sharing and others. • Develop a national policy to address the issue of human-animal conflicts in and around protected areas, especially trans-boundary issues <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Enhance the understanding of the Judiciary on importance of biodiversity, its links to local livelihoods and 	<ul style="list-style-type: none"> • Regulation on IPR, plant variety protection and farmer's rights have already been developed. 	<ul style="list-style-type: none"> • Bangladesh Biological Diversity Act is in the final stage to be enacted. • In 2012, the Government formulated a new set of laws for the protection of wildlife in the country and these were adopted by the parliament as the <i>Wildlife (Conservation and Security) Act 2012</i>. The law contains a wide ranging definition of wildlife and forest related offences and crimes. Protected Areas are elaborately expanded in this Act to include 10 new types of areas for the conservation and safety of wildlife. • ECA Rules are under preparation. • Wildlife Crime Control Unit has been established under the Bangladesh Forest Department in 2012. • Three other initiatives have also been taken by the government to conserve our biodiversity, viz. <i>Brick Burning (Control) (Amendment) Act, 2013</i>, <i>Saw-mill (License) Rules, 2012</i>, and <i>Transit Rule for Bangladesh, 2011</i>. • 3R Strategy and Programmatic Clean Development Mechanism (on-going) - has positive implication on wetland conservation

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	environment, emerging international trends in environmental law <ul style="list-style-type: none"> Establish a information sharing mechanism on environmental justice and related provisions 		
13. Establish an open and transparent monitoring and reporting system status and trends of implementing the principles of CBD.	Short term (0- 3 years) <ul style="list-style-type: none"> Develop tools and techniques for monitoring and implementation of NBSAP Prepare biodiversity baseline report and develop reporting tools. Identify options for participatory implementation of NBSAP Medium term (4-7 years) <ul style="list-style-type: none"> Encourage public and private sector initiatives on supporting implementation and monitoring of actions through provision of appropriate incentives. 	<ul style="list-style-type: none"> Bangladesh Government has introduced environment conservation award to encourage public initiatives towards environment conservation. 	<ul style="list-style-type: none"> Bangladesh developed and submitted both 4th and 5th NR to CBD secretariate. Both the reports were developed in consultative process and participatory manner.
14. Develop a financial strategy that is innovative and sustainable.	Short term (0- 3 years) <ul style="list-style-type: none"> Identify ways of realizing the principles of the financial strategy that identifies possible sources of support for implementation of NBSAP Assist agencies and ministries in identifying funding strategies for conservation as well as encourage resource allocations through their annual budgets Develop a medium term and long-term investment plan for realizing the actions under NBSAP Medium term (4-7 years) <ul style="list-style-type: none"> Encourage donors and partners to mainstream elements of NBSAP and the actions thereof into their plans and programmes of support Long term (8 -10 years) <ul style="list-style-type: none"> Support development of innovative funding 	<ul style="list-style-type: none"> There is no separate financial mechanism yet in place to support the implementation of NBSAP. Government of Bangladesh has sporadic financial arrangements through its MTBF (Mid-Term Budgetary Framework) to support project based biodiversity conservation efforts. NSAPR (National Strategy for accelerated Poverty Reduction) has also highlighted conservation of biodiversity with specific targets to be achieved. 	<ul style="list-style-type: none"> The 7th Five Year Plan (2015-20) considered implementation of NBSAP targets in a broader way. Co-management Council Fund given by Arranyak Foundation and CREL, as seed money. CBA-ECA: Endowment fund established at upazila level in selected ECAs. PA entry fees: Introduced and managed under co-management arrangement. Tanguar Haor: Fish catch sharing applied among the fisher community, co-management committee and the administration. The World Bank-funded Bangladesh Forest Department's SRCWP project is supporting NGOs to conduct 24 projects. In addition to these, 10 projects are being implemented by government agencies. (www.regionalwildlife.gov.bd). Overall, many projects gave revolving funds to CBOs; and many are functioning till now

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
<p>15. Address issues of synergies with other Multilateral Environmental Agreements (MEAs) and process that deal with climate change, disaster management, livelihoods, food security and sustainable development.</p>	<p>options for actions under NBSAP</p> <ul style="list-style-type: none"> Encourage private sector partnership on financing implementation with appropriate monitoring mechanisms <p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> Review and revise national disaster management plans that include elements of contributions from biodiversity into implementing such plans. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> Develop local activities on issues of adaptation and mitigation. Develop a portfolio of actions on 'anticipatory research' to address the future offsets of climate change <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> Identify options for carbon markets that are linked to quality carbon sequestration Integrate elements of conservation of biodiversity and development planning into National Adaptation Programmes of Action (NAPAs). Support development of policies that address issues of mitigating the impacts of trade, globalization and IPRs on local livelihoods as well as conservation. Promote sustainable use practices and market linkages by developing policies and regulations through cooperatives and other appropriate mechanisms Promote sustainable agricultural practices by: providing incentives to farmers for following sustainable practices; supporting use of modern and traditional technology blends; supporting effective 	<ul style="list-style-type: none"> CDMP is working on integrating biodiversity issues into disaster management programmes. NAPA and BCCSAP have been developed by the Government of Bangladesh to address climate change risks. Both this policy document have got specific elements to address climatic impacts on Biodiversity 	<ul style="list-style-type: none"> The National Plan for Disaster Management (2010-15), has not included elements of contribution from biodiversity. NAP updated under UNCCD has considered conservation of Biodiversity Bangladesh Delta Plan under preparation has also given importance to biodiversity and natural resources conservation.

NBSAP Strategy	Actions in NBSAP	Activities reported in the Fourth National Report (MoEF, 2010)	Accomplishment during the Fifth National Report (2010-2015)
	Public Distribution System.		
16. Integrate biodiversity conservation into the national development making, planning and process.	<p>Short term (0- 3 years)</p> <ul style="list-style-type: none"> • Develop anticipatory methods to deal with issues of managing the environment, adoption of new technologies and strengthening resource rights. • Encourage private sector involvement in development planning as well as implementing pro-poor environmental and fiscal reforms. <p>Medium term (4-7 years)</p> <ul style="list-style-type: none"> • Strengthen institutional and individual capacities at the local level to deal with issues of negotiation as well as implementation. • Make foreign direct investment pro-poor and pro-environment. • Find ways to ensure Multilateral Environmental Agreements (MEAs) more explicitly contribute to poverty reduction in their implementation. • Encourage sustainable production and sustainable consumption methods. • Enhance effectiveness of development cooperation and debt relief that is not only based on the WTO principles and negotiations but also on ethics and equity aimed at sustainable development and poverty reduction. <p>Long term (8 -10 years)</p> <ul style="list-style-type: none"> • Integrate poverty-environment-development issues into national development frameworks. • Decentralize environmental management and prioritize actions on the national development agenda. • Reduce the environmental vulnerability of poor by providing appropriate coping strategies. 	<ul style="list-style-type: none"> • NSAPR included Biodiversity • PPP has been initiated for natural resource conservation under various project activities. 	<ul style="list-style-type: none"> • IUCN Bangladesh developed a community-based biodiversity monitoring protocol for Tanguar Haor (Alam <i>et al.</i>, 2012). • Private sector engagement in development planning as well as implementing pro-poor environmental and fiscal reforms are limited. • The Vision 2021 formulated by the Government of Bangladesh in 2010 envisaged 'Environmentally Sustainable Development' as a key approach. • Development of Bangladesh Delta Plan 2100 is under preparation. • 7th Five Year Plan Integrated Biodiversity issues.

2.3 Mainstreaming Biodiversity into Sectoral and Cross-sectoral Policies, Strategies and Programmes

Mainstreaming is the important aspect of ensuring conservation of biodiversity, sustainable use of its components or addressing the main drivers of the losses of biodiversity. Mainstreaming should be taken place at the institutional, systemic and individual level. Despite the formulation of the NBSAP in 2006, an absence of long-term comprehensive programme in achieving implementation of the biodiversity strategies in various sectors is a setback towards mainstreaming.

Mainstreaming has to go a long way towards integrating various stakeholders related to natural resource management of the country. Because various actors have their own development mandates to achieve rather having focus on biodiversity conservation or ensuring sustainable use. For example, the Ministry of Agriculture is setting priority at food grain production by introducing high-yielding varieties. The Department of Fisheries also wants to see fish production in terms of as many tons as possible with limited focus on fish biodiversity conservation. The *National Shrimp Policy 2014* is, however, an encouraging example of integrating biodiversity conservation in economic development. Ministry of Water Resources aims at extending geographical coverage of flood control drainage and Irrigation schemes that caused serious hindrance to floodplain biodiversity.

Mainstreaming of the Bangladesh NBSAP requires concerted efforts and actions from all relevant stakeholders to achieve the common goal of biodiversity conservation. Considering the aim and spirit of the NBSAP, the priority areas are mainstreaming NBSAP into institutional level, individual level and in policy and legislative framework. The Seventh Five Year Plan (2015-16 to 2020-21) of the Government of Bangladesh has proposed to mainstream updated NBSAP in line with the Aichi Biodiversity Targets.

The noteworthy environment and biodiversity related policies in Bangladesh are *Bangladesh Environment Policy 1992*, *The Forest Policy 1994*, *The Water Policy 1999*, *National Landuse Policy 2001*, *National Fisheries Policy 1998*, and *National Environment Management Action Plan (NEMAP) 1995* that hold strong elements of biodiversity conservation. The level of mainstreaming of the NBSAP into individual policies and strategies so far achieved in Bangladesh may be said satisfactory. But the integration and harmonization among the policies to achieve the common goal in respect to biodiversity conservation is still a big gap to fill-in. Inter-sectoral conflicts still remain as challenges towards mainstreaming biodiversity in the country.

Bangladesh has made some progress in implementing the NBSAP objectives by developing new rules and acts. In some cases, existing legislative mechanisms are reviewed and updated, e.g. the *Wildlife Protection Act 1974* has been updated to *Bangladesh Wildlife (Conservation and Security) Act, 2012*. The traditional form of government-owned wetland leasing out systems has already been updated in 2005. Community based management approaches instead of traditional leasing system in some government-owned wetlands has been introduced in some cases. The *Forest Policy of 1994* has explicit aim of bringing 25% lands of the country under forest cover by 2015. Similar development initiatives have taken place in Bangladesh in recent times that could be treated as the success in achieving NBSAP principles. The Government, in dealing with climate change induced threats to biodiversity, also puts sufficient emphasis to uphold the principles of CBD while developing and updating National Adaptation Plan of Action (NAPA) and Bangladesh Climate Change Strategy and Action Plan 2009 (BCCSAP).

The conservation efforts in some areas are undertaken by involving local stakeholders and communities, especially in the wetland ecosystems of the country. Biodiversity issue is intricately related with various development policies and programs of the government. In the context of Bangladesh, if we look at various policies in the interface of biodiversity, we find that policy regime has to go a long way towards mainstreaming. In this regard, integration of Biodiversity in various policies and implementation of those policies is very vital. An analysis of relevant policies with mainstreaming gaps is given in Table 42.

Table 42 Analysis of Biodiversity Related Major National Policies

Sl. No	Name of the sector or ministry	Name of the policy	Conservation elements and gaps
1	Ministry of Environment and Forests	Environment Policy 1992	Section 3 has a clear mention of biodiversity and its conservation as a cross-cutting issue. Section 4 has suggested adoption of International Conventions, Treaties and Protocols and thereby incorporated the issues of CBD.
2	-Do-	Forest Policy ¹ 1994	Biodiversity has been mentioned in this policy in a very sketchy manner. None of the 29 statements of this policy has incorporated biodiversity.
3	Agriculture	National Agriculture Policy 2013	Biodiversity conservation, sustainable use of land and water resources, IPM, integrated crop cultivation and collection, conservation and use of genetic resources are emphasized. Emphasis has been given to balanced use of fertilizer as well as to popularize organic fertilizer.
5	Fisheries	National Fisheries Policy 1998	The 5th objective has mentioned about the maintenance of ecological balance and conservation of biodiversity. This is enough to induce 'biodiversity' in the fisheries sector. National Fisheries Strategy 2006 has been formulated, during policy revision this may be considered as well.
6	-Do-	National Shrimp Policy 2014	While emphasizing on shrimp farming, it has some mention of "Environment Friendly" practices. Under item 2d of the policy it has stated to conserve biodiversity in shrimp cultivation area. Statement 5.3.5 of the policy has explicitly stated to prohibit deforestation of mangroves for shrimp farming, which may indirectly help conserve biodiversity.
7	Land	Jalmohal (water-body) Management Policy 2009, amended in 2012.	This policy has mostly dealt with the leasing authorities of government and control on water bodies depending on its size. It has a mention of declare some of the government owned waterbodies as fish "reserve". Section 35 of this policy has given an absolute authority to the Ministry of Land to decide on these issues.
8	-Do-	Landuse Policy 2001	It has mentioned that the agricultural land was 22.6 million acres which declined to 20.2 million acres in 1997. It has expressed concern on the conversion of agricultural lands to other uses. It has mentioned about the conservation of forest land. It has suggested for land zoning and promulgation of a 'zoning law'. It stated that proper implementation of environment policy 1992 and forest policy 1994 will bring in overall improvement of the situation. Regarding wetland it has opined that the present day production of 14 million tons of fish from 4.3 million hectares of wetland can be enhanced to 20 million tons. It has however expressed concern over the decline of wetland in the country. It has suggested for afforestation as well as settlements, on newly accreted lands. It has suggested developing a 'land data bank' as well. It has suggested to go for 'certificate of land ownership'.
9	-Do-	Khas Land Settlement Policy 1995 & 1997	There are two sets of policies (used as rules) namely 'Agriculture Khas land management and settlement policy, 1997' and 'Non-Agriculture Khas land management and

¹The "Wildlife Conservation and Security Act" declared in 2012, has all the required provisions towards biodiversity conservation, especially through creation of protected areas. It has the provisions to go for conservation areas even on privately owned lands.

Sl. No	Name of the sector or ministry	Name of the policy	Conservation elements and gaps
			settlement policy 1995'. None of these has any consideration of biodiversity.
10	-Do-	Khas Land Settlement Policy for Hotel Motel 1998	It has no mention of biodiversity.
11	-Do-	Salt Mohal Management Policy 1998	It has no mention of biodiversity
12	Water Resource ministry	National Water Policy 1999	It has indication on minimum stream flow and mention of preservation of the environment. But it has no explicit mention of biodiversity conservation.
13	-Do-	Coastal Zone Policy 2005	It has incorporated the biodiversity aspects but under a complex umbrella of many sectors. Thus it is completely ineffective. It has incorporated too many diverse issues as policy and made it too complex, completed and confusing. It is a fact that the coastal areas have too many elements to look into, and a large number of national sectoral policies are in force in this zone. The Coastal Zone Policy 2005 is too big as a policy document. The identification of 19 districts as 'coast zone' is an appreciable outcome of this document.

2.4 Challenges for implementing NBSAP

Although some notable activities have been accomplished so far, there are still challenges towards implementing the NBSAP as given below:

- Inter-sectoral communication and coordination.
- Importance on conservation of biodiversity and its sustainable use.
- Ill-understanding on ecosystem goods and services and their economic values.
- Implementation of existing legislative mechanism or framework to halt the conversion of biodiversity rich ecosystems into commercial, industrial and settlement purposes.
- Climate change induced hazards are taking heavy tolls on conservation initiatives.
- Spatial information gap regarding biodiversity and ecosystems related issues
- Raising awareness about Biodiversity
- Inadequate financial, technical and technological capacity of respective organizations is a barrier for implementing the NBSAP in Bangladesh.

3. Bangladesh's progress towards Aichi Biodiversity Targets and Millennium Development Goals

3.1 Introduction

The 10th meeting of the Conference of the Parties (COP) of the CBD held during 18-29 October 2010 adopted a revised and updated 'Strategic Plan for Biodiversity 2011-2020'. This plan provides an overarching global framework on biodiversity conservation after mixed achievements of the implementation of the '2010 Biodiversity Targets'. This Strategic Plan includes Aichi Biodiversity Targets 2020 – a total of 20 targets set out under five Strategic Goals (A-E) (Table 43).

In the light of the Strategic Plan and its Targets, Bangladesh has started updating its NBSAP in 2014. Bangladesh NBSAP was originally prepared in 2006 (MoEF, 2006). Implementation of NBSAP was assessed and shared with the CBD through Fourth National Report (MoEF, 2010). In tune to the spirit of the Aichi Biodiversity Targets Bangladesh is formulating its national Targets through evidence-based approach. This approach entails indepth research with a participatory, peer-reviewing process through multi-stakeholder and expert consultations. In order to be effective, the Department of Environment under the Ministry of Environment and Forests along with other government agencies attempted to integrate these learnings into the Seventh Five Year Plan of Bangladesh.

3.2 Achievements towards Aichi Targets

The Aichi Biodiversity Targets came into effect since 2011 and sets 20 targets to be achieved by 2020. Bangladesh is in the process of developing its National Biodiversity Targets until 2020 or beyond. As a requirement of the Fifth National Report to the CBD, Table 43 captures the progress of Bangladesh towards achieving the Aichi Biodiversity Targets until 2015.

Table 43 Achievements under Strategic Goals of Aichi Biodiversity Targets 2020

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society- Aichi Biodiversity Targets 1 to 4		
Target No	Target Statement	Achievement until 2015
01	By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	<ul style="list-style-type: none"> ▪ A commendable progress has been made at the community awareness level around Protected Areas and Ecologically Critical Areas through various project activities. ▪ Some of the personnels of Biodiversity related agencies are aware of the values of Biodiversity. ▪ University level students and academia of relevant discipline are aware of values of biodiversity through education and research programmes. ▪ A large number of people are aware on the issues of biodiversity conservation through celebrating the World Environment Day, the World Wetlands Day, the World Migratory Birds Day, the Earth Day, the World Wildlife Day, the international Tiger Day, the Vulture Day, the World Ocean Day, World Water Day and the International Day for Biodiversity to name a few. Greater mass awareness on those significant days are yet to be devices.
02	By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	<ul style="list-style-type: none"> ▪ In policy and planning processes, importance of biodiversity has already been incorporated to the some extent (e.g. Constitutional inclusion, the Poverty Reduction Strategy Paper & National Strategy for Accelerated Poverty Reduction and the latest 7th Five Year Plan). ▪ Economic valuation of biodiversity and other ecosystem services are yet to be incorporated in national accounting and reporting system.
03	By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socioeconomic conditions.	<ul style="list-style-type: none"> ▪ Positive incentive in terms of price reduction of non-urea fertilizer in order to discourage over-use of nitrogen or fertilizer. ▪ The Government of Bangladesh is encouraging integrated pest management in order to minimize excess use of fertilizer, pesticides and insecticides. ▪ Reduced subsidy in chemical fertilizer is in place. Initiatives has been taken to conserve biodiversity by introducing financial systems, for example, micro-capital grant, endowment fund (both under the CBA-ECA project) and alternative income generation activities (in numerous projects). ▪ Diclofenac has been banned and Ketoprofen is in the process of banning to save critically endangered vulture population. Two Vulture Safe Zones were declared in December 2014.
04	By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	<ul style="list-style-type: none"> ▪ Bangladesh Bank (Central Bank) has established green banking programme to support financing for energy efficient and environment-friendly industrial activities. ▪ Corporate social responsibility is coming into the scene to meet the environmental standards.

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use- Aichi Biodiversity Targets 5 to 10

Target No	Target Statement	Achievements until 2015
05	By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	<ul style="list-style-type: none"> ▪ No updated information on the rate of degradation and loss of natural habitat. ▪ The rate of Degradation of forests has been addressed through expansion of Protected Area ▪ Protected Areas, Ecologically Critical Areas and fish sanctuaries have been established; the drivers of degradation have not been addressed at its full range. ▪ Ministry of Land is implementing land zoning at local level (upazila or sub-district level). ▪ Biological zoning approach has been adopted in some PA to ensure the protection of wildlife species and floral habitats.
06	By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	<ul style="list-style-type: none"> ▪ Department of Fisheries has introduced fishing area restriction, seasonal fishing ban and banned bottom trawling. ▪ Sustainable management of aquatic resources has been practiced in a limited scale at important ecosystems, e.g. in the Sundarban and Tanguar Haor. ▪ Fisheries stock survey – is regularly on-going in certain habitats. ▪ Marine fisheries stock survey has been planned under the economy action plan of the government. ▪ A large area has been brought under sanctuary management and operationalized by the local fisher communities. ▪ Hilsa management plan is in place (2000, 2006).
07	By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	<ul style="list-style-type: none"> ▪ Policies and programmes are in place for fisheries and aquaculture; but not adequately implemented as of now. No specific policy and strong programme are available for agriculture and aquaculture in terms of biodiversity conservation. ▪ Forests are now managed sustainably, no extraction of trees from natural forests, only sustainable extraction is allowed from plantations of the reserved forests ▪ Some Protected Areas and wetlands have management plans pertaining to biodiversity conservation promoting co-management of forest and wetland resources. ▪ Fertilizer Management guidelines are in place.
08	By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	<ul style="list-style-type: none"> ▪ Activities like, Environment Impact Assessments, installation of effluent treatment plants, monitoring and enforcement, damage assessment and integrated pest management have been undertaken widely.
09	By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	<ul style="list-style-type: none"> ▪ Quarantine system has been established at the ports of entry. However, there is space to enhance the capacity of manpower and logistics, in order to increase functionality of the system.
10	By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	<ul style="list-style-type: none"> ▪ Some initiatives to reduce anthropogenic pressures on mangrove ecosystem and inland wetlands have been taken. For example, CREL project is being implemented with the aim to improve the livelihoods of local communities dependent on vulnerable and critical ecosystems, like corals in the St. Martin's Island.

Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity – Aichi Biodiversity Targets 11 to 13

Target No	Target Statement	Achievements until 2015
11	By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	<ul style="list-style-type: none"> 38 forest PAs now cover 1.8% of the total area of the country and about 10.55% of the total forest area. 13 ECAs declared in the wetlands areas covering 384,529 ha which is 2.60% of the total country. The total marine protected area is 2,436 sq. km which is 2.05% of total marine area (118,813 sq. km) of Bangladesh.
12	By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	<ul style="list-style-type: none"> Red List of animals prepared by IUCN Bangladesh is in place (2000). This is currently being updated by IUCN Bangladesh under the SRCWP project of Bangladesh Forest Department. Implementation of Tiger Action Plan (2009-2017)
13	By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	<ul style="list-style-type: none"> A good number of germplasms of cultivated crops and commercially viable plant species are preserved in government research institutes and universities. Limited private sector involvement is present currently.

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services- Aichi Biodiversity Targets 14 to16

Target No	Target Statement	Achievements until 2015
14	By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	<ul style="list-style-type: none"> Significant progress has been made in this area. Major ecosystems, like Tanguar Haor, Hakaluki Haor, Hail Haor, Sonadia Island, Lawachara Forest, Teknaf Forest, Chunati Wildlife Sanctuary, Modhupur National Park, and Community Conserved Areas in the Chittagong Hill Tracts are examples of steps taken to restore and safeguard focusing co-management and community-based natural resource management approaches. Substantial portion of plain land forest Ecosystems has already been restored through implementing social forestry system with the involvement of women, poor and vulnerable people of local communities as beneficiaries.
15	By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	<ul style="list-style-type: none"> Carbon stock of 15 Protected Area including Sundarbans has been assessed already. More than 15% of the plain land forests have been restored. Government has taken initiatives to restore the ecosystems of hill forests through massive enrichment plantation, natural regeneration and introduction of Social Forestry in the hilly districts of Bangladesh.
16	By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	<ul style="list-style-type: none"> In September 2011, Bangladesh signed the Nagoya Protocol to the CBD. Bangladesh has finalized <i>Bangladesh Biological Diversity Act</i> which addressed access benefit sharing issues.

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building- Aichi Biodiversity Targets 17 to 20

Target No	Target Statement	Achievements until 2015
17	By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	<ul style="list-style-type: none"> ▪ Updating of the NBSAP is underway by Department of Environment since 2014. ▪ Consultation at different levels is in progress for updating the NBSAP by 2016.
18	By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	<ul style="list-style-type: none"> ▪ Traditional knowledge related to biodiversity has been documented, like the Aurvedic practices, including an establishment of a university. ▪ A book entitled 'Traditional use of ethnomedicinal plants of the Chittagong Hill Tracts' has been published by the Government of Bangladesh. ▪ Hill communities' traditional medicinal knowledge and practices have been documented in many research papers and books.
19	By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	<ul style="list-style-type: none"> ▪ Research on commercially important crop genetic resources are being carried out by national agricultural research institutes on rice, jute, tea and many agricultural and horticultural crops. ▪ DNA bar-coding initiated in taxonomic identification of species. ▪ Study is being conducted on state of research and assessment of technological needs.
20	By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011-2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	<ul style="list-style-type: none"> ▪ NBSAP updating process included activity on developing resource mobilization strategy.

3.3 Contribution to the Millennium Development Goals

The Millennium Development Goals (MDGs) were adopted by 147 Heads of State and 189 States in the United Nations (UN) global conferences of the 1990s. The United Nations Millennium Declaration of the year 2000 marked a strong commitment to many dimensions of poverty and to sustainable human development. Progress of Bangladesh in achieving the eight MDGs were published in the latest report entitled *The Millennium Development Goals: Bangladesh Progress Report 2015* (GED, 2015).

The Government of Bangladesh has the latest report on MDG in 2015 detailing the achievement of the following goals:

1. Goal 1: Eradicate Extreme Poverty and Hunger
2. Goal 2: Achieve Universal Primary Education
3. Goal 3: Promote Gender Equality and Empower Women
4. Goal 4: Reduce Child Mortality
5. Goal 5: Improve Maternal Health
6. Goal 6: Combat HIV/AIDS, malaria and other diseases
7. Goal 7: Ensure Environmental Sustainability
8. Goal 8: Develop a Global Partnership for Development

Various news media, governmental and non-governmental organizations have reported on the MDGs over the years. It is eminent that Bangladesh has surpassed expectations of achievements and quoted as the 'role model' towards achieving the goals. The Table 44 summarises the current status and challenges of the MDG 7 (Ensure Environmental Sustainability) in Bangladesh.

Table 44 Current Status and Challenges in Attaining Targets of MDG 7

Targets and Indicators	Base year 1990/91	Status in 2000	Current status (source)	Target by 2015
Target 7.A: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources				
Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss				
7.1: Proportion of land area covered by forest, % (tree coverage)	9.0	11.3	13.40 (DoF 2014) (Tree density>30%)	20.0 (Density >70%)
7.2: CO ₂ emissions, total, per capita and per \$1 GDP (PPP)				
7.2a: CO ₂ emissions, metric tons per capita	0.14	0.21	0.23 (2 nd National Communication, 2012)	-
7.3: Consumption of ozone-depleting substances in ODP tonnes	202.1 ODP tonnes	816.4	64.88 (DoE, 2013)	65.39
7.4: Proportion of fish stocks within safe biological limit	-	-	54 inland and 16 marine species	-
7.5: Proportion of total water resources used	-	-	2.9% (UNSD 2010)	-
7.6: Proportion of terrestrial and marine areas protected	0.91	3.15	1.81% (Terrestrial) 1.34% (Marine) BFD,2013	5.0
7.7: Proportion of species threatened with extinction	-	-	a. 23% of resident vertebrates (IUCN 2003) b. 5.81% of vascular plants (BNH 2013)	-
Target 7.C: Halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation				
7.8: Proportion of population using an improved drinking water source	68	76	97.9 (MICS 2012-2013) 98.5 (SVRS 2013)	100
7.9: Proportion of population using an improved sanitation facility	34	45	55.9 (MICS 2012-2013) 64.2 (SVRS 2013)	100
Target 7.D: Halve, by 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers				
7.10: Proportion of urban population living in slums		7.8 (BBS 2001)	5.25 (BBS, 2014)	-

Source: GED, 2015

Through this section, a view on the complementarity between the MDGs and Aichi Targets is seen. It is important to note that the eight MDGs and five Strategic Goals of the Aichi Targets are mostly complementary in nature. Nevertheless, it can be said that the Aichi Strategic Goals address specifically the importance of biodiversity in the environmental pillar of sustainable development concept and the 7th Goal of the MDG. Thus, Aichi Strategic Goals can be envisioned as goals that, if achieved, would continue to fulfill the relevant Goals of SDG that is adopted after the era of MDG.

4. Concluding Remarks

Biodiversity National Assessment 2015 or the Fifth National Report of Bangladesh to the CBD has been prepared as a part of Bangladesh's commitment to the CBD and in the light of the guidance provided by the CBD Secretariat. The report first captured the present status and trends of biodiversity of Bangladesh at ecosystem, species and genetic levels. It has shown better understanding of some species and ecosystems since the submission of the Fourth National Report in 2010. Despite the unfathomable importance of biodiversity in achieving and maintaining human well-being, the multifaceted threats to biodiversity continued to rise asking for further concerted efforts.

The implementation and mainstreaming of the NBSAP made up the second part of this national report. An analysis of the biodiversity conservation efforts between 2009-2014 captured the implementation of the NBSAP since submission of the last National Report to the CBD. Bangladesh has made some good progress in some areas by implementing some development projects. Progress, however, is not so satisfactory in many areas. Moderate progress has been seen in most of the cases as outlined in the NBSAP. Mainstreaming of the NBSAP has progressed at limited scale. Analysis showed that most of the pertinent policies is yet to integrate biodiversity into the document. Some good examples have been created in recent years in some sectors where a balance between economic development and biodiversity conservation has been envisaged.

The report also states achievements towards the Aichi Biodiversity Targets 2020 and the progress of implementing MDG's environmental targets in the light of biodiversity conservation in Bangladesh. The country is in the process of developing national biodiversity targets for 2020 in the light of Aichi Targets. In this report, however, a progress is given against the global Targets 2020. Essentially linked with the progress of NBSAP implementation, Bangladesh has shown moderate progress in achieving the Aichi Targets until 2014. Bangladesh is, however, considered as a role model in attaining the MDGs. Overall progress against the MDG7–Ensure Environmental Sustainability – is moderate with some systemic and institutional challenges.

Although the report has been prepared to meet Bangladesh's commitment to the CBD, it has given Bangladesh a great opportunity to take stock of its biodiversity and conservation efforts over the period of 2009-2014. It has also given space to check how the Government and other agencies are performing to fulfill the Aichi Biodiversity Targets 2020. Such an exercise brings together relevant stakeholders to discuss, to debate and to contribute to this periodic national assessment.

Bangladesh is currently updating its NBSAP originally prepared in 2004. The revised NBSAP would give country the opportunity to give a momentum in biodiversity conservation. A new set of national targets in the light of the Aichi Biodiversity Targets 2020 would help Bangladesh to identify areas to focus on, especially by mainstreaming biodiversity in all pertinent sectors and national efforts. On a global scale, a new set of 17 goals have recently been approved in September 2015 in the General Assembly of the United Nations as the Sustainable Development Goals (SDGs). These goals have 169 targets and aim to carry out sustainable development in the post-MDG era until 2030. Biodiversity has been exclusively upheld in the Goals 14 and 15, focusing on marine and terrestrial ecosystems separately. It is believed that coherence between the MDG and Aichi Biodiversity Targets 2020 will continue in the SDG era.

The Sixth National Report to the CBD is due in a few years time. The lessons learnt from the whole exercise of developing national biodiversity assessment report trigger some important way forwards:

- The preparation of such report has to be done by DoE itself with maximum efforts of DoEs own manpower and resources.
- DoE has to gather relevant information into in a continuous basis so that when submission time arrives, the report could quickly be developed and submitted.
- DoE have to update the biodiversity database in a systematic manner through CHM, so that gathering information does not become a herculian task at the time of report preparation.

References

- AF (Arannayk Foundation) (2010) Conserving forests for the future: Annual report 2009. Arannayk Foundation, Dhaka
- Ahamed, F., Hossain, M.Y., Fulanda, B., Ahmed, Z.F. and Ohtomi, J. (2012) Indiscriminate exploitation of wild prawn postlarvae in the coastal region of Bangladesh: A threat to the fisheries resources, community. *Ocean and Coastal Management*, 66: 56-62.
- Ahmad, I.U., Greenwood, C.J., Barlow, A.C.D., Islam, M.A., Hossain, A.N.M., Khan, M.M.H. and Smith, J.L.D. (2009) *Bangladesh Tiger Action Plan 2009-2017*. Bangladesh Forest Department, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh
- Ahmed, K.K.U., Ahamed, S.U., Hasan, K.R. and Mustafa, M.G. (2007) Option for formulating community based fish sanctuary and its management in beel ecosystem in Brahmanbaria. *Bangladesh J. Fish*, 30: 1-10.
- Ahsan, D.A., Naser, M.N., Bhaumik, U., Hazra, S. and Bhattacharya, S.B. (2014) *Migration, Spawning Patters and Conservation of Hilsa Shad in Bangladesh and India*. Academic Foundation and IUCN, New Delhi, India, p. 95.
- Alam, A.B.M.S., Chowdhury, M.S.M. and Sobhan, I. (2012) *Biodiversity of Tanguar Haor: A Ramsar Site of Bangladesh, 1: Wildlife*. IUCN Bangladesh Country Office, Dhaka
- Alam, M.K. (2008) Forests and forestry in Bangladesh. In: Ahmed, Z.U., Begum, Z.N.T., Hassan, M.A., Khondker, M., Kabir, S.M.H., Ahmad, M., Ahmed, A.T.A., Rahman, A.K.A. and Haque, E.U. (eds.), *Encyclopedia of Flora and Fauna of Bangladesh*, 1. Bangladesh profile, Asiatic Society of Bangladesh, Dhaka, pp. 73-86.
- Altrell, D., Saket, M., Lyckeback, L., Piazza, M., Ahmad, I.U., Banik, H., Hossain, M.A.A. and Chowdhury, R.M. (2007) *National Forest and Tree Resources Assessment Bangladesh 2005-2007*. Bangladesh Forest Department (BFD); Ministry of Environment and Forest (MoEF); Bangladesh Space Research and Remote Sensing Organization (BSRRSO), Ministry of Defense & Food and Agriculture Organization of the United Nations (FAO), p. 192.
- Aptroot, A. and Iqbal, S.H. (2011) Some lichens of Bangladesh. *The Bryologist*, 114(3): 466-468.
- Ara, H. and Khan, B. (eds.) (2015) *Bulletin of the Bangladesh National Herbarium*, 4. Bangladesh National Herbarium, Dhaka, p. 96.
- Ara, H., Khan, B. and Uddin, S.N. (eds.) (2013) *Red Data Book of Vascular Plants of Bangladesh*, 2. Bangladesh National Herbarium, Dhaka, p. 280.
- Aziz, N., Motaleb, M.A., Wahed, M.A., Alam, A.B.M.S. and Sultana, M. (2014) *Biodiversity in the Floodplain Ecosystems of Bera, Santhia and Sujanagar Upazila of Pabna District in Bangladesh*. Wetland Biodiversity Rehabilitation Project, implemented by Department of Fisheries, Ministry of Fisheries and Livestock and GIZ/BMZ, Dhaka, Bangladesh, p. 250.
- Banglapedia (2004) *National Encyclopedia of Bangladesh*. Asiatic Society of Bangladesh, 1st edition. Dhaka, Bangladesh
- Bashar, M.A. (2014) *Butterflies of Bangladesh: A broad approach for nature lovers*, 1. Biodiversity Conservation Trust Foundation (BCTF), University of Dhaka, p. 514.
- Baten, M.A., Khan, N.A., Ahammad, R., and Misbahuzzaman, K. (2010) *Village common forests in Chittagong Hill Tracts, Bangladesh: Balance between Conservation and Exploitation*. Dhaka: Unnayan On- neshan - The Innovators, 13.
- BBS (Bangladesh Bureau of Statistics) (2014) GDP of Bangladesh 2014-2015 (P). http://bbs.gov.bd/WebTestApplication/userfiles/Image/GDP/GDP_2014_15%28p%29.pdf
- BBS (Bangladesh Bureau of Statistics) (2012) *Population and Housing Census 2011*.
- BBS (Bangladesh Bureau of Statistics) (2011) *Population and Housing Census 2011: Bangladesh at a Glance*. Dhaka: BBS [Online] http://www.bbs.gov.bd/webtestapplication/userfiles/Bangladesh_glance.pdf

- Bernaecsek, G.M. (2001) *Guide to the Shellfishes of the Bangladesh Sundarbans, Khulna, Bangladesh*. ADB: BAN 1643/3158, p. 111.
- BFD (Bangladesh Forest Department) (2010) *Project Document*. SEALS
- BFD (Bangladesh Forest Department) (2015) First Phase Tiger Status Report of Bangladesh Sundarban.
- Bhuiyan, M. N. U., Ali, M. A., Rahman, M. M. 2015. Maritime Boundary Confirmation of Bangladesh: Potentialities of Sea Resources and Challenges Ahead. *The Cost and Management*. 43(5): 18-24.
- Bhuiyan, M.K., Hossain, M.K. and Alam, M.S. (2014) Banspata (*Podocarpus nerifolius* D. Don) - A Critically Endangered Tree Species of Bangladesh, Institute of Forestry and Environmental Sciences, Chittagong University, Chittagong. p. 72.
- Bird, J.P., Lees, A.C., Chowdhury, S.U., Martin, R. and Haque, E.U. (2010) A survey of the Critically Endangered Spoon-billed Sandpiper *Eurynorhynchus pygmeus* in Bangladesh and key future research and conservation recommendations. *Forktail*, 26: 1-8.
- BWDB (Bangladesh Water Development Board) (2005) *Bangladesher Nad Nadi, Pani biggyan*. June 2005, Bangladesh Water Development Board, Dhaka, p. 621.
- Choudhury, J.K. (2013) Tourism: An emerging threat to ecosystem. In: *Dipu, S. & Ahmed, F., (2013). Sundarban: Rediscovering Sundarban - The Mangrove Beauty of Bangladesh*. Reza Khan (ed.). Dhaka: Nymphaea Publication, Bangladesh
- Choudhury, J.K., Biswas, S.R., Islam, M.S., Rahman, O. and Uddin, S.N. (2004) *Biodiversity of Ratargul Swamp Forest, Sylhet*. IUCN-The World Conservation Union, Bangladesh Country Office, Dhaka, p. 24.
- Christie P. and Ole Moi-Yoi, K.L. (2011) *Status of Marine Protected Areas and Fish Refugia in the Bay of Bengal Large Marine Ecosystem*. BOBLME Project, Ecology-10. Online: <http://www.boblme.org/documentRepository/BOBLME-2011-Ecology-10.pdf>
- DoE (2012) *Bangladesh Environment and Climate Change Outlook 2012*. Department of Environment, Ministry of Environment and Forests, Government of Bangladesh, Dhaka, p.138.
- DoF (2014a) *Fisheries Resources Survey System (FRSS)* In: Fisheries Statistical Yearbook of Bangladesh, Department of Fisheries, Bangladesh. Dhaka: Volume 30: p. 52.
- DoF (2014b) *National Fisheries Week Compendium* (in Bengali), Matshya Bhaban, Ramna, Dhaka, p. 144.
- DoF (2015) Fisheries Statistical Report of Bangladesh 2013-14. Department of Fisheries, Bangladesh, Dhaka.
- DoF (2008) *Matshya Pakkhya Saranika-2008*. Department of Fisheries, Ministry of Fisheries and Livestock. The Government of the Peoples Republic of Bangladesh, Ramna, Dhaka, p. 96.
- DoF (2005) *National Fisheries Fortnight Compendium* (in Bengali), Dhaka: Matshya Bhaban, Ramna, p. 95.
- Dutta, S., Hossain, M.K., Hossain, M.A. and Chowdhury, P. (2014) Flora diversity of Sitakunda Botanical garden and eco-park in Chittagong, Bangladesh. *Indian J. Tropical Biodiversity*, 22 (2): 106-118.
- Feeroz, M.M. (2001) Species diversity and population density of non-human primates in north-east and south-east of Bangladesh. *ECOPRINT*, 8(1): 53-57.
- Feeroz, M.M., (ed.) (2013) Biodiversity of Protected areas of Bangladesh, 3 Teknaf Wildlife Sanctuary. *BioTrack*. Arannayk Foundation, Dhaka.
- Feeroz, M.M., Hasan, M.K. and Hossain, M.K. (2012) Biodiversity of Protected areas of Bangladesh. Vol. II: Dudpukuria-Dhopachari Wildlife Sanctuary. *BioTrack*. Arannayk Foundation, Dhaka, p. 224.
- Feeroz, M.M., Hassan, M.K. and Khan, M.M.H. (2014) *Amphibians and reptiles of Bangladesh: A Field Guide*. Arannayk Foundation, Dhaka, p.196.
- GED (General Economic Division) (2015) *Millennium Development Goals 2015: Bangladesh Progress Report 2015*, Bangladesh Planning Commission, Government of the People's Republic of Bangladesh.

- GED (General Economic Division) (2012a) *The Millennium Development Goals: Bangladesh Progress Report 2011*. Dhaka: GED. Bangladesh Planning Commission, Government of Bangladesh.
- GED (General Economic Division) (2012b) *Perspective Plan of Bangladesh 2010-2012*. Dhaka: GED. Online: <http://www.plancomm.gov.bd/wp-content/uploads/2013/09/Perspective-Plan-of-Bangladesh.pdf>
- Ghose, B. (2014) Fisheries and aquaculture in Bangladesh: Challenges and opportunities. *Ann Aquac Res* 1(1): 1001.
- Gittins, B.P. and Akonda, A.W. (1982) What survive in Bangladesh? *Oryx*, 16(3): 276-281.
- Haldar, G.C. Ahmed, K.K. Alamgir, M. Akhter, J.N. and Rahman, M.K. (2002) Fish and fisheries of Kaptai Reservoir, Bangladesh. In: Cowx, I.G. (ed.), *Management and Ecology of Lake and Reservoir Fisheries*, pp. 144-160. Blackwell Science Publishers, Oxford, UK
- Haque, A.K.E. and Aich, D. (2014) Economic Evaluation of Ecosystem Services. In: Hussain, Z. (ed.), *Bangladesh Sundarban Delta Vision 2050: A first step in its formulation - Document 2: A Compilation of Background Information*. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh
- Haque, A.K.M.A. (1976) Comments on the abundance and distribution of the Ganges susu, *Platanista gangetica* and the effect of the Farrakka Barrage on its population. *ACMRR/MM/SC 132*. Advisory Committee on Marine Resources Research, Scientific Consultation on Marine Mammals. FAO, Rome
- Harun-Ur-Rashid, M. and Chowdhury, M.A.I. (2013) Additions to the angiosperm flora in the Sitapahar Reserve Forest of Kaptai, Rangamati, Bangladesh. *Bangladesh J. Plant Taxon.* 20(2): 255-257.
- Hasan, M., Islam, M.M., Khan, M.M.R., Alam, M.S., Kurabayashi, A., Igawa, T., Kuramoto, M. and Sumida, M. (2012) Cryptic Anuran Biodiversity in Bangladesh Revealed by Mitochondrial 16S rRNA Gene Sequences. *Zoological Science*, 29(3): 162-172.
- Hoq, M.E., Haroon, A.K. Yousuf and Hussain, M.G. (eds) (2011) *Shark fisheries in the Bay of Bengal, Bangladesh: Status and potentialities*. Support to Sustainable Management of the BOBLME Project, Bangladesh Fisheries Research Institute (BFRI), Bangladesh, p. 76.
- Hossain, M.A.R. (2013) *Biodiversity of Shrimp and Prawn in the River and Estuary of Bangladesh. National Fish Week 2013 Compendium* (in Bengali with English abstract). Department of Fisheries, Ministry of Fisheries and Livestock, Dhaka, pp. 38-42.
- Hossain, M.A.R. (2014) Habitat and fish diversity: Bangladesh perspective, pp 1-26. In: Wahab, M.A., Shah, M.S., Hossain, M.A.R., Barman, B.K. and Hoq, M.E. (eds.), *Recent Advances in Fisheries of Bangladesh. Proc. of 5th Fisheries Conference & Research Fair 2012. 18-19 January 2012, Bangladesh Agricultural Research Council, Dhaka, Bangladesh Fisheries Research Forum, Dhaka, Bangladesh.* p.166.
- Hossain, M.A.R., Kabir, H., Faruque, A. M. O. and Hossain, M. (2015) Livelihood security: implications from aquaculture sectors. In: Habiba, et. al. (eds.) *Food security and risk reduction in Bangladesh*. Springer Publication Tokyo-Heidelberg- New York- Dordrecht-London. pp 83-109.
- Hossain, M.A.R., Nahiduzzaman, M. and Tiersch, T.R. (2011) Development of a sperm cryopreservation approach to the fish biodiversity crisis in Bangladesh. In: Tiersch and Green, (eds), *Cryopreservation in Aquatic Species*, 2nd ed. pp. 852-861. World Aquaculture Society, Baton Rouge, Louisiana
- Hossain, M.K. (2014) *Akashmoni (Acacia auriculiformis) - Should we plant or not?* In: Souvenir of the Forest Department published on the occasion of World Environment Day on 5th June.
- Hossain, M.K. and Hoque, A.T.M.R. (2013) *Eucalyptus Dilemma in Bangladesh*. Institute of Forestry and Environmental Sciences, University of Chittagong, Chittagong, p. 148.

- Hossain, M.N., Rokanuzzaman, M., Rahman, M.A., Bodiuzzaman, M. and Miah, M.A. (2013) Causes of deforestation and conservation of Madhupur Sal Forest in Tangail Region. *J. Environ. Sci. & Natural Resources*, 6(2): 109-114.
- Hossain, M.Z., Saha, M.L., Aziz, C.B. and Hoque, S. (2010) Effects of deforestation on the properties of soil of *Sal* forests in Bangladesh. *The Dhaka Univ. J. Biol. Sci.* 19 (1): 63-72.
- Huda, M.S. and Haque, M.E. (2003) Field guide to Finfishes of Sundarban. Aquatic Resource Division, SBCP, Bangladesh Forest Department, Boyra, Khulna, p. 197.
- Iqbal, I. (2006) The railway in colonial India: Between ideas and impacts. In: Srinivasan, R., Tiwari, M. and Silas, S. (eds), *Our Indian Railway: Themes in Indian Railway History*, pp.173-186, Foundation Books Pvt. Ltd., Darayganj, New Delhi, India.
- Irfanullah, H.Md. (2013) Plant taxonomic research in Bangladesh (1972-2012): A critical review. *Bangladesh J. Plant Taxon.*, 20(2): 267-279.
- Irfanullah, H.Md. (2011) Conserving threatened plants of Bangladesh: Miles to go before we start? *Bangladesh J. Plant Taxon.*, 18(1): 81-91.
- Islam, M.S. (2003) Perspectives of the coastal and marine fisheries of the Bay of Bengal, Bangladesh. *Ocean & Coastal Management*, 46(8): 763-796.
- Islam, S.A., Miah, M.A.Q. and Habib. M.A. (2013) Diversity of fruit and timber tree species in the coastal homesteads of southern Bangladesh. *J. Asiat. Soc. Bangladesh, Sci.*, 39(1): 83-94.
- Islam, Sk.S. (2003) State of forest genetic resources conservation and management in Bangladesh. *Forest Genetic Resources Working Papers, Working Paper FGR/68E*. Forest Resources Development Service, Forest Resources Division. FAO, Rome
- IUCN (2012) *Situation Analysis on Climate Change*. Ecosystems for Life: A Bangladesh-India Initiative. IUCN, International Union for Conservation of Nature.
- IUCN Bangladesh (2015) First vulture safe zone declared in Bangladesh. Dhaka: Online: http://www.iucn.org/about/union/secretariat/offices/asia/asia_where_work/bangladesh/?18777/First-vulture-safe-zone-declared-in-Bangladesh
- IUCN Bangladesh (2005) *Major Interventions for Sustainable Wetland Resource Management*. IUCN Bangladesh Country Office, Dhaka, pp. x+134.
- IUCN Bangladesh (2004) *Conservation of Asian Elephants in Bangladesh*. IUCN, Bangladesh Country Office, Dhaka
- IUCN Bangladesh (2000) *Red List of Threatened Animals of Bangladesh*. IUCN - World Conservation Union, Bangladesh Country Office, Dhaka, Bangladesh
- Kamal, A.H.M. and Short, F. (2009) A new record of seagrass *Halophila beccarii* Ascherson in Bangladesh. *CMU. J. Nat. Sci.*, 8(2): 201-206.
- Khan, H. R., Rahman, K., Abdur Rouf, A. J. M., Satter, G.S., Oki, Y. and Adachi, T. (2007) *Assessment of degradation of agricultural soils arising from brick burning in selected soil profiles*. *Int J. of Environ. Sci.* 4: 470-480.
- Khan, A.Z. (2012) Nijhum Dweep - The 'Busiest Airport' of Migratory Birds. *Jalaplavit*, 3: 10-14.
- Khan, M.A.R. (1985) *Mammals of Bangladesh*. Dhaka, pp. 62-64.
- Khan, M.M.H. (2012) Population and prey of the Bengal Tiger *Panthera tigris tigris* (Linnaeus, 1758) (Carnivora: Felidae) in the Sundarbans, Bangladesh. *Journal of Threatened Taxa*, 4(2): 2370-2380.
- Khan, M.M.H. (2005) Species diversity, relative abundance and habitat use of the birds in the Sundarbans East Wildlife Sanctuary, Bangladesh. *Forktail*, 21: 79-86.
- Khan, M.S., Rahman, M.M. and Ali, M.A. (eds) (2001) *Red data book of vascular plants of Bangladesh*. Dhaka: Bangladesh National Herbarium, Dhaka
- Khandokar, F., Rashid, M., Delip, K., Das, X. and Hossain, M. (2013) Status and abundance of Butterflies in the Lawachara National Park, Bangladesh. *Jahangirnagar University J. Biol Sci.*, 2(2): 121-127.
- Miah, M.M.A. (2010) Fish and ecosystem diversity of Hakaluki haor - a major fishery in northeast Bangladesh. PhD Thesis, Department of Fish. Biology & Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh, p. 216.

- MoEF (Ministry of Environment and Forests) (2010) *Biodiversity National Assessment and Programme of Action 2020*. Ministry of Environment and Forests, Government of Bangladesh, Dhaka, Bangladesh, pp. x+112.
- MoF (Ministry of Finance) (2013) *Bangladesh Economic Review 2013*. Online: http://mof.gov.bd/en/index.php?option=com_content&view=article&id=249&Itemid=1
- MoFA (Ministry of Foreign Affairs) (2012) *Delimitation of Bangladesh-Myanmar Maritime Boundary: A Frontier for Deepening Cooperation*. Foreign Office Briefing Notes: Special Issue 2. April 2012. Ministry of Foreign Affairs, Government of Bangladesh, Dhaka. Online: <http://www.mofa.gov.bd/Docx/MaritimeSpecialIssue.pdf>
- Mohiuddin, M., Alam, M.K. and Hossain, M.K. (2012) Indigenous knowledge-based technologies practiced in hill farming systems in Bandarban hill district of Bangladesh. *Bangladesh J For. Science*, 32(1): 20-27.
- Motaleb, M.A. and Irfanullah, H.Md. (2011) Tobacco cultivation in Bangladesh: Does it have any impacts on traditional agro-practice? *Indian Journal of Traditional Knowledge*, 10(3): 481-485.
- Motaleb, M.A., Hossain, M.K., Alam, M.K., Mamun, M.M.A.A. and Sultana, M. (2013) *Commonly used Medicinal Herbs and Shrubs by Traditional Herbal Practitioners: Glimpses of Thanchi upazila of Bandarban*. International Union for Conservation of Nature (IUCN), Dhaka, Bangladesh, p. 294.
- Motaleb, M.A., Rahman, S.M., Rahman, S. and Sultana, M. (2011) *The Asian Elephants and Associated Human-Elephant Conflict in South-Eastern Bangladesh*. IUCN (International Union for Conservation of Nature and Natural Resources), Dhaka, Bangladesh, pp.x+104.
- Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A. B., and Kent. J. (2000) Biodiversity hotspots for conservation priorities. *Nature*, 403: 853–858.
- Neogi, A.K., Baki, M.A., Sadat, M.N., Selim, S.R. and Bhouiyan, N.A. (2014) Five New Record of Butterfly Species from Dhaka, Pirojpur and Cox's Bazar Districts of Bangladesh. *Journal of Entomology and Zoology Studies*, 2(2): 197-200.
- Neumann-Denzau, G., Mansur, E.F. and Mansur, R. (2008) Nests, eggs, hatchlings and behaviour of the Masked Finfoot *Heliopais personatus* from the Sundarbans in Bangladesh, with first nesting observations. *Forktail*, 24: 92-99.
- Nishat, A., Huq, S.M.I., Barua, S.P., Khan, A.H.M. and Moniruzzaman, A.S. (eds) (2002) *Bio-ecological Zones of Bangladesh*. IUCN, Bangladesh Country Office, Bangladesh, Dhaka, p.141.
- Olivier, R. (1978) Distribution and status of the Asian elephant. *Oryx*, 14: 379-424.
- Rahaman, S.M.B., Golder, J., Rahaman, M.S., Hasanuzzaman, A.F.M., Huq, K.A., Begum, S., Islam, S.S. and Bir, J. (2013) Spatial and temporal variations in phytoplankton abundance and species diversity in the Sundarbans mangrove forest of Bangladesh. *J. Marine Sci. Res. Dev.* 3: 126.
- Rahim, M.A., Alam, A.K.M.A., Alam, M.S. and Anwar, M.M. (2011) Underutilized fruits in Bangladesh, Rahim, M.A., Hashem, M.A., Chowdhury, M.S.H, Kwon, T.R., Rahman, M.H. and Hossain, M.M. (eds), BAU-GPC, Bangladesh Agricultural University, Mymensingh, Bangladesh, Biodiversity International Malaysia and Rural Development Administration (RDA), Korea.
- Rahman, A.K.A. (2005) *Freshwater Fishes of Bangladesh*. 2nd ed., Zoological Society of Bangladesh, Dhaka, p. 394.
- Rahman, M. and Nævdal, G. (2000) Population genetic studies of hilsa shad, *Tenualosa ilisha* (Hamilton), in Bangladesh waters: evidence for the existence of separate gene pools. *Fisheries Management and Ecology*, 7(5): 401-411.
- Rahman, S.C., Jenkins, C.L., Trageser, S.J. and Rashid, S.M.A. (2014) Radio-telemetry study of Burmese python (*Python molurus bivittatus*) and elongated tortoise (*Indotestudo elongata*) in Lawachara National Park, Bangladesh: A preliminary observation. In: *The Festschrift on the 50th Anniversary of The IUCN Red List of Threatened Species™*. IUCN, Dhaka, Bangladesh, pp. 54-62.

Rahman, MS., Hossain, GM., Khan, SA. and Uddin, SN. 2015. An annotated checklist of the vascular plants of Sundarban Mangrove Forest of Bangladesh. *Bangladesh J. Plant Taxon.* 22:17-41

Ranjitsingh, M.K. (1978) In: IUCN/ SSC Asian Elephant Group News 3, Bangladesh. *Tiger paper*, 5(2): 28-33.

Rashid S.M.A., Akonda, A.W. and Ahmed, B. (2015) Ganges River Dolphin (*Platanista gangeticagangetica*) in the Padma, Jamuna and Hurasagar-Baral rivers of Pabna District, Bangladesh. *Int. J. Curr. Sci.* 14: E107-124.

Rashid, S.M.A. and Scott, D. (1989) Observation on the waders of Lower Gangetic Delta, Greater Noakhali District, Bangladesh. *Stilt*, 14: 58-62.

Roy, R. C. K. (2000) *Land rights of the indigenous peoples of the Chittagong Hill Tracts, Bangladesh*. Copenhagen: International Work Group for Indigenous Affairs (IWGIA).

Salafsky, N., Salzer, D., Stattersfield, A.J., Hilton-Taylor, C., Neugarten, R., Butchart, S.H.M., Collen, B., Cox, N., Master, L.L., O'connor, S. and Wilkie, D. (2008) A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. *Journal of Conservation Biology*, 22(4): 897-911.

Sarker, A., Baki, M.A., Biswas, M.K., Dey, D. and Masud, A.A. (2014) Marine gastropods and bivalves of Satin Martin's Island in the Bay of Bengal. In: *The Festschrift on the 50th Anniversary of The IUCN Red List of Threatened Species™*. IUCN, Dhaka, Bangladesh, pp. 75-78.

Shahadat, O., Ahmed, T., Neogi, A.K. (2014) Confirmation record of a butterfly species *Euploea radamantheus radamantheus* Fabricius, 1793 (Family: Nymphalidae) from Dudpukuria-Dhopachari wildlife sanctuary, Bangladesh. *International Journal of Fauna and Biological Studies*, 1(5): 22-23.

Sobhan, I., Alam, A.B.M.S. and Chowdhury, M.S.M. (2012) *Biodiversity of Tanguar Haor: A Ramsar Site of Bangladesh*, 2: Flora. IUCN, Bangladesh Country Office, Dhaka, pp. xii+236.

The Arbitral Tribunal (2014) Award: In the matter of the Bay of Bengal Maritime Boundary: Arbitration between the People's Republic of Bangladesh and the Republic of India. Permanent Court of Arbitration, (headed by Judge Rüdiger Wolfrum), The Hague, 7 July 2014.

Uddin, S.N. and Hassan, M.A. (2012a) Angiosperm flora of Rampahar Reserve Forest under Rangamati district in Bangladesh. I. Liliopsida (Monocots). *Bangladesh J. Plant Taxon.*, 19(1): 37-44.

Uddin, S.N. and Hassan, M.A. (2012b) Pteridophyte flora of Rampahar and Sitapahar reserve forests under Rangamati district in Bangladesh. *Dhaka Univ. J. Biol. Sci.* 21(2): 153-161.

Uddin, M. J and Inoue M (2012) Management of Village Common Forests in the Chittagong Hill Tracts of Bangladesh: Historical Background and Current Issues in Terms of Sustainability. Open Journal of Forestry, Scientific Research Publishing; USA

WTTC (World Travel and Tourism Council) (2014) *The Economic Impact of Travel & Tourism 2014*: Bangladesh. Online: <http://www.wttc.org//media/files/reports/economic%20impact%20research/country%20reports/bangladesh2014.pdf>

Annex – Tables

Annex : Table 1 Government Revenue from Forestry

Financial year	Sale proceeds	Number of beneficiaries	Money received by beneficiaries	Tree firming fund	Government revenue	Production of timber (Cum)	Production of fuelwood (Cum)	Production of Poles Number
1999-00	\$79,246	243	\$33,526	\$7,797	\$37,923	823.43	1598.47	29330
2000-01	\$1,547,448	3522	\$643,331	\$154,342	\$749,775	27565.88	30875.05	374216
2001-02	\$3,478,018	9420	\$1,558,966	\$341,612	\$1,577,440	45667.31	56874.22	597718
2002-03	\$3,930,538	10376	\$1,712,326	\$388,131	\$1,830,081	55143.06	65834.51	809284
2003-04	\$7,513,272	13507	\$3,274,088	\$736,769	\$3,485,736	45349.95	64871.69	889744
2004-05	\$6,961,944	17464	\$3,096,594	\$692,310	\$3,133,029	88825.86	92896.41	594603
2005-06	\$6,876,828	13840	\$3,067,693	\$678,494	\$3,088,644	45944.14	53641.13	352650
2006-07	\$461,278	1518	\$206,052	\$45,809	\$133,436	4494.64	8008.01	10006
2007-08	\$4,084,186	11512	\$1,869,597	\$388,144	\$1,788,917	21681.40	23907.97	112059
2008-09	\$1,144,611	2384	\$557,661	\$113,623	\$468,101	6434.94	9065.46	31694
2009-10	\$1,961,486	2124	\$952,761	\$195,431	\$813,293	8166.40	10733.14	44957
2010-11	\$6,351,771	8291	\$2,995,303	\$621,633	\$2,800,413	31973.57	21620.40	223982
2011-12	\$8,274,454	9132	\$3,799,277	\$825,040	\$1,780,560	51201.82	45425.56	337970
2012-13	\$6,418,309	2300	\$2,903,698	\$604,515	\$2,731,497	16384.13	12834.32	130973
2013-14	\$8,798,669	4236	\$3,785,571	\$876,552	\$3,882,484	35509.20	30436.63	473123
Total	\$67,882,056	109869	\$30,456,443	\$6,670,201	\$28,301,328	485165.74	528622.96	5012309

Source: SEALS

Annex : Table 2 Major Wildlife found in Different Forests

Scientific Name	English Name	Evergreen	Deciduous	Mangroves
<i>Elephas maximus</i>	Elephant	x		
<i>Panthera tigris tigris</i>	Bengal Tiger			x
<i>Hoolock hoolock</i>	Hoolock Gibbon	x		
<i>Trachypithecus pileatus</i>	Capped Langur	x	x	
<i>Trachypithecus phayrei</i>	Phayre's Langur	x		
<i>Nycticebus bengalensis</i>	Slow Loris	x		
<i>Macaca mulatta</i>	Rhesus Macaque	x	x	x
<i>Macaca leonine</i>	Pig tailed Macaque	x		x
<i>Sus scrofa</i>	Wild Boar	x	x	x
<i>Muntiacus muntjak</i>	Barking Deer	x		x
<i>Cervus unicolor</i>	Sambar	x		
<i>Axis axis</i>	Spotted Deer			x
<i>Selenarctos thibetanus</i>	Asiatic black Bear	x		
<i>Panthera pardus</i>	Indian Leopard	x		
<i>Felis chaus</i>	Jungle Cat	x	x	x
<i>Prionailurus viverrinus</i>	Fishing Cat		x	x
<i>Vulpes bengalensis</i>	Fox		x	
<i>Canis aureus</i>	Jackal		x	
<i>Lutra perspicillata</i>	Smooth Coated Otter	x		x
<i>Crocodylus porosus</i>	Estuarine Crocodile			x
<i>Ophiophagus hanna</i>	King Cobra	x		x
<i>Naja kauthia</i>	Monoclelet Cobra		x	x
<i>Naja naja</i>	Binoclelet Cobra	x	x	x
<i>Bungarus caeruleus</i>	Common Krait	x	x	x
<i>Bungarus faciatus</i>	Banded Krait	x	x	x
<i>Trimeresurus erythrurus</i>	Bamboo pit Viper	x		
<i>Python molurus</i>	Indian Python	x		x
<i>Python reticulate</i>	Rock Python	x		
<i>Varanus bengalensis</i>	Bengal Monitor	x	x	x
<i>Varanus salvator</i>	Yellow Monitor	x		x
<i>Calotes versicolor</i>	Garden Lizard	x		
<i>Calotes emma</i>	Emma's Lizard	x		
<i>Draco sp.</i>	Flying Lizard	x		
<i>Microhyla rubra</i>	Red narrow-headed Frog	x		
<i>Humerana humeralis</i>	Bhamo Frog	x		
<i>Hylarana leptoglossa</i>		x		
<i>Hylarana nigrivittata</i>		x		
<i>Chiromantis vittatus</i>	Tree Frog	x		
<i>Chiromantis doriae</i>		x		
<i>Oxydozyga borealis</i>		x		
<i>Kalaula pulchra</i>	Painted bull Frog	x		
<i>Kalaula taplonanica</i>			x	
<i>Uperodon globulosus</i>	Balloon Frog		x	

Source: Feeroz, 2001; Khan, 2010, personal communication

Annex : Table 3 Review on the Status of Plant Species in Different Forest Areas

Year	Author	Study area	Status of species
1925	Heinig ,R.L.	Chittagong and Chittagong Hill Tracts (CHT)	Compiled 1,559 species in the area
1955	Sinclair,J.	Cox's Bazaar	Listed 700 plant taxa in the area
1988	Alam, M.K.	Sylhet forests	790 woody taxa (excluding monocots and gymnopserms, 400 are tree species)
1990	Khan, M.S.	Chunati Wildlife Sanctuary	477 plant species in the area
1992	Ahmed <i>et al.</i>	Hathazari Forest Range	33 regenerating tree species
1993	Ahmed, G.U. and Haque, S.M.S	Natural forest of Ukhia, Cox's Bazaar	38 tree species
1994	Ahmed, G.U. and Bhuyian, M.K.	Natural forest of Ukhia, Cox's Bazar	42 known and few unknown regenerating species
1994	Khan <i>et al.</i>	Teknaf Game Reserve	Keystone species consisting of 290 species
1995	Alam , M.K.	Sal forests	260 species
1996	Alam <i>et al.</i>	Village forest	183 species (excluding bamboo)
1997	Hossain <i>et al.</i>	Bamu Reserve Forest	85 tree species
1997	Nath <i>et al.</i>	Sitapahar Forest Reserve of CHT	762 individual stems belonging to 85 tree species
1999	Alam, M.K. and Pasha, M.K.	University of Chittagong Campus	665 species
1999	Hossain <i>et al.</i>	Mixed Tropical Forest at Kaptai of CHT	Listed 62 identified and about 20 unidentified regenerating tree species
2000	Nath <i>et al.</i>	Sitapahar Forest Reserve of CHT	85 tree species
2000	Rahman <i>et al.</i>	Chunati Wildlife Sanctuary	86 tree species (68 natural and 18 planted)
2001	Das, D.K. and Alam, M.K	Overall Bangladesh	Briefly describe 342 tree species of Bangladesh
2001	Khan, M.S. and Hoq, A.M.	Chunati Wildlife Sanctuary	422 plant species
2002	Khabir <i>et al.</i>	Sal Forest, Comilla	738 tree stems/ha; 23,708 regeneration (seedling, sapling and coppice)/ha
2002	Rahman, M.L. and Hossain, M.K.	Chunati Wildlife Sanctuary	59 medicinal plant species
2004	Hossain <i>et al.</i>	Chittagong (South) Forest Division	64 regenerating tree species
2007	Alamgir,M. and Al-Amin, M.	Bamerchara and Danerchara forests	39 species under 18 families
2007	Motaleb, M.A. and Hossain, M.K.	Tankawati natural forest, Chittagong	29 regenerating tree species
2007	Yusuf <i>et al.</i>	Rangamati and Bandarban districts	69 medicinal plant species under 40 families
2008	Ahmed <i>et al.</i>	Bhawal National Park	20 regenerating species
2009	Motaleb, M.A. and Hossain, M.K.	Tankawati natural forest, Chittagong	62 naturally growing tree species
2010a	Malaker <i>et al</i>	Lawachara natural forest	159 plants species
2010b	Malaker <i>et al.</i>	Madhupur Sal Forest	174 plant species under 54 families
2010	Uddin, M.Z. and Hassan, M.A.	Lawachara natural forest	374 angiosperm under 84 families
2011	Rahman <i>et al.</i>	Khadimnagar National Park & Tilagar Eco-Park,	55 regenerating tree species
2011	Sobuj, N.A. and Rahman, M.	Khadimnagar National Park	74 plant species of which 26 tree species, 17 shrubs and 31 herbs
2011	Uddin <i>et al.</i>	Satchari National Park	245 plant species under 72 families
2012	Uddin, M.Z. and Hassan, M.A.	Rampahar Reserve Forest, Rangamati	Listed 89 monocot (Liliopsida)

Annex : Table 4 Community Conserved Areas as Village Conservation Forests (VCF)

Name of th VCF	Area in acre (approx.)	Year of establishment	Name of Community	No. of household
<u>Langadu Upazila, Rangamati</u>				
Bame Adarok Chara	500	1967	Chakma	156
Maddhya Hari Haba	650	1977	Chakma	60
Badalchari Badhichara	500	1990	Chakma	79
Dulu Chari	150	1975	Chakma	39
Maddhya Chara	500	1996	Chakma	60
Kalabunia	300	1987	Chakma	79
Range Para	300	2008	Chakma	80
Ranjit Para	500	1967	Chakma	55
<u>Bilaichari Upazila, Rangamati</u>				
Pangkhua Para	70	2008	Pangkhua	95
Bilaicharimon Hajachara	200	1980	Chakma	70
Sap Chari	300	1965	Chakma	64
<u>Barkal Upazila, Rangamati</u>				
Nah Bhanga	200	1990	Chakma	23
Begana Chari	300	1960	Chakma	78
Jakko Bajei	100	2008	Chakma	23
Pagochya Chari	180	Before 1945	Chakma	27
Buchehari	100	1982	Chakma	19
Indramuni Kabari Para	75	Before 1945	Chakma	37
Rokbibachara	90	Before 1945	Chakma	32
Dhumoujjychara Paribesh o Grammen Bon Sangrokkhon Sommittee	29	1998	Chakma	25
Garjantoli Paribesh O Grammen Bon Sangrokkhon Sommittee	200	1987	Chakma	75
Tripuachara Paribesh O Grammen Bon Sangrokkhon Sommittee	200	1982	Chakma	44
<u>Rajasthali Upazila, Rangamati</u>				
Kukkyachari	35	2008	Khyang	35
Arhachari	100	2008	Khyang	26
Dhonuchari	120	1970	Khyang	23
Headman Para	50	1965	Tripura	22
Rose Para	80	1982	Khyang	32
Boli Para	100	1982	Tripura	48
Bora Para	100	1980	Khyang	18
Kistha Para	100	2008	Tripura	33
<u>Bandarban District</u>				
Bijoy Para, Roangchari	175	1962	Tanchangya	40
Paglachara, Roangchari	100	1960	Tanchangya	27
Suanglu Para Roangchari	15	1985	Bowm	40
Kham Thang Pransa Para Roangchari	100	2008	Khyang	25
Ranglai Chairman Para	22	1993	Mro	48
Emphu Para	50	1960	Mro	34
Renikhyang Bagan Para	40	1995	Mro	29
Chini Para	31	1993	Mro	38

An Update on Biodiversity

Implementation and Mainstreaming of NBSAP

Progress Towards Aichir Biodiversity Targets

References

Annex

Annex : Table 5 Important Bird and Biodiversity Areas (IBAs) of Bangladesh

Site Name	Site Name
Aila Beel	Pablakhali Wildlife Sanctuary
Ganges-Brahmaputra-Meghna delta	Patenga Beach
Hail Haor	Rajkandi Reserved Forest
Hakaluki Haor	Rampahar-Sitapahar Wildlife Sanctuary
Hazarikhil Wildlife Sanctuary	Rema-Kalenga Wildlife Sanctuary
Himchari National Park	Sangu Matamuhari
Jamuna-Brahmaputra river	Sonadia Island
Lawachara / West Bhanugach Reserved Forest	Sunderbans (East, South, West Wildlife Sanctuaries)
Madhupur National Park	Tanguar Haor and Panabeel
Muhuri Dam	Teknaf Game Reserve

Source: www.birdlifeinternational.org

Annex : Table 6 Shark Fisheries in the Bay of Bengal

Sl. No	Bangla Name	Scientific name	English name	IUCN redlist	Gazette notification	SOS MMGNT fishermen catch	SOS LMGNT fishermen catch
1.	Chokha Hangor/Kamot	Rhizoprionodon acutus	Milk shark	LC	Y	Y	
2.	Thutti Hangor / chhuri Kamot	Scoliodon laticaudus	Dog shark, Yellow Dogfish (Spade nose shark)	NT	Y	Y	Y
3.	Haturi Hangor	Eusphyra blochii	Arrow headed hammerhead shark	NT	Y	Y	Y
4.	Bagha/Zebr a Hangor	Stegostoma fasciatum	Zebra / Leopard shark	VU	Y		
5.	Nil Hangor	Carcharhinus falciformis	Silky shark	NT	Y		
6.	Bilai Hangor	Chiloscyllium punctatum	Spotted cat shark	NT	Y		
7.	Muichia Hangor	Chiloscyllium griseum	Gray Bamboo shark	NT	Y		
8.	Kani Hangor	Mustelus kanekonis	Kani shark	DD	Y		
9.	Kala Hangor	Carcharhinus limbatus	Blacktip shark	NT	Y		
10.	Fouree Hangor	Chaenogaleus macrostoma (Negogaleus balfour-old name)	Fairi shark, Hooktooth shark	VU	Y		
11.	Korati Hangor	Pristis microdon / pristis	Largetooth Sawfish	CE	Y		
12.	Timi Hangor	Rhiniodon (Rhincodon) typus	Whale shark	VU		Y	
13.		Carcharhinus sorrah	Spottail Shark	NT		Y	Y
14.	Bagha / Boli Hangor	Galeocerdo cuvier	Tiger shark	NT		Y	Y
15.		Carcharhinus melonopterus	Blacktip reef shark	NT		Y	
16.	Haturi Hangor / Julia Mongor	Sphyrna zygaena	Smooth hammer head shark	NT			
17.		Carcharhinus leucas	Bull shark	NT			
18.		Chiloscyllium indicum	Ridge back cat / Bamboo shark	NT			

Sl. No	Bangla Name	Scientific name	English name	IUCN redlist	Gazette notification	SOS MMGNT fishermen catch	SOS LMGNT fishermen catch
19.		Carcharhinus amblyrhynchos	Grey shark	NT			
20.		Atelomycterus marmoratus	catshark	NT			
21.		Galeorhinus galeus		VU			
22.		Mustelus (Myrmillo) manaz		DD			
23..		Carcharhinus amboinensis		DD			
24.	Hangor / Kamot	Carcharhinus dussumieri	White cheek shark	NT			
25.		Carcharhinus elliotiHemipristis elongata	Snaggletooth shark	VU			
26.	Thuta Hangor	Carcharhinus macloti	Hardnose shark	NT			
27.	Kamot / Hangor	Glyphis gangeticus	Ganges shark	CE			
28.		Glyphis glyphis	Speartooth shark	EN			
29.		Triaenodon obesus	Whitetip reef shark	NT			
30.		Eusphyra blochii	Slender Hammerhead	NT			
31.	Julia Mongor	Sphyrna lewini	Scalloped Hammerhead	EN			
32.		Mobula hypostoma	Atlantic Devilray	DD			
33.		Mobula mobular	Giant Devil Ray	EN			
34.		Rhinoptera bonasus	Cownose Ray	NT			
35.		Pristis pectinata	Smalltooth Sawfish	CE			
36.	Sobuj Korati Hangor	Pristis zijsron	Long comb Green Sawfish	CE			

Source: Hoq et al., 2011

Annex : Table 7 Present Status of Banspata (*Podocarpus nerifolius*) in Natural Forests and Plantations

Sl. No.	Forest/ Plantation areas	Tree no.	Status/Health of the individuals	Remarks
1.	Massalong reserve in Bagaichari, Rangamati	06	Naturally occurring, over mature and vulnerable	Extremely depleting trees
2.	Korerhat, Chittagong North Forest Division	01	Planted in guest house premises	Pole stage
3.	Near Padua Rest house, Chittagong	01	Planted in guest house premises	Pole stage
4.	Hazarikhill Forests	03	Planted near Silviculture office	Trees
5.	Ukhia Forests	02	Naturally occurring	Coppice was found
6.	Lawachara Forests	04	Planted and Natural	Trees
7.	Duapalong Beat office of Ukhia Range	02	Planted	Poles
8.	Lawachara	02	Planted near Silviculture research office	Sapling
9.	Sitakunda Eco-park, Chittagong	05	Planted at Eco-park	Pole stage
10.	Silviculture nursery, Bangladesh Forest Research Institute, Chittagong	03	Planted at BFRI premises	Sapling and Pole stage
11.	Institute of Forestry and Environmental Sciences, University of Chittagong	03	Planted at IFESCU Campus	Pole stage
12.	Botanical Garden & Soil Research Institute, University of Chittagong	02	Planted at CU Campus	Pole stage
13.	Baldha Garden, Wari Dhaka	01	Planted	Tree
14.	National Herbarium	01	Planted	Tree
15.	Mirpur Botanical Garden, Dhaka	51	Planted	Saplings, poles and trees
16.	Ukhia, Cox's Bazar	15	Planted in office compound and homesteads	Seedlings, saplings and poles
17.	Bangladesh Agricultural University, Mymensingh	05	Planted in the Botanical Garden	Tree, Pole and Sapling
18.	Jahangirnagar University	03	Planted in the Botanical Garden	Pole and sapling
19.	Keochia Silviculture Research Station, Chittagong	01	Planted by the side of Silviculture office	Pole stage
Total		111		

Source: Bhuiyan et al., 2014

Annex : Table 8 Threatened Vascular Plants of Bangladesh (Ara *et al.*, 2013); CR: Critically Endangered, EN: Endangered, VU: Vulnerable

No.	Scientific name	Local name	Family	Habit	Threatened categories
1	<i>Acanthus leucostachyus</i>	Kastacha	Acanthaceae	Herb	EN*
2	<i>Achyrospermum wallichianum</i>	Nk	Lamiaceae	Herb	EN
3	<i>Agrostophyllum khasianum</i>	Nk	Orchidaceae	Herb	VU
4	<i>Alphonsea ventricosa</i>	Noga Kola	Annonaceae	Tree	EN
5	<i>Amorphophallus excentricus</i>	Nk	Araceae	Herb	CR
6	<i>Ancistrocladus wallichii</i>	Nk	Ancistrocladaceae	Small tree	CR
7	<i>Angiopteris sylhetensis</i>	Sylheti Rajdheki	Angiopteridaceae	Fern	CR
8	<i>Antidesma khasianum</i>	Khasia Jam	Euphorbiaceae	Shrub/ Small tree	VU
9	<i>Antidesma montanum var. salicinum</i>	Nk	Euphorbiaceae	Shrub/ Small tree	VU
10	<i>Ariopsis peltata</i>	Nk	Araceae	Herb	CR
11	<i>Aspidopterys oxyphylla</i>	Nk	Malpighiaceae	Climbing shrub	EN
12	<i>Asplenium phyllitidis</i>	Simon Aspleen	Aspleniaceae	Epiphyte	CR
13	<i>Atalantia monophylla</i>	Ban Kamola	Rutaceae	Tree	EN
14	<i>Begonia alaecida</i>	Nk	Begoniaceae	Herb	CR
15	<i>Beilschmiedia roxburghiana</i>	Nk	Lauraceae	Tree	EN
16	<i>Bhesa robusta</i>	Salkachra	Celastraceae	Tree	VU
17	<i>Boesenbergia islamii</i>	Nk	Zingiberaceae	Herb	EN
18	<i>Brownlowia elata</i>	Moos	Tiliaceae	Tree	VU
19	<i>Bulbophyllum protractum</i>	Nk	Orchidaceae	Herb	EN
20	<i>Canscora andrographioides</i>	Nk	Gentianaceae	Herb	EN
21	<i>Carex caespititia</i>	Nk	Cyperaceae	Herb	CR
22	<i>Careya herbacea</i>	Bhui Dalim	Lecythidaceae	Shrub	VU
23	<i>Careya sphaerica</i>	Nk	Lecythidaceae	Tree	CR
24	<i>Casearia kurzii</i>	Shokshi Gach	Flacourtiaceae	Tree	EN
25	<i>Castanopsis castanicarpa</i>	Huria Batna, Lumba Kanta Batna	Fagaceae	Tree	VU
26	<i>Caulokaemperia linearis</i>	Nk	Zingiberaceae	Herb	EN
27	<i>Chisocheton dysoxylifolius</i>	Nk	Meliaceae	Tree	VU
28	<i>Chonemorphia assamensis</i>	Nk	Apocynaceae	Climbing shrub	EN
29	<i>Cleisostoma appendiculatum</i>	Nk	Orchidaceae	Herb	EN
30	<i>Colocasia mannii</i>	Nk	Araceae	Herb	EN
31	<i>Colocasia virosa</i>	Nk	Araceae	Herb	CR
32	<i>Crepidium biauratum</i>	Nk	Orchidaceae	Herb	EN
33	<i>Cryptocarya amygdalina</i>	Bhuiya Gachh	Lauraceae	Tree	EN
34	<i>Cryptocarya andamanica</i>	Nk	Lauraceae	Tree	CR
35	<i>Cucumis hystrix</i>	Bandor Shasha	Cucurbitaceae	Climber	EN
36	<i>Curcuma amada</i>	Amada	Zingiberaceae	Herb	EN
37	<i>Curcuma latifolia</i>	Nk	Zingiberaceae	Herb	EN
38	<i>Cyclobalanopsis oxyodon</i>	Batna	Fagaceae	Tree	EN
39	<i>Cyperus thomsonii</i>	Nk	Cyperaceae	Herb	VU
40	<i>Dalhousiea bracteata</i>	Goddhi Pata	Fabaceae	Shrub	EN
41	<i>Dehaasia kurzii</i>	Modon-mosto	Lauraceae	Tree	VU
42	<i>Dendrobium ruckeri</i>	Nk	Orchidaceae	Epiphyte	CR
43	<i>Diospyros benghalensis</i>	Lohamori, Khalta	Ebenaceae	Tree	VU
44	<i>Diospyros ramiflora</i>	Oori Gab, Goolul	Ebenaceae	Tree	EN
45	<i>Dolichandrone spathaecea</i>	Gorshingiah	Bignoniaceae	Tree	EN
46	<i>Dryptes assamica</i>	Ban Bokul	Euphorbiaceae	Tree	EN
47	<i>Elaeocarpus petiolatus</i>	Nk	Elaeocarpaceae	Tree	EN
48	<i>Elaeocarpus prunifolius</i>	Nk	Elaeocarpaceae	Tree	EN
49	<i>Elaeocarpus rugosus</i>	Phul Champa	Elaeocarpaceae	Tree	VU
50	<i>Erythroxylum kunthianum</i>	Nk	Erythroxylaceae	Shrub	CR
51	<i>Euonymus attenuatus</i>	Nk	Celastraceae	Tree	VU
52	<i>Fissistigma polyanthum</i>	Nk	Annonaceae	Woody climber	VU

No.	Scientific name	Local name	Family	Habit	Threatened categories
53	<i>Garcinia anomala</i>	Thechu	Clusiaceae	Tree	EN
54	<i>Garcinia lanceifolia</i>	Cow, Thisuru	Clusiaceae	Tree	VU
55	<i>Gardenia resinifera</i>	Dikamali	Rubiaceae	Tree	CR
56	<i>Glochidion heyneanum</i>	Nk	Euphorbiaceae	Tree	EN
57	<i>Glochidion hirsutum</i>	Nk	Euphorbiaceae	Shrub	EN
58	<i>Glochidion sphaerogynum</i>	Kaimula	Euphorbiaceae	Tree	VU
59	<i>Gomphostemma mastersii</i>	Nk	Lamiaceae	Herb	EN
60	<i>Gomphostemma melissifolium</i>	Nk	Lamiaceae	Herb	EN
61	<i>Gomphostemma salarkhaniana</i>	Nk	Lamiaceae	Herb	CR
62	<i>Gomphostemma velutinum</i>	Nk	Lamiaceae	Herb	EN
63	<i>Heritiera papilio</i>	Papilio Sundori	Sterculiaceae	Tree	CR
64	<i>Hodgsonia macrocarpa</i>	Nk	Cucurbitaceae	Climber	VU
65	<i>Homalium nepalense</i>	Nk	Flacourtiaceae	Small tree	CR
66	<i>Horsfieldia amygdalina</i>	Holdu Barella	Myristicaceae	Tree	VU
67	<i>Horsfieldia kingii</i>	Nk	Myristicaceae	Tree	VU
68	<i>Ilex embelioides</i>	Nk	Aquifoliaceae	Tree	CR
69	<i>Ilex odorata</i>	Nk	Aquifoliaceae	Tree	EN
70	<i>Knema clarkeana</i>	Nk	Myristicaceae	Tree	VU
71	<i>Lepisanthes tetraphylla</i>	Nk	Sapindaceae	Shrub/Tree	VU
72	<i>Leptochilus decurrens</i>	Nk	Polypodiaceae	Fern	EN
73	<i>Lithocarpus thomsonii</i>	Dholi-batna, Rai-batna, Bansua	Fagaceae	Tree	VU
74	<i>Litsea thomsonii</i>	Nk	Lauraceae	Tree	VU
75	<i>Machilus fruticosa</i>	Nk	Lauraceae	Tree	EN
76	<i>Mastixia macrophylla</i>	Nk	Cornaceae	Tree	CR
77	<i>Melodinus monogynus</i>	Sandul Kon	Apocynaceae	Climbing shrub	EN
78	<i>Mesua floribunda</i>	Banspatti, Kasu Korol	Clusiaceae	Tree	CR
79	<i>Michelia mannii</i>	Nk	Magnoliaceae	Tree	CR
80	<i>Michelia panduana</i>	Nk	Magnoliaceae	Tree	CR
81	<i>Microtoena griffithii</i>	Nk	Lamiaceae	Herb	CR
82	<i>Mitrephora maingayi</i>	Thabut net	Annonaceae	Tree	EN
83	<i>Munronia pinnata</i>	Nk	Meliaceae	Shrub	EN
84	<i>Nepenthes khasiana</i>	Kolshi Pata	Nepenthaceae	Woody climber	CR
85	<i>Nyssa javanica</i>	Nk	Nyssaceae	Tree	CR
86	<i>Oberonia mannii</i>	Nk	Orchidaceae	Herb	EN
87	<i>Oberonia wallichii</i>	Nk	Orchidaceae	Herb	VU
88	<i>Ochna pumila</i>	Bhui Champa	Ochnaceae	Shrub	CR
89	<i>Olax nana</i>	Nk	Olacaceae	Undershrub	CR
90	<i>Parthenocissus semicordata</i>	Munderi	Vitaceae	Climber	VU
91	<i>Pentasacme wallichii</i>	Nk	Asclepiadaceae	Herb	CR
92	<i>Persicaria ecliata</i>	Bishkatali	Polygonaceae	Herb	EN
93	<i>Phoenix acaulis</i>	Ban Khejur	Arecaceae	Palm	EN
94	<i>Phyllanthus roxburghii</i>	Nk	Euphorbiaceae	Shrub	EN
95	<i>Picrasma javanica</i>	Nilghanta	Simaroubaceae	Tree	VU
96	<i>Polyalthia simiarum</i>	Arjan, Chami	Annonaceae	Tree	VU
97	<i>Rhaphidophora schottii</i>	Nk	Araceae	Climber	EN
98	<i>Scaphium scaphigerum</i>	Shampan, Pogan	Sterculiaceae	Tree	VU
99	<i>Siphonodon celastrineus</i>	Katt bel	Celastraceae	Tree	EN
100	<i>Smilax roxburghiana</i>	Kumari Lata	Smilacaceae	Climber	EN
101	<i>Sonerila maculata</i>	Nk	Melastomataceae	Herb	CR
102	<i>Staurogyne thyrsoidea</i>	Nk	Acanthaceae	Herb	VU
103	<i>Sterculia versicolor</i>	Nk	Sterculiaceae	Tree	EN
104	<i>Stuednera colocasiifolia</i>	Nk	Araceae	Herb	EN
105	<i>Stuednera gagei</i>	Nk	Araceae	Herb	EN

No.	Scientific name	Local name	Family	Habit	Threatened categories
106	<i>Stichoneuron membranaceum</i>	Nk	Stemonaceae	Herb	CR
107	<i>Symplocos macrophylla</i>	Nk	Symplocaceae	Tree	VU
108	<i>Syzygium reticulatum</i>	Nk	Myrtaceae	Tree	EN
109	<i>Tarenna scandens</i>	Gujer-kota	Rubiaceae	Shrub	EN
110	<i>Tectaria simonsii</i>	Simontari Dheki	Dryopteridaceae	Herb	CR
111	<i>Tetradium glabrifolium</i>	Ban-Neem	Rutaceae	Shrub/ Tree	EN
112	<i>Tetraphyllum bengalense</i>	Nk	Gesneriaceae	Herb	CR
113	<i>Tetrastigma dubium</i>	Kuanria	Vitaceae	Climbing shrub	EN
114	<i>Thelypteris loyalii</i>	Loyal fern	Thelypteridaceae	Fern	CR
115	<i>Thottea tomentosa</i>	Nk	Aristolochiaceae	Herb	CR
116	<i>Trivalvaria dubia</i>	Nk	Annonaceae	Tree	VU
117	<i>Turpinia cochinchinensis</i>	Tauk Shama	Staphyleaceae	Tree	VU
118	<i>Typhonium gracile</i>	Nk	Araceae	Herb	VU
119	<i>Wendlandia heyneana</i>	Dhali Rong Gach	Rubiaceae	Shrub/ Tree	CR
120	<i>Xerospermum laevigatum</i>	Ban Lichu	Sapindaceae	Tree	VU

Annex : Table 9 Germplasm Conservation of Forest Tree Species During 2000-2012 in Different Silviculture Research Stations, BFRI

Sl. No.	Species name	BFRI Silviculture Research Stations				
		HQ	Keochia	Lawachara	Charaljani	Charkai
1	Agar (<i>Aquilaria agallocha</i>)	-	√	-	√	√
2	Arjun (<i>Terminalia arjuna</i>)	-	-	-	√	-
3	Banderhola (<i>Duabanga grandiflora</i>)	√	-	-	-	-
4	Banspata (<i>Podocarpus neriifolius</i>)	-	-	√	-	-
5	Barun (<i>Crataeva magna</i>)	-	-	√	-	-
6	Bazna (<i>Zanthoxylum rhetsa</i>)	-	-	√	-	-
7	Bhutum (<i>Hymenodictyon orixensis</i>)	√	-	-	-	√
8	Bohera (<i>Terminalia bellirica</i>)	-	√	-	-	-
9	Boilam (<i>Anisoptera scaphula</i>)	√	√	-	-	-
10	Bon-amra/Amra (<i>Spondias pinnata</i>)	-	-	-	-	√
11	Chalmugra (<i>Gynocardia odorata</i>)	-	-	√	-	-
12	Chapalish (<i>Artocarpus chaplasha</i>)	√	√	-	-	√
13	Chhatim (<i>Alstonia scholaris</i>)	-	√	-	-	-
14	Chickrassy (<i>Chukrasia tabularis</i>)	√	√	-	-	-
15	Civit (<i>Swintonia floribunda</i>)	√	√	√	√	√
16	Dewa/Borta (<i>Artocarpus lakoocha</i>)	-	-	√	-	-
17	Dhaki-jam (<i>Syzygium grande</i>)	-	√	-	-	-
18	Dholi-garjan (<i>Dipterocarpus gracilis</i>)	-	√	-	√	√
19	Dharmara (<i>Stereospermum personatum</i>)	-	√	√	√	√
20	Dhup (<i>Canarium resiniferum</i>)	√	√	√	-	-
21	Dudh-kuruch (<i>Wrightia arborea</i>)	-	√	-	-	-
22	Gandhi-gazari (<i>Miliusa velutina</i>)	-	-	-	√	√
23	Gila-batna/Khami (<i>Castanopsis tribuloides</i>)	-	-	√	-	-
24	Glicridia (<i>Glicridia sepium</i>)	-	√	-	-	-
25	Golab-jam (<i>Syzygium jambos</i>)	-	√	-	-	-
26	Gurja-batna (<i>Lithocarpus pachyphyllus</i>)	-	-	√	-	-

Sl. No.	Species name	BFRI Silviculture Research Stations				
		HQ	Keochia	Lawachara	Charaljani	Charkai
27	Haldu (<i>Haldina cordifolia</i>)	√	√	√	√	-
28	Hargaza (<i>Dillenia pentagyna</i>)	-	-	√	-	-
29	Hartaki (<i>Terminalia chebula</i>)	-	-	-	-	√
30	Jat-batna (<i>Castanopsis lancifolia</i>)	-	-	√	-	-
31	Jawa /barela (<i>Holigarna caustica</i>)	-	-	√	-	-
32	Joyna (<i>Schleichera oleosa</i>)	-	-	√	-	-
33	Kalo-jam (<i>Syzygium cumini</i>)	-	√	-	-	√
34	Kanak (<i>Schima wallichii</i>)	-	-	√	-	-
35	Kannyari (<i>Gardenia coronaria</i>)	√	√	√	√	√
36	Kainjal-bhadi (<i>Bischofia javanica</i>)	-	-	-	√	-
37	Kanaidinga/Thona (<i>Oroxylum indicum</i>)	√	√	-	-	√
38	Kerung (<i>Pongamia pinnata</i>)	-	√	-	-	-
39	Khayer (<i>Acacia catechu</i>)	√	-	-	-	√
40	Lal-awal/ goda/awal (<i>Vitex peduncularis</i>)	-	-	√	-	-
41	Lohakat (<i>Xylia xylocarpa</i> var. <i>kerrii</i>)	-	√	√	-	-
42	Mahua (<i>Madhuca indica</i>)	-	-	√	√	-
43	Melaleuca (<i>Melaleuca leucadendra</i>)	-	√	-	-	-
44	Menda (kalo)- (<i>Litsea monopetala</i>)	√	√	√	-	-
45	Moos (<i>Brownlowia elata</i>)	-	√	-	-	-
46	Nageswar (<i>Mesua ferrea</i>)	-	√	-	-	-
47	Parul (<i>Stereospermum suaveolens</i>)	√	-	-	-	-
48	Pitraj (<i>Aphanamixis polystachya</i>)	-	√	-	-	-
49	Putranjiva (<i>Putranjiva roxburghii</i>)	-	-	-	-	√
50	Raktan (<i>Lophopetalum fimbriatum</i>)	-	√	√	-	-
51	Shidha-jarul (<i>Lagerstroemia parviflora</i>)	-	-	√	√	-
52	Sil-batna (<i>Castanopsis indica</i>)	-	√	-	-	-
53	Sil-bhadi (<i>Garuga pinnata</i>)	-	-	√	-	-
54	Simul (<i>Bombax ceiba</i>)	-	√	-	-	-
55	Sonalu (<i>Cassia fistula</i>)	-	-	-	√	√
56	Telsur (<i>Hopea odorata</i>)	√	√	-	-	√
57	Tali (<i>Palaquium polyanthum</i>)	-	-	√	-	-
58	Teli-garjan (<i>Dipterocarpus turbinatus</i>)	√	√	√	√	√
69	Toon (<i>Toona ciliata</i>)	-	-	√	-	-
60	Udal (<i>Firmiana colorata</i>)	-	√	√	√	√
61	Uriam (<i>Mangifera sylvatica</i>)	√	√	-	√	-

Source: Islam, 2003

Annex : Table 10 Species Taken Under Conservation Programme in the Campus of University of Chittagong During 2011-2014

Sl. No	Scientific name	Local name
1	<i>Anisoptera scaphula</i>	Boilam
2	<i>Artocarpus lacucha</i>	Borta, Dewa
3	<i>Bischofia javanica</i>	Kanjlbhadi
4	<i>Brownlowia elata</i>	Moos
5	<i>Calophyllum inophyllum</i>	Ponyal
6	<i>Canarium resiniferum</i>	Dhup, Pairag
7	<i>Cassia fistula</i>	Sonalu
8	<i>Castanopsis indica</i>	ShilBatna
9	<i>Chukrasia tabularis</i>	Chikrassy
10	<i>Cinnamomum iners</i>	Tez-bohu
11	<i>Couropita guianensis</i>	Naglingom
12	<i>Dipterocarpus alatus</i>	Dhullya-garjan
13	<i>Dipterocarpus costatus</i>	BaittyaGarjan
14	<i>Dipterocarpus turbinatus</i>	TeliGarjan
15	<i>Duabangag grandiflora</i>	Bandarhaua
16	<i>Elaeocarpus tectorius</i>	Titpai
17	<i>Firmiana colorata</i>	Ujal, Pata-gota
18	<i>Gardenia coronaria</i>	Konnari
19	<i>Haldina cordifolia</i>	Haldu
20	<i>Hopea odorata</i>	Telsur
21	<i>Hydnocarpus kurzii</i>	Chalmugra
22	<i>Hymenodictyon orixensis</i>	Bhutum/ Bhuikadam
23	<i>Lagerstroemia parviflora</i>	SidhaJarul
24	<i>Lithocarpus acuminata</i>	Kala Batna
25	<i>Litsea monopetala</i>	Menda
26	<i>Lophopetalum wightianum</i>	Raktan
27	<i>Mangifera sylvatica</i>	Uri-Aam
28	<i>Oroxylum indicum</i>	Kanaidinga
29	<i>Palaquim polyanthum</i>	Tali
30	<i>Podocarpus neriifolius</i>	Banspata
31	<i>Pongamia pinnata</i>	Kerung, Karanja
32	<i>Protium serratum</i>	Gutgutya
33	<i>Pterospermum acerifolium</i>	Muchakunda
34	<i>Pterospermum semisagittatum</i>	Lana-Assar
35	<i>Pterygota alata</i>	Narikeli
36	<i>Sapindus saponaria</i>	Rita
37	<i>Saraca asoca</i>	Ashok
38	<i>Scaphium wallichii</i>	Shampan
39	<i>Schima wallichii</i>	Kanak
40	<i>Schleichera oleosa</i>	Kusum
41	<i>Shorea robusta</i>	Sal
42	<i>Spondias pinnata</i>	Bon Amra
43	<i>Sterculia foetida</i>	Box badam
44	<i>Sterculia villosa</i>	Udal
45	<i>Stereospermum tetragonum</i>	Dharmara
46	<i>Stereospermum chelonoides</i>	Parul
47	<i>Swintonia floribunda</i>	Civit
48	<i>Syzygium grande</i>	Dhaki Jam
49	<i>Tabebuia chrysantha</i>	Tabebuia
50	<i>Terminalia bellirica</i>	Bahera
51	<i>Terminalia chebula</i>	Haritaki
52	<i>Toona ciliata</i>	Toon
53	<i>Vitex glabrata</i>	Goda, Horina
54	<i>Vitex peduncularis</i>	Arsol
55	<i>Xylia xylocarpa</i>	Lohakath
56	<i>Zanthoxylum rhetsa</i>	Bazna

Annex: Table 11 Seedling Seed Orchards Established at the University of Chittagong Campus

Site No.	Location	Plantation year	Age (yrs.)	No. of seedlings	Area (ha)	Remarks
01	West of Marine Science building	2011	03	903	0.361	
02	West of Marine Science building	2012	02	455	0.182	
03	East of Nasir Colony	2012	02	697	0.436	
04	Near Director Building, IFESCU	2013	01	300	0.12	
05	Jungalia Hill	2013	01	4355	3.92	
06	Jungalia Hill Mixed plantation	2013	01	760	0.684	
07	Jungalia Hill	2014	0.2	4659	2.912	
08	Jungalia Hill (BFRI source)	2014	0.2	2540	1.02	
Total				14,669	9.635	

Annex: Table 12 Review on the Number of Insect Species Reported from Bangladesh

SI No.	Order	Number of species identified/recorded	References & Comments	Collection Depository* (no. of specimen)
1	Thysanura	03	Kabir, et al. (2008)	IMDZCU (3)
2	Collembola	07	Islam, et al. (1973); Bhuiya et al. (1990); Ahmad et al. (2009); Mazumdar (2014)	IMDZCU (5)
3	Ephemeroptera	05	Kabir, et al. (2008)	--
4	Neuroptera	06	Ahmed, et al. (2009)	IMDZCU (3)
5	Diptera	270	Alam, et al. (1964); Ahmed (1987); Gapud (1992); Ahmed, et al. (2009); Masuduzzaman (2012); Bashar, et al. (2010); Bhuiya, et al. (2014)	IMDZCU (111)
6	Lepidoptera	366 (Moths) 320 (Butterflies) Total=686	Alam, et al. (1964); Gapud, 1992; Ahmed, et al. (2009); Islam, 2013; Chowdhury & Hossain, 2013; Bashar, 2014; Rajia & Bhuiya, 2015 (unpublished list on Moths); Monwar Hossain, 2015 (IUCN Red List Lead Assessor on Butterfly; pers. comn).	IMDZCU (117)
7	Coleoptera	255	Alam, et al. (1964); Gapud (1992); Anonymous, 1973 -2013; Ritchie (1995)	IMDZCU (65)
8	Orthoptera	67	Kabir, et al. (2008); Alam, et al. (1964); Gapud (1992)	IMDZCU (45)
9	Phasmida	05	Bhuiya (2015) personal collection	IMDZCU (5)
10	Dermaptera	27	Kabir, et al. (2008)	IMDZCU (5)
11	Dictyoptera	15	Kabir, et al. (2008)	IMDZCU (10)
12	Odonata	168	Kabir, et al. (2008); Mollah, et al. (eds) (2003); Chowdhury & Miah (1988); Chowdhury & Mohiuddin (2011); Bashar, et al. (2014)	IMDZCU (35)
13	Isoptera	60	Alam, et al. (1964); Gapud (1992); Kabir, et al. (2008)	IMDZCU (25)
14	Mallophaga	05	Kabir, et al. (2008)	IMDZCU (2)
15	Siphunculata	05	Kabir, et al. (2008)	IMDZCU (2)
16	Hymenoptera	466	Alam, et al. (1964); Bhuiya and Sufian (1984 – 1985); Bhuiya and Miah, (1990, 2007); Boucek and Bhuiya, (1991); Bhuiya, 1998, 2001; Miah & Islam (2012); Bhuiya, et al. (1999, 2000, 2003, 2005, 2007, 2014); Islam (1984-2014); Ahmed, et al. (2009).	IMDZCU (506)
17	Homoptera	147	Alam, et al. (1964); Gapud (1992); Ahmad, et al. (2008)	IMDZCU (55)
18	Hemiptera	128	Alam, et al. (1964); Gapud (1992); Ahmad, et al. (2008)	IMDZCU (53)
19	Thysanoptera	31	Alam, et al. (1964); Gapud (1992); Ahmad, et al. (2008)	IMDZCU (15)
20	Siphonaptera	04	Ferdousi, et al. (2004), <i>in</i> : Ahmed, et al. (2009)	IMDZCU (2)
21	Others	Record uncertain	-----	IMDZCU (unidentified)
Total Number		2360	(Estimated Total Record)	

Source: Bhuiya, 2015* (personal communication)

*Number of species within different orders may be added in due course as they are recorded.

*IMDZCU = Insect Museum Department of Zoology Chittagong University.

Annex: Table 13 Status and Trends of Crop Diversity

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Cereals					
Wheat	<i>Triticum aestivum</i>	636		35	Increasing
Foxtail millet	<i>Setaria italica</i>	531		3	Decreasing
Proso millet	<i>Panicum miliaceum</i>	197		1	Decreasing
Sorghum	<i>Sorghum bicolor</i>	187			Decreasing
Maize	<i>Zea mays</i>	104		20	Increasing
Barley	<i>Hordeum vulgare</i>	55		6	Increasing new varieties
Buckwheat	<i>Fagopyrum esculentum</i>	6			Decreasing
Triticale	<i>Triticosecale</i> spp.	5		2	Remaining the same
Pearl millet	<i>Pennisetum americanum</i>	2			Increasing
Teff	<i>Eragrostis abyssinica</i>	2			Remaining the same
Oat	<i>Avena sativa</i>	1			Remaining the same
Finger millet	<i>Eleusine coracana</i>	1			Decreasing
Total- 12		1,727	0	67	
Pulses					
		PGRC	PRC		
Grasspea	<i>Lathyrus sativus</i>	1795	350	4	Decreasing landraces and increasing new variety and breeding lines
Chickpea	<i>Cicer arietinum</i>	760	800	9	Increasing new variety, landraces and breeding lines
Lentil	<i>Lens culinaris</i>	414	900	7	Increasing new variety, and decreasing landraces
Blackgram	<i>Vigna mungo</i>	68	980	3	Increasing breeding lines and decreasing landraces
Pigeonpea	<i>Cajanus cajan</i>	83	80		Remaining the same
Mungbean	<i>Vigna radiate</i>	99	600	6	Increasing
Horse gram	<i>Macrotyloma uniflorum</i>	32			Decreasing
Cowpea	<i>Vigna unguiculata</i>	31	100	2	Remaining the same
Field Pea	<i>Pisum sativum</i>	158	350	1	Increasing new variety, landraces and breeding lines
Fababean	<i>Vicia faba</i>	13	60		Increasing
Rice bean	<i>Vigna umbellata</i>	6			Remaining the same
'Bazari'	Unknown	1			Not known
Total-12		3,460	4,220	32	
Oilseeds					
		PGRC	ORC		
Mustard	<i>Brassica rapa, B. juncea, B. napus</i>	202	136	17	Increasing variety and decreasing landraces
Sesame	<i>Sesamum indicum</i>	109	61	5	Increasing
Soyabean	<i>Glycine max</i>	50	102	6	Increasing
Sunflower	<i>Helianthus annuus</i>	48	16	2	Increasing
Ground nut	<i>Arachis hypogaea</i>	23	120	10	Increasing
Linseed	<i>Linum usitatissimum</i>	18	20	1	Decreasing
Niger	<i>Guizotia abyssinica</i>	3	21	1	Increasing
Castor	<i>Ricinus communis</i>	1			Decreasing
Safflower	<i>Carthamus tinctorius</i>	1	3	1	Decreasing
Total -9		455	479	43	

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Vegetables		PGRC	HRC		
Red amaranth	<i>Amaranthus gangeticus</i>	708	46	1	Increasing
Stem amaranth	<i>Amaranthus tricolor</i>		79	2	Increasing
Leafy amaranth	<i>Amaranthus blitum</i>		7	1	Increasing
Grain amaranth	<i>Amaranthus hypochondriacus</i>	4			Remaining the same
Other Amaranths	<i>Amaranthus viridi</i>	7			Remaining the same
	<i>Amaranthus cruentus</i>				Remaining the same
	<i>Amaranthus hybridus</i>				Remaining the same
	<i>Amaranthus dubius</i>				Remaining the same
	<i>Amaranthus palmeri</i>				Remaining the same
	<i>Amaranthus lividus</i>				Remaining the same
	<i>Amaranthus spinosus</i>				Remaining the same
Hyacinth bean	<i>Lablab purpureus</i>	624	152	7	Increasing
Pumpkin	<i>Cucurbita moschata</i>	478	126	2	Increasing
Bottle gourd	<i>Lagenaria siceraria</i>	347	51	4	Increasing
Brinjal	<i>Solanum melongena</i>	282	380	16	Increasing
Okra	<i>Abelmoschus esculentus</i>	225	163	1	Increasing
Ash gourd	<i>Benincasa hispida</i>	206	59	1	Increasing
Yard longbean	<i>Vigna sesquipedalis</i>	180	25	1	Increasing
Sponge gourd	<i>Luffa cylindrical</i>	157	39		Increasing
Ridge gourd	<i>Luffa acutangula</i>	155	32	1	Increasing
Snake gourd	<i>Trichosanthes anguina</i>	142	46	1	Increasing
Tomato	<i>Solanum lycopersicon</i>	67	330	21	Increasing
Cucumber	<i>Cucumis sativus</i>	59	121		Increasing new variety and decreasing landraces
Bitter gourd	<i>Momordica charantia</i>	47	42	2	Increasing new variety and decreasing landraces
Radish	<i>Raphanus sativus</i>	43	32	4	Increasing
Spinach	<i>Spinacia oleracea</i>	40			Increasing
Indian spinach	<i>Basella alba</i>	39	38	2	Increasing
French bean	<i>Phaseolus vulgaris</i>	32	36	3	Not known
Broad leaf mustard	<i>Brassica juncea</i>	16			Not known
Kangkong	<i>Ipomoea reptans</i>	9	8	1	Increasing
Rozelle	<i>Hibiscus sabdariffa</i>	8			Not known
Sword bean	<i>Canavalia gladiata</i>	6			Not known
Pak choi/Batisak	<i>Brassica chinensis</i>	3	5	1	Increasing
Chinese cabbage	<i>Brassica campestris subsp. Chinensis</i>	3	5		Increasing
Mallow	<i>Malva verticillata</i>	3			Remaining the same
Winged bean	<i>Psophocarpus tetragonolobus</i>	3			Decreasing
China shak	<i>Brassica pekinensis</i>	2	5	1	Remaining the same
Cabbage	<i>Brassica oleracea var. capitata</i>	2	20	2	Increasing
Cauliflower	<i>Brassica oleracea var. botrytis</i>	2	22	2	Decreasing
Butterfly pea	<i>Clitoria ternatea</i>	1			Remaining the same
Velvet bean	<i>Mucuna utilis</i>	1			Remaining the same
'Zirani'	Unknown	1			Not known
Giant gradilla	<i>Passiflora quadrangularis</i>		2	1	Remaining the same

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Jack bean	<i>Canavalia ensiformis</i>		2	1	Increasing
Cheena kopi	<i>Brassica chinensis</i>		5	1	Increasing breeding lines
String bean	<i>Phaseolus vulgaris</i>		10	1	Increasing
Lettuce	<i>Lactuca sativa</i>		17	1	Increasing landraces and breeding lines
Broccoli	<i>Brassica oleracea var. botrytis</i> L.		21		Increasing breeding lines
Water melon	<i>Citrullus lanatus</i>		26	1	Increasing new variety
Teasle gourd	<i>Momordica dioica</i>		32		Increasing
Capsicum	<i>Capsicum annum</i>		36	1	Increasing new variety and breeding lines
Garden pea	<i>Pisum sativum</i>		37	3	Remaining the same
Carrot	<i>Daucus carota</i>		43		Increasing landraces and breeding lines
Pointed gourd	<i>Trichosanthes anguina</i>		61	2	Increasing
Drum stick	<i>Moringa oleifera</i>		15	1	Decreasing
Total-47		3,902	2,176	90	
Fruit germplasm		PGRC	HRC	HRC	
Aonla	<i>Emblica officinalis</i>	2	13	1	Not known
Apple	<i>Malus sylvestris</i>		2		Not known
Avocado	<i>Persea americana</i>		6		Not known
Bael	<i>Aegle marmelos</i>	2	36	1	Increasing
Banana	<i>Musa sp.</i>	2	80	5	Increasing
Ber	<i>Ziziphus mauritiana</i>	4	105	4	Increasing new variety and decreasing landraces
Bilimbi	<i>Averrhoa bilimbi</i>	1	2		Not known
Bread fruit	<i>Artocarpus altilis</i>		1		Remaining the same
Bullock's heart	<i>Annona reticulata</i>	1	10		Decreasing
Burmese grape	<i>Baccurea sapida</i>		34	1	Increasing
Butter tree	<i>Sclerocarya birrea</i>	1			Not known
Calabash tree	<i>Crescentia cujete</i>	1			Not known
Carambola	<i>Averrhoa carambola</i>		15	2	Decreasing
Caranda	<i>Carissa congesta</i>	2	3		Not known
Cashewnut	<i>Anacardium occidentale</i>		4		Not known
Cherry	<i>Cerosus vulgaris</i>		2		Not known
Coconut	<i>Cocos nucifera</i>		13	2	Increasing
Cowa	<i>Garcinia indica</i>	1	2		Not known
Custard apple	<i>Annona squamosa</i>	1	10		Decreasing
Date palm	<i>Phoenix sylvestris</i>	1	5		Not known
Indian dillenia	<i>Dillenia indica</i>	2	2		Not known
Dragon fruit	<i>Hylocereus undatus</i>	2	2	2	Increasing
Durian	<i>Durio zibethmus</i>		2		Not known
Elephant's foot apple	<i>Feronia limonia</i>	2	20		Not known
Fig	<i>Ficus carica</i>	1	2		Not known
Flacourtia	<i>Flacourtia jangomas</i>		5		Not known
Giant grandilla	<i>Pessilora quadrangularia</i>	1			Not known
Golden apple	<i>Spondias dulcits</i>		41	2	Increasing
Grape	<i>Vitis vinifera</i>		4		Not known
Guava	<i>Psidium guajava</i>	2	50	3	Increasing
Hogplum	<i>Spondias pinnata</i>		5		Not known

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Indian olive	<i>Olea europaea</i>	2	10	2	Not known
Jaboticaba	<i>Myrciaria cauliflora</i>		1		Not known
Jackfruit	<i>Artocarpus heterophyllus</i>	4	300	4	Increasing
Jamun	<i>Syzygium cumini</i>	4	6		Decreasing
Lemon	<i>Citrus limon</i>	2	25	3	Not known
Lime	<i>Citrus aurantifolia</i>	1	2		Not known
Litchi	<i>Litchi chinensis</i>	1	12	5	Increasing
Longan	<i>Dimocarpus longan</i>	4	20	2	Increasing
Loquat	<i>Eriobotrya japonica</i>		1		Not known
Madagascar plum	<i>Neodypsis decaryi</i>	1	1		Not known
Mandarin	<i>Citrus reticulata</i>	1	10	2	Increasing
Mango	<i>Mangifera indica</i>	6	250	10	Increasing
Mangosteen plum	<i>Garcinia mangostana</i>		1		Not known
Monkey jack	<i>Artocarpus lakoocha</i>	1	1		Decreasing
Musk melon	<i>Cucumis melo</i>	92			Increasing
Papaya	<i>Carica papaya</i>		20	1	Not known
Passion Fruit	<i>Passiflora edulis</i>		2	1	Not known
Peach	<i>Prunus pefrsica</i>		2		Not known
Pear	<i>Pyrus communis</i>	1	3	1	Not known
Persimmon	<i>Diospyros kaki</i>		3		Not known
Phalsa	<i>Grewia astatica</i>		1		Not known
Pineapple	<i>Annus comosus</i>		3		Remaining the same
Pomegrante	<i>Punica granatum</i>		17		Decreasing
Pummelo	<i>Citrus grandis</i>	2	50	4	Increasing
Rambutan	<i>Nephelium lappaceum</i>	1	1	1	Increasing
River ebony	<i>Diospyros peregrina</i>	2	6		Decreasing
Rose apple	<i>Syzygium jambos</i>	1	2		Not known
Sapota	<i>Manilcara achras</i>	1	25	3	Not known
Satkara	<i>Citrus macroptera</i>		17	1	Not known
Snake fruit	<i>Salacca zalacca</i>		1		Not known
Soursop	<i>Annona mauricaa</i>		2		Not known
Star apple	<i>Chrysophyllum cainito</i>		1		Not known
Star gooseberry	<i>Phyllanthus distichus</i>	1	4		Decreasing
Strawberry	<i>Fragaria ananassa</i>		10	3	Increasing
Sweet Lime	<i>Citrus limetoides</i>		2	1	Not known
Sweet orange	<i>Citrus sinensis</i>	1	4	1	Increasing
Tamarind	<i>Tamarindus indica</i>	4	3	1	Decreasing
Tisa	<i>Sapotaceae spp.</i>	1	1		Not known
Titi jam	<i>Antidesma ghesambilla</i>	2			Decreasing
Toikar	<i>Garcinia pedunculato</i>		6	1	Not known
Velvet apple	<i>Diospyros discolor</i>	3	20	1	Not known
Water chestnut	<i>Trapa bispinosa</i>		2		Not known
Wax jambu	<i>Eugenia javanica</i>	1	6	2	Increasing
Wild jackfruit	<i>Artocarpus hirsutus</i>	1			Not known
Wild mango	<i>Mangifera silvatrica</i>				Remaining the same
Total-76		170	1,331	73	
Spices		PGRC	SRC		
Chilli	<i>Capsicum frutescens</i>	150	40	2	Increasing
Turmeric	<i>Curcuma longa</i>		35	5	Not known

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Orion	<i>Allium cepa</i>	1	30	5	Increasing
Betel leaf	<i>Peper betel</i>		24	2	Remaining the same
Coriander	<i>Coriandrum sativum</i>	31	18	1	Increasing
Ginger	<i>Zinger officinale</i>		18	1	Not known
Garlic	<i>Allium sativum.</i>		15	2	Not known
Cumin	<i>Cuminum cyminum</i>		12		Not known
Fennel	<i>Foeniculum vulgare</i>	1	10		Not known
Bay leaf	<i>Pimenta achris</i>	1	5		Remaining the same
Ajowan	<i>Trachyspermum ammi</i>	1	4		Not known
Celery	<i>Apium graveolens</i>		4		Not known
Fenugreek	<i>Trigonella foenum-graecum.</i>	4	3	2	Not known
Plum	<i>Prunus dumestica</i>		3	1	Increasing
Long pepper	<i>Pepper longan</i>		3		Not known
Cinnamon	<i>Cinnamomum verum</i>	1	2		Not known
Curry leaf	<i>Murraya koenigii</i>		2		Not known
Pandan wangi	<i>Pandanus amaryllifolius</i>		2		Not known
Chui jhal	<i>Pepper chaba</i>		2		Not known
Black cumin	<i>Nigella sativa</i>	7	1	1	Not known
Lemon grass	<i>Cymbopogon citratus</i>		1		Remaining the same
Black pepper	<i>Pepper nigrum</i>		1	1	Increasing
Achiote	<i>Bixa orellana</i>		1		Not known
All Spice	<i>Pimenta dioica</i>		1		Not known
Amada	<i>Curcuma amada.</i>		1		Not known
Aromatic ginger	<i>Kaempferia glagalanga</i>		1		Not known
Bitter fenel	<i>Foeniculum vulgare</i>		1		Not known
Bunching onion	<i>Allium fistulosum</i>		1	1	Increasing
Camphor	<i>Cinnamomum camphora</i>		1		Not known
Cardamom (large)	<i>Amomum subulatum</i>		1		Not known
Cardamom (small)	<i>Elettaria cardamomum</i>		1		Increasing
Clove	<i>Syzygium aromaticum</i>		1		Increasing
Culantro	<i>Eryngium foetidum</i>		1		Not known
Shallot	<i>Allium ascalonicum</i>		1		Not known
Tarragon	<i>Artemesia drucunculus</i>		1		Not known
Vanilla	<i>Vanilla planifolia</i>		1		Not known
Polaw pata			1		Not known
Bos			1		Not known
Pesta badam	<i>Prunus dulcis</i>		1		Not known
Dill	<i>Peucedanum officinale</i>	1			Not known
Postodana	<i>Papaver somniferum</i>	1			Not known
Long coriander	<i>Eryngium foetidum</i>			1	Not known
Total-42		199	252	25	
Tuber crops		PGRC	TCRC		
Potato	<i>Solanum tuberosum</i>		400	71	Increasing new variety and breeding lines
Potato (TPS)	<i>Solanum tuberosum</i>		300	2	Breeding lines
Sweet potato	<i>Ipomoea batatas</i>		255	13	Increasing new variety and breeding lines
Taro (Muhki kachu)	<i>Colocasia esculenta</i>	5	25	2	Not known

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Elephant foot yam	<i>Amorphophallus campanulatus</i>	2	5		Not known
Taro (Pani kachu)	<i>Colocasia esculenta</i>		71	5	Not known
Dud kachu	<i>Xanthosoma nigrum</i>		4		Not known
Moulovi kachu	<i>Xanthosoma artovirens</i>		3		Not known
Man kachu	<i>Alocasia macrorrhiza</i>		3		Not known
Cassava	<i>Manihot esculenta</i>		2		Not known
Yam	<i>Dioscorea spp.</i>	57			Decreasing
Turmeric		28			Not known
Total -11		92	1,068	93	
Flower and ornamentals		PGRC	HRC		
Gladiolus	<i>Gladiolus spp.</i>		30	5	Increasing
Orchid	<i>Orchid spp.</i>		120	1	Not known
Chrysanthemum	<i>Chrysanthemum spp.</i>		30	3	Increasing
Alpinia	<i>Alpinia spp.</i>		2	1	Remaining the same
Marigold	<i>Tagetes erecta</i>		4	1	Increasing
Lily	<i>Amaryllis spp.</i>		12	1	Remaining the same
Dahlia	<i>Dahlia variabilis</i>		20	1	Increasing
Anthurium	<i>Anthurium andreanum</i>		8	1	Increasing
Gerbera	<i>Gerbera jamesonii</i>		26	2	Increasing
Tuberose	<i>Polianthes tuberosa</i>		3		Increasing
Rose	<i>Rosa spp.</i>		16		Increasing
Lilium	<i>Lilium spp.</i>		1		Not known
China aster	<i>Callistephus chinensis</i>		4		Remaining the same
Heliconia	<i>Heliconia spp.</i>		5		Remaining the same
Gypsophila	<i>Gypsophilla spp.</i>		2		Increasing
Calathea	<i>Calathea spp.</i>		3		Increasing
Caladium	<i>Cladium spp.</i>		4		Increasing
Begunia	<i>Begonia obliqua</i>		2		Remaining the same
Coleus	<i>Coleus blumei</i>		3		Remaining the same
Canna	<i>Canna spp.</i>		3		Remaining the same
Ficus	<i>Dicus ebstica</i>		2		Remaining the same
China rose	<i>Hibiscus rosasinensis</i>		7		Not known
Acalypha	<i>Acalypha wikesiana</i>		2		Remaining the same
Alternanthera	<i>Alternanthera caracasana</i>		2		Remaining the same
Hedge apple	<i>Maclura pomifera</i>		4		Remaining the same
Bougainvillea	<i>Bougainvillea spp.</i>		6		Increasing
Euphorbia	<i>Euphorbia spp.</i>		10		Remaining the same
Cactus and succulents			35		Increasing
Palm			5		Remaining the same
Fern			4		Remaining the same
Climbers			5		Not known
Jasmines			5		Not known
Adeinum	<i>Adenium obesum</i>		4		Not known
Ixora	<i>Ixora spp.</i>		2		Not known
Croton			6		Not known
Dracaena	<i>Dracaena spp.</i>		6		Not known
Dieffenbachia	<i>Dieffenbachia spp.</i>		2		Not known
Aralia	<i>Aralia spp.</i>		2		Not known
Aglaeonema	<i>Aglaeonema spp.</i>		3		Not known

Crop Type	Scientific name	Status of diversity			Trends of diversity
		No. of accession at PGRC	No. of acc. other than PGRC	No. of variety	
Conifers			2		Not known
Ananas	<i>Ananas spp.</i>		2		Not known
Spider plant	<i>Chlorophytum comosum</i>		2		Not known
Money plant	<i>Epipremnum qureum</i>		2		Not known
Philodendron	<i>Philodendron bipinnatifidum</i>		2		Not known
Mussaenda	<i>Mussaenda erythrophylla</i>		2		Not known
Perennial tree			16		Not known
Perennial shrub			11		Not known
Total -47			449	16	
Medicinal and Aromatic plants		PGRC			
Malabar nut	<i>Adhatoda zeylanica</i>	1			Not known
Aloe	<i>Aloe vera</i>	1			Not known
Indian lilac	<i>Azadirachta indica</i>	1			Not known
Ashoka	<i>Saraca indica</i>	1			Not known
Myrobalan	<i>Terminalia bellirica</i>	1			Not known
Mint	<i>Mentha spp.</i>	3			Not known
Lemon grass	<i>Cymbopogon citratus.</i>	1			Not known
Creast	<i>Andrographis paniculata</i>	1			Not known
Gigantic swallow	<i>Calotropis gigantea</i>	1			Not known
Wild basil	<i>Ocimum americanum</i>	1			Not known
Asparagus	<i>Asparagus racemosus</i>	1			Not known
Granadilla	<i>Cissus quadrangularis</i>	1			Not known
American life plant	<i>Kalanchoe pinnata</i>	1			Not known
Deuils cotton	<i>Abroma augusta</i>	1			Not known
Indian Birthwort	<i>Aristolochia indica.</i>	1			Not known
Rati crab's eyes	<i>Abrus precatorius</i>	1			Not known
Spiral ginger	<i>Costus speciosus</i>	1			Not known
Chaste tree	<i>Vitex negundo</i>	1			Not known
Total-18		20			
Fibre, narcotics and others					
Tobacco	<i>Nicotiana tabacum</i>	26		1	Decreasing
Jute	<i>Corchorus capsularis</i>	19			Not known
Mesta	<i>Hibiscus sabdariffa</i>	7			Not known
Sunhemp	<i>Sesbania aculeat</i>	5			Not known
Yam bean	<i>Pachyrhizus erosus</i>	1			Decreasing
Cotton	<i>Gossypioieae spp.</i>			6	Increasing
Coffee	<i>Coffea arabica</i>	2			Not known
Total -7		60		7	
Grand total-281		10,085	9,975	446	

Source: BARI, 2015









