

BASELINE STUDY: 10

Environmental Pollution

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Executive Summary: Study 10

The environmental quality of Bangladesh is degrading severely with rapid economic growth of the country. Unsustainable development process, anthropogenic activities and the changing climate has created serious strain on the environmental quality. Severe degradation and pollution of air, water, and soil are not only threatening the ecosystem and public health, but also restraining economic growth. Hence, controlling air, water and soil pollution is increasingly getting priority in the development goals and plans of the country. Moreover, environmental pollution control for safeguarding the environmental quality is associated with Millennium Development Goal for ensuring environmental sustainability.

Environmental pollution control is emphasized in several policies, acts, strategies and plans of Bangladesh. The National Environmental Policy, 2013 signifies the necessity of controlling air, water and industrial pollution. However, it does not mention anything about controlling soil pollution. Water pollution is discussed in National Water Policy and Bangladesh Water Act, 2013. National Land Use Policy, 2001 very briefly mentions the area of soil pollution. There is no other separate policy or act for controlling soil pollution except this document.

There is no separate law or policy for controlling air pollution also. There is one regulatory instrument named as "Motor Vehicles Ordinance-1983" which specified on the reduction of smokes from the vehicles and also imposed penalty for creating health hazards due to smokes from the vehicles in the public places but it is not enforced regularly. In addition, there is another regulation for controlling air pollution from brick kiln is mentioned in an act named "Preparing Brick and Establishing Brick Kilns (Control) Amendment. 2013;" but it lacks proper guidelines for setting up eco-friendly manufacturing units with sustainable technology. It also does not mention the permissible limit for hazardous gas emission and the means of measuring it, or specify the authorities to oversee the emission. Brick kilns are one of the highest air-polluting establishments in the country.

For conserving environment, developing environmental standards and controlling and abating pollution, The Bangladesh Environmental Conservation Act of 1995 and Rules 1997 was promulgated, which (and its amendments) are currently the main legislation in relation to environmental protection of the country. The Environmental Standards established in the Rules need to be revised in line with the other international standard. The ambient Water quality standards, effluent quality standards, do not sufficiently cover all the parameters. In order to address the waste management issues and reduce environmental, social and economic problem related to current waste management system, National 3R Strategies has been formulated. Moreover, Clean Dhaka Master Plan, 2005 and Action Plan for solid waste management in 19 towns of Bangladesh are some of the initiatives to address the waste management issues. Noise Pollution (Control) Amendment, 2004 was formulated to address the noise pollution issue of the country. Section 2 discusses these existing relevant policies, laws, plans and strategies and tries to find out the gap for improvisation.

In this section relevant stakeholders with the theme of environmental pollution are identified and their roles are briefly discussed. Ministry of Environment and Forest and Department of Environment are the regulating authority in enforcing and monitoring environmental regulation to ensure safeguarding to environment. They also take different programs related to environmental improvement and pollution control. The other government department like DPHE, City Corporation(s), WSSA(s), DAE, DTCA, etc are government organization for implementing different projects and programs related to environmental management. EPZ(s), BEPZA, and other similar institutions are also taking different measures to ensure compliance to environmental regulations. The NGOs sector is also playing an important role in awareness growing, knowledge generation, policy advocacy and sensitizing regulating authorities regarding possible environmental degradation and management.

The baseline study was prepared considering some priority areas and hotspots. Due to time and resource limitation, air pollution, water pollution, soil pollution, waste management, and noise have been considered as priority. The study

was limited to major cities, major rivers, rivers around the major cities, hot spot areas like coastal region, hill tract areas, etc.

The state of environmental pollution of Bangladesh is severe. Bangladesh has fourth worst urban air quality among 91 countries according to WHO³. From the analysis of the data of “Clean Air and Sustainable Development” (initiated by Ministry of Environment and Forest), it was found that the level of oxides of Nitrogen and Particular Matter – NO_x, PM_{2.5} and PM₁₀, was alarmingly high in the ambient air, and the standard limit for these parameters exceeded very frequently in different stations among the 11 continuous air monitoring stations. Additionally, from the analysis of data, it was found that the air quality of the dry season is much worse than that of wet season. The situation is worst in Dhaka and its neighbouring cities e.g. Gazipur and Narayanganj.

In case of water pollution also, the scenario is very alarming. Pollution from industries, agricultural activities, sewerage, ships, trans-boundary sources are making the rivers more and more polluted day by day. For understanding the state of pollution of the river water, 13 rivers beside the major cities were selected and pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD₅) and, Chemical Oxygen Demand (COD) parameters of the selected rivers were analysed. Almost all the selected rivers were found polluted to some extent in this analysis. DO and BOD were two major parameters which were not within limit in most of the selected rivers. In general, rivers around Dhaka city and Narayanganj are the most polluted rivers in the country.

Though soil pollution is another major environmental concern, this issue is not recognized properly in various policy documents. Soil pollution is closely linked with water pollution. Improper disposal of solid waste is also responsible for soil pollution. Agricultural activities, ship breaking industries, industrial effluent etc are other major causes of soil pollution. Arsenic contamination is another major issue in this regard. However, more emphasis should be given on this sector.

Though solid waste management and sewerage treatment are daunting problems, especially in the urban areas of Bangladesh, these sectors are not properly noticed. Per capita waste generation rate of Bangladesh is not clearly known but according to estimation by “Waste Concern”, a company dealing with waste management, it was 0.41 kg/capita/day in 2005. However, in urban areas the rate was estimated as 0.5 kg/capita/day in 2004. The rate of waste generation shows an increasing trend with time and economic development. It is also seen that the generation rate of waste is generally higher in high income group as their purchasing power is more than the other income groups. In the existing system of solid waste management of Bangladesh informal sectors, community initiatives and formal sectors work together. However, the solid waste management system in Bangladesh is not adequate and sustainable. Moreover, current waste water management in Dhaka and all other big cities/towns are not properly addressed. Very limited part of only Dhaka city is currently connected with Pagla sewage treatment plant as a result most sewage ends up in the surrounding canals and rivers causing severe pollution.

Few national scale projects relevant to environmental pollution have been identified. Some of the mentionable projects are “Clean Air and Sustainable Development”, “Market Development Activities for *Bondhu Chula*”, “Extension and Modernization of Divisional Laboratory of DoE”, “Chittagong for enhancing capacity of monitoring and examining the impact of climate change”, “CDM Using Municipal Organic Waste of Towns (City Corporation/Municipalities) in Bangladesh”, “Implementation of 3R (Reduce, Reuse and Recycle) Pilot Initiative (Phase-1)”, “Institutional Strengthening for the Phase-out of Ozone Depleting Substances (Phase-VI)”, “Conversion from HCFC-141b to Cyclopentane technology in the manufacture of insulation foam in domestic refrigerators at Walton Hi-Tech Industries Ltd, Bangladesh,” “Phase-out of CFC Consumption in the Manufacture of Metered Dose Inhalers (MDIs) in Bangladesh” etc.

³ <http://www.thedailystar.net/bangladesh-4th-most-polluted-in-world-23348>

Bangladesh is facing some major issues and challenges in the field of retrieving environmental quality from the present degraded condition and future threats. Some of the major issues in the planning context of this field are growth of ship building and recycling industries in coastal and marine areas, restoration of polluted rivers, trans-boundary pollution, coal-based power generation, guiding landuse changes ensuring protection of natural landscape, bringing all waste and waste water in management process, cost recovery of waste water treatment plants and solid waste management plants, impact of channelization of major rivers on ecosystem and many more.

Environmental pollution sector is interlinked with other thematic sectors of the Bangladesh Delta Plan 2100. For instance, air pollution is closely connected with industrial activities, transportation system, land management system, agricultural practices, urbanization, infrastructure, etc. Water and soil pollution are related to other thematic studies such as water resources, river system management, climate change and disaster management, agriculture and food security, infrastructural development, industrial development, coastal polder issues, etc.

Significant knowledge gaps in the environmental pollution sector are encountered during planning process. Knowledge gap is more in the field of water and soil pollution sector than the air pollution sector. Lack of reliable data of water quality of major rivers, lack of data about soil quality, data gaps in the sector of air quality, absence of emergency response plan, inadequate knowledge on climate change related issues are identified as major sectors of knowledge gap in the context of planning.

Preparation of long-term plan requires the incorporation of some strategic measures in the Bangladesh Delta Plan 2100 such as: pollution monitoring, pollution prevention and control measures; development of emergency response plan; treatment and management of waste water and solid waste; restoration of polluted environment; strategic change in other sectors interlinked with environmental pollution, and development of financial mechanism for pollution prevention, control and management.

1. Introduction

1.1. Background

This baseline study on the thematic area of environmental pollution has been prepared with the aim of contributing to the preparation of the Bangladesh Delta Plan 2100. The Plan, which is expected to be a holistic, adaptive, and long-term strategic plan to contribute in disaster risk reduction, water safety and climate change resilience and adaptation, food security and economic development of the country. The BDP2100 considers 15 thematic areas, which will be integrated in the context of holistic planning. The 'Environmental Pollution' is one of the 19 thematic areas. The aim of this thematic study is to understand the existing situation, its relationship with the objectives of Delta Plan, and to identify the strategic measures and plans that need to be incorporated in the Delta Plan.

1.2. Need of the Study on Baseline Environmental Pollution and Management

Environmental pollution is closely related with the process of overall economic development. The restoration of polluted rivers, prevention and mitigation of environmental pollution, and safeguarding the environmental quality are the challenging issues in integrated development planning. Safeguarding the environmental quality by controlling environmental pollution is interlinked with the goal of ensuring environmental sustainability under the Millennium Development Goal for Bangladesh.

1.3. Overview of Environmental Pollution and Management in Bangladesh

The state of environment of the country is under pressure of unsustainable development, anthropogenic activities, and the changing climate. Severe air, water, soil and noise pollutions are threatening human health, ecosystems and economic growth of the country. Air pollution is caused due to population growth, burning fossil fuels, industrialization and associated motorization. The surface water in Bangladesh is polluted due to industrial discharge. The groundwater in different parts of the country has been contaminated by arsenic. The soil quality is highly degraded by uncontrolled use of chemical fertilizer and polythene. The residents of major cities of Bangladesh are also exposed to high level of noise pollution. Poverty, over-population and lack of sufficient awareness regarding the issue are believed to be the common causes behind this present state of environment.

The environmental pollution especially water pollution, air pollution and soil pollution are increasingly getting priority in the country's development strategies and plans. Environmental degradation is affecting country's economic growth. Lack of proper implementation and monitoring of environmental rules hinder the achievement of environmental goals. There is a good initiative of enforcing installation of effluent treatment plants (ETPs) in industries but are still faraway from the effective operation and monitoring of these ETPs. Only the mega cities like Dhaka, Chittagong, Khulna, Rajshahi, etc have limited waste management and waste water treatment facilities.

2. Review of Existing Relevant Strategies, Plans and Policies

2.1. National Environmental Policy, 2013 (NEP, 2013)

The NEP 2013 has been formulated revising and updating the NEP 1992 with the aim of integrating environment conservation and management in the mainstream of development. The NEP 2013 is based on 17 principal issues and 12 objectives. The NEP 2013 suggests 271 Action Plans for 23 sectors.

2.1.1. Principles

The 17 principles of NEP, 2013 focus on population growth control, environmental protection, introducing scientific processes and considering environmental impacts and risks for acquiring, using and preserving natural resources and

environment, valuation of natural resources and ecosystem services, considering the accessibility of local people and equity in case of using natural resources and eco-system services, decent and reasonable use of natural resources and reducing their wastage, sustainable use of renewable resources, poverty reduction and strengthening food security through biodiversity conservation, enforcing polluters pay principle, including the issue of preserving environment in all national level policy and ensuring their enforcement in public and private sectors, prioritizing preventive measures than curative measures in national level, including adaptive and mitigative strategies in all development plan and their implementation related to combating impacts of climate change, considering climate change impacts and disaster management issues during the construction of any infrastructure in the country.

2.1.2. Objectives

The 12 (twelve) objectives of NEP include provisioning natural balance and overall development through sustainable development and environmental conservation, reducing adverse impacts of climate change and decreasing the loss of natural disaster in the country, determining and controlling environment polluting and degrading activities, ensuring environment friendly development in all sectors, ensuring sustainable, long-term and environment friendly use of all national resources, emphasizing on mass awareness creation for conserving nature, establishing public-private partnership for improving environment, inaugurating and flourishing global and regional co-operation for improving global environment, mainstreaming environmental policies and strategies, creating competent population for combating against the challenges related to climate change and ecological sectors, assessing environmental impacts in all the necessary sectors, discouraging intrusion of alien and invasive species and taking decisions about them based on sufficient research.

2.1.3. Sectors

The action plans of the policies are elaborated under 23 different sectors such as (i) land (ii) water resources (iii) air (iv) food and potable water (v) agriculture (vi) health and health care provision (vii) accommodation, housing and urbanization (viii) education and mass awareness (ix) forest (x) biodiversity, ecosystem conservation and biosafety (xi) hilly ecosystem (xii) fisheries and animal resources (xiii) coastal and marine ecosystem (xiv) industry (xv) fuel and mineral resources (xvi) communication and transportation (xvii) ecotourism (xviii) population (xix) combating the impacts of climate change (xx) disaster management (xxi) science, research, information and communication technologies (xxii) other pollution control, and (xxiii) economic development. In this report, the action plans related to pollution and prevention of pollution under the above-mentioned sectors would be discussed.

2.1.4. Action Plans Relevant to BDP 2100 and Environmental Pollution

In the Action plans mentioned under section 2.1.3, the first section in the land plan discusses about land sector, emphasizes on sustainable land management, but there is no mention about land/soil pollution.

In action plan number 2(also plan no 23) under the water resources sector, it is mentioned that the water bodies and water resources should be kept free from pollution and illegal grabbing. This section emphasizes on protecting water resources. The policy requires necessary steps to restore and conserve the water bodies which have reached a delicate level due to continuous degradation. In necessary cases, the water bodies should be declared as protected area or ecologically critical area to accelerate the restoration process. The policy suggests about provisioning new industrial zoning for protecting the water bodies from possible pollution of industries. It also states that the water polluting industries have to have effluent treatment plant. Water monitoring system should be established for preventing pollution from different sources. Re-evaluation of all types of development planning which are contradictory with the act of conserving river, water bodies and environment, is suggested in this section.

Management of air is discussed in section 3 of environmental policy. Maintaining the air quality and keeping the pollutants within the limit is suggested in this section. It is also suggested to enforce law for maintaining the air quality and to upgrade the air quality standards if needed for improving the air quality. This policy restricts the import

of very old vehicles and makes it mandatory to obtain emission testing certificate before getting or renewing fitness certificate of the vehicles. It is also advised in this section to define quality standard of the fuels to be used in industries and vehicles and to strictly comply with that. Moreover, the emission standard of specific industries and vehicles should also be set and maintained for improving the air quality. Emission tax should be fixed and collected for violating the defined standards.

Under section 4, the safety issues regarding food and potable water are mainly discussed. For preserving the water sources from pollution, it has been restricted to establish industries and/or dumping ground near the sources. All types of food which are adulterated, stale, contaminated, expired, polluted through radiation, mixed with artificial colour and/or chemicals, genetically modified, are prohibited to exportation, production, distribution, buying and selling.

Organic farming is encouraged in section 5, which discusses the environmental concerns related to agriculture. In order to reduce agricultural pollution it is encouraged to use organic fertilizer and organic pesticide. In the action plan 22 of this section it is advised to take proper measures to reduce the emission of methane from paddy field and to stop open burning of agricultural waste.

In the next section (6), under health and health care provision, it is mentioned that all activities in the development and other sectors should be prevented, which can cause pollution or create imbalance in nature or threaten public health.

It is advised in the education and mass awareness section (8) to encourage all the educational institutions to keep them pollution free and to take preventive measures for reducing the polluting activities. It is also suggested to provide incentive through honour to the best educational institution in terms of environmental development.

During conducting research in the field of genetic engineering to find out measures to reduce environmental pollution, it is instructed in biodiversity, ecosystem conservation and biosafety section to apply and follow all the rules related to biosafety.

For conserving the fish population and production in the Bay of Bengal it is instructed in section 12 to prevent all the harmful activities, and measures should be taken to stop marine pollution. In section 13 also, it is suggested to take national and international level steps to control marine pollution.

Controlling industrial pollution is emphasized in this policy. In section 14, which talks about industries, it is briefed to take controlling measures to stop pollution from industries. The need of conducting EIA before establishing any new industry is also signified. It is instructed to prohibit the establishment of polluting industries and to gradually stop activities of already established industries which pollute the environment. Finding out alternatives to discourage the use of products from polluting industries is also suggested here. Introducing zero discharge/zero emission programs in the industries and implementing clean development mechanism (CDM) throughout the country is also suggested in this section. Mandatory measures to establish central effluent treatment plant in the industries should be taken according to the action plan 9 of this section. It is also advised to all the industrial units to ensure internal security and healthy environment.

Under the section fuel and mineral resources (15), it is discussed that the use of fuels which accelerates environmental pollution and climate change should be discouraged and the use of alternative and comparatively greener fuel should be encouraged. Harmful substances such as sulphur should be reduced to its minimum level in the fuel oil used in the country. Export of coal with excessive sulphur content is advised to reduce. In case of extracting fuels, the harmful impacts on environment and local people should be considered with importance and destructive extraction methods should be prohibited according to this policy.

Reduction of environmental pollution is also emphasized in communication and transportation section (16). It is instructed to ensure prohibition of all environment polluting activities in all road, rail, air and water transportation sectors. Rail and water transportation is encouraged in this policy as these are fuel efficient and less polluting sectors.

Strengthening the implementation of CDM such as carbon trading is encouraged in section 19, which discusses regarding combating the impacts of climate change. It is suggested in section 21 that environment pollution monitoring and controlling should be included in national science and technology policy. In section 22, it is instructed that other pollutions such as sound and vibration, radiation, thermal, photo/lighting, and indoor pollutions should be prevented.

In NEP 2013 it is advised that the legal framework and laws should be upgraded and already established/upgraded laws and environmental courts should be utilized and enforced to control the pollution and degradation of environment, ecosystem, and resources.

Table 1: Summary Table of NEP 2013 with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Formulated by	Relevance to BDP 2100 and Environmental Pollution
National Environmental Policy 2013	2013	Ministry of Environment and Forest	<ul style="list-style-type: none"> ▪ The NEP 2013 has been formulated revising and updating the NEP 1992 with the aim of integrating environment conservation and management in the mainstream of development. ▪ The NEP 2013 is based on 17 principal issues and 12 objectives relevant to sustainable development, valuation of ecosystem services, food safety, polluter's pay principle, and adaptation and mitigation to combat climate change ▪ The NEP 2013 suggests 271 Action Plans for 23 different sectors. ▪ Water and air pollution control and regulation are given importance ▪ Reduction of industrial pollution and pollution from communication and transportation sector is emphasized ▪ The action plans includes some new instrument or initiatives like Environmental Auditing, Air Quality Index, Emission Tax, Climate Change Resilience Agriculture, 3R, Land Zoning, EIA for housing and urban development projects, Core Zone and Buffer Zone of forest, Local and national Contingency for preventing Pollution from Sea/water traffic accident, ship waste collection and management plan at port, CDM, import and use of rehabilitation of climate displaced/migrants, EURO-5 and EURO V vehicle only, Low Carbon Growth, Waste Heat Recovery initiatives, Green Job, Economic Valuation of Ecosystem Services, etc.

Source: CEGIS

2.2. National Water Policy

The National Water Policy 1999 was adopted to ensure efficient and equitable management of water resources, equity in water supply, sustainable public and private water supply system including delineation of water rights and proper price signals of water, decentralization of water resources management system and revising the institutional framework for increasing the role of women in this sector, a legal and regulatory environment to promote the process of decentralization, sound environmental management and to attract private investment in this sector, capacity building and enhancement of knowledge with the participation of population for achieving the objective of present water policy and also to create a future water policy with economic efficiency, gender equity, social justice and environmental awareness.

2.2.1. Sectors

The National Water Policy is explained in fifteen different sectors such as (i) river basin management, (ii) planning and management of water resources, (iii) water rights and allocation, (iv) public and private involvement, (v) public water investment (vi) water supply and sanitation (vii) water and agriculture (viii) water and industry (ix) water, fisheries and wildlife (x) water and navigation (xi) water for hydropower and recreation (xii) water for the environment (xiii) water for preservation of haors, baors and beels (xiv) economic and financial management (xv) research and information management.

2.2.2. Action Plans Relevant to BDP 2100 and Environmental Pollution

The issue of water pollution is discussed in several sections of this policy. In the first sector river basin management, the issue of trans-boundary pollution is mentioned and the necessity of agreements with the co-riparian countries is also stated to prevent chemical and biological pollution, created through anthropogenic activities.

Under section six, the scarcity of potable water due to pollution of surface water and contamination of arsenic in ground water is discussed. Drinking polluted and contaminated water poses serious threat to the public health. To address these issues, the government is to mandate relevant public water and sewerage institution which would provide necessary drainage and sanitation including treatment of domestic wastewater and sewage and replacement of open drains and construction of sewers, in the interest of public health. Reduction in wastage and pollution of water due to human activities is also a concern as stated in this section.

In the section Water and Agriculture, strengthening the regulatory system for non-point source pollution from agricultural chemicals such as pesticides and fertilizers is suggested.

Water and Industry section suggests the establishment of zoning regulation for locating new industries with the consideration of fresh and safe water availability and effluent discharge possibilities. This section of the policy suggests that, the standard of effluent disposal into common waterways would be set up by WARPO in consultation with DoE. Effluent disposal from the industries would be monitored by the Government agencies to prevent pollution. Moreover, it is also stated in this section that, the industrial polluters would be required to pay for the clean-up process of the water body which was polluted by them.

The protection, restoration and enhancement measures of environment, which are consistent with National Environmental Management Action Plan (NEMAP) and National Water Management Plan (NWMP), should be given full consideration according to the suggestion of the action plan under section 12. Adopting polluter pay principle and educating industrial and farming communities are also two significant propositions in this section.

Introduction of financial incentives for water re-use and conservation, and responsible use of groundwater, and for preventing over-exploitation and pollution is proposed in section 14, which discusses the economic and financial management side of the policy.

Table 2: Summary Table of National Water Policy with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Formulated by	Relevance to BDP 2100 and Environmental Pollution
National Water Policy	1999	Ministry of Water Resources	<p>The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned, and institutional capacity building for water resource management. Some of the mentionable suggestions of the policy are:</p> <ul style="list-style-type: none"> ▪ Zoning regulations will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities ▪ Effluent disposal will be monitored by relevant Government agencies to prevent water pollution; ▪ Standards of effluent disposal into common watercourses will be set by WARPO in consultation with DOE; ▪ Industrial polluters will be required under law to pay for the clean-up of water- body polluted by them.

Source: CEGIS

2.3. Bangladesh Water Act, 2013

The Bangladesh Water Act, 2013 is mainly based on the National Water Policy and it is designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh. The law forms a National Water Resources Council with the prime minister as the head and 11 other ministers as the members of the council. The council also includes representatives from relevant departments and nominated national experts to formulate relevant guidelines and policies in this regard. An executive committee under the ministry of water resources will work for implementing the decisions/policy/guidelines developed by the council.

The act declares all form of water within the territory of Bangladesh as the property of the government. However, the surface water in private property can be used by the owner for all the needed purpose. The act requires permit/license for withdrawing large scale of surface or groundwater; however, the maximum amount of water that can be withdrawn is not mentioned in the law.

Prevention of trans-boundary water pollution is also discussed in the act. In this regard, combined survey, study and research on the international rivers and activities to prevent chemical and biological pollutant are suggested. According to this act, for regulating and controlling water pollution, the provisions of Bangladesh Environment Conservation Act, 1995 (the 1st law of 1995) would be applicable. Non-compliance with the law would cause a maximum penalty of five years of imprisonment and/or BDT 10,000.

This law was one of the highly needed steps for protecting the water resources. It significantly recognizes the management aspects of natural flow of surface water and recharge of groundwater. However, one of the major

drawbacks of this law is the requirement of written complaint from the Director General of WARPO or his/her appointee before filing a law suit under the provisions of this act.

Table 3: Summary Table of Bangladesh Water Act 2013 with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Relevance to BDP 2100 and Environmental Pollution
Bangladesh Water Act 2013	2013	<p>The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and groundwater, availability of water to all concerned, and institutional capacity building for water resources management. Some of the mentionable suggestions of the policy are:</p> <ul style="list-style-type: none"> ▪ Zoning regulations will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities; ▪ Effluent disposal will be monitored by relevant Government agencies to prevent water pollution; ▪ Standards of effluent disposal into common watercourses will be set by WARPO in consultation with DOE; ▪ Industrial polluters will be required under law to pay for the clean-up of water-body polluted by them.

Source: CEGIS

2.4. National Land Use Policy, 2001

Realizing the pressure on the land of Bangladesh due to high density of population and viewing agriculture as one of the major economic activities, the National Land Use Policy, 2001 was formulated. The objectives of this policy focus on effective ways of using the lands which include land zoning system to regulate unplanned expansion of residential areas, establishment of industrial or commercial activities; balanced use of land harmonious with the environmental system, prevention of soil pollution etc.

The necessity of land zoning is emphasized in this policy as a way of regulating the unplanned use of the land resources. This policy also aims to declare a national zoning law under which the local governments would develop their own zoning map. It also suggests providing training to the relevant government officials and elected members of the city corporations, municipalities, district councils, upazila council for elucidating them with the idea of land zoning and for building their capacity.

The use of agricultural land, especially the irrigable ones, for other purposes is strictly discouraged in this policy. Moreover, due to rural-urban migration, the demand of land for housing is increasing and hence the pressure on agricultural land. The policy suggests undertaking specific coordinated policies regarding housing. It also states the importance about protecting the water bodies and increasing the fish production. Moreover, controlling and regulating industrial pollution for preventing soil pollution is also suggested here. The importance of mass awareness for successful outcome of any policy matter is stated with significance. The policy reiterates the use of land in a harmonious way with the nature and environment.

Table 4: Summary Table of National Land Use Policy with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Formulated by	Relevance to BDP 2100 and Environmental Pollution
National Land Use Policy	2001	Ministry of Land	<ul style="list-style-type: none"> ▪ The Policy aims to control the present trend of conversion of agricultural land use to other use; ▪ The necessity of land zoning is emphasized in this policy as a way of regulating the unplanned use of land resources and aims to declare a national zoning law; ▪ One of the major objectives of the policy is to ensure safeguarding of environment in land use practices

Source: CEGIS

2.5. National 3R Strategy for Waste Management

“National 3R strategies” is developed to reduce the environmental, social and economic problems associated with the current disposal system of waste. 3Rs, which means Reduce, Reuse and Recycle, is the principle of reducing, reusing and recycling resources and products. The Strategy has been formulated in line with the National Goal of eliminating waste disposal on open dumps, rivers and floodplains by 2015 and promoting recycling of waste through mandatory segregation of waste at source as well as creating a market for recycled products and providing incentives for recycling of waste.

The inadequacy of national policy and support, absence of relevant strategies, lack of institutional capacity, lack of public cooperation, barriers in financing and cost recovery are recognized and discussed in the strategy report. The objectives of the National 3R Strategies are to address the key issues and challenges of waste management which are acting as barriers in promotion of 3Rs, defining the roles of various actors to promote 3R and guiding the creation of enabling condition for successful implementation of 3R strategies. The priority sectors for 3R are identified as municipal solid waste, industrial waste, biomedical waste, institutional and commercial waste and agricultural waste.

The first core principle of the National 3R Strategies distinguishes waste as a resource. Realizing the importance of the source separation of waste, it is regarded as the second core principle of the strategies. Third and fourth principles state that technologies should be environment friendly, appropriate and affordable. Cleaner production is another core principle which is the continual effort to prevent pollution, reduce the use of energy, water and material resources and to minimize waste in the production process. Product life extension, industrial symbiosis and by-product exchange, polluters’ pay principle and take-back provisions, green purchasing, establishing environmental management system, public-private partnership to secure improvements in the services, collaboration with scientific research bodies to promote 3R, correspondence between service received and payment made in the case of waste collection and disposal, supporting the informal sectors to achieve the objectives of 3R, gender sensitive approach and clear commitment to gender equity are also included as core principles of the strategies. Additionally another core principle of the strategies suggests undertaking separate laws for specific products, setting recycling target, including ‘design for environment considerations’ concepts for reducing environmental impacts at all phases of product life cycle.

Table 5: Summary Table of National 3R Strategy for Waste Management with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Formulated by	Relevance to BDP 2100 and Environmental Pollution
National 3R Strategy for Waste Management	2010	Ministry of Environment and Forest	<ul style="list-style-type: none"> ▪ The priority sectors are: <ul style="list-style-type: none"> ○ Municipal solid waste ○ Industrial waste ○ Biomedical waste ○ Institutional and commercial waste ○ Agricultural waste ▪ One of the objectives of the strategy is to guide creation of enabling condition of successful implementation of 3R strategies ▪ The strategy suggests a cost recovery mechanism based on levying a service charge for waste management that includes collection, transportation, separation, treatment, recycling and disposal

Source: CEGIS

2.6. The Bangladesh Environment Conservation Act 1995 and Rules 1997

The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977. The law aims to conserve and improve the environmental quality and to control and mitigate the pollution of the environment.

One of the main strategies of the act is the declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas. Restricting vehicles which emit smoke or gas that are injurious to public health or harmful for environment, is another provision of this act. Manufacture, sale etc of the articles which are harmful for environment or injurious to public health is restricted through this act. For repairing the damages of the ecosystem caused by a person or a group of people, the Director General of DoE should determine the compensation for remedy of the injuries to the ecosystem. In case of discharge of excessive environment pollutant, the DG should take necessary remedial measures to control or mitigate environmental pollution and the recover the cost of those remedial measures from the responsible person/people/group for the pollution. This act provides the authorization power of providing environmental clearance to the DG. Promulgating standards for quality of air, water, noise and soil for different areas and for limiting discharge and emitting waste, is also a concern of this act. Formulation and declaration of environmental guidelines is also another sphere of concern in this act.

Through exercising the powers conferred by section 20 of the Bangladesh Environment Conservation Act 1995, the government of Bangladesh has formulated Environment Conservation Rules 1997. It came into force in August 1997. Environmental Conservation Rules 1997 consists of a set of relevant rules to implement the ECA' 95, which specifies A categorized list (green, orange and red) of the projects, the procedure to take environmental clearance, and ambient standards in relation to water pollution, air pollution and noise, as well as permitted discharge/emission levels of water and air pollutants and noise by projects. Considering sites and the impact on the environment, the industrial

units and projects have been classified into four categories namely Green (projects with positive environmental impacts or negligible negative impacts), Orange A (projects with minor and mostly temporary environmental impacts), Orange B (projects with moderately significant environmental impacts for which mitigation measures are easily identified) and Red (projects, which may cause 'significant adverse' environmental impacts).

ECR 1997 requires three tiers of EA:

- Screening: required for all projects;
- Initial Environmental Examination (IEE): required of Orange B and Red category projects; and
- Environmental Impact Assessment (EIA): required of Red category projects.

ECR 1997 also includes Environmental standards which were prescribed for varying water sources, ambient air, noise, odour, industrial effluent and emission discharges, vehicular emission, etc. with the main aim of limiting the volume and concentrations of pollution discharged into the environment.

Table 6: Summary Table of Environmental Conservation Act 1995 with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Formulated by	Relevance to BDP 2100 and Environmental Pollution
Environmental Conservation Act 1995 and Rules 1997	Act in 1995 and Rules in 1997, Amendments thereafter	Ministry of Environment and Forest	<p>The main objectives are:</p> <ul style="list-style-type: none"> ▪ Conservation and improvement of the environment; and ▪ Control and mitigation of pollution of the environment. <p>The main strategies of the Act can be summarized as:</p> <ul style="list-style-type: none"> ▪ Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas; ▪ Regulations in respect of vehicles emitting smoke harmful for the environment; ▪ Environmental clearance; ▪ Regulation of the industries and other development activities' discharge permits; ▪ Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes; ▪ Promulgation of a standard limit for discharging and emitting waste; and ▪ Formulation and declaration of environmental guidelines

Source: CEGIS

2.7. National Environmental Management Action Plan

National Environment Management Action Plan (NEMAP) was a 10-year Plan (1995 – 2005) of the government prepared by the Ministry of Environment and Forest (MOEF) with input from all segments of civil society. It was considered as the basis for concrete programs and interventions aimed at promoting better management of scarce resources and reversing present trends of environmental degradation, as well as increasing awareness about environment. It also considered the commitments made under the Agenda 21, and may be considered as the first initiative towards the preparation of a National Agenda 21. To accomplish all these tasks, NEMAP will determine the Institutional Issues and Actions, sectoral Issues and Actions, Location Specific Issues and Actions, and Long Term Issues and Actions.

2.8. The Motor Vehicle Ordinance, 1983

The ordinance stated to impose a penalty of maximum two hundred taka for those vehicles that are emitting smokes that poses health hazard in the public places. It also restricts the passenger from smoking in public service vehicles and in any other vehicles with notice of not smoking. This ordinance is enforced occasionally but a regular enforcement would be helpful to reduce air pollution in big cities including Dhaka. However, it is to be noted that amount of the penalty is very low which may be revised as well.

2.9. Acts for Regulating Pollution from Brick Kilns

The first act to regulate brick burning was formulated during 1989 which was named as Brick Burning (Control) Act 1989. That act was emended (revised) twice and the revised versions were published as Brick Burning (Control) (Emendation) 1992 and Brick Burning (Control) (Emendation) 2001. However, in November 2013, a new law in this regard was formulated which is referred to as Preparing Brick and Establishing Brick Kilns (Control) Amendment 2013. This latest amendment is effective and followed at present.

This ordinance strictly bans the establishment of brick kilns in residential, business and reserved areas, agricultural land, government or private forests, orchard, sanctuary or wetland, and in ecologically critical area. It also restricts the collection of soil from agricultural land, mountains, and hillocks for manufacturing bricks. However, no one would be able to collect soil from haor-baors, ponds, canals, beels, river beds, chars and fallow land for brick manufacturing purpose without the permission from appropriate authority. In order to reduce the use of soil, this act requires all the brick kilns with modern technology to prepare at least 50% hollow brick or compressed brick. This act prohibits burning fuel wood or any kind of wood for brick production/ burning. Moreover, it proscribes the use of coal which exceeds the standards of sulphur, mercury, ash contents or other similar substances. Violation of this law would cause a person a maximum of 5 years of jail and/or BDT 500,000. All the punishable crimes under this law would be incognizable and bailable.

Recommendation: However, except for restricting the use of coal, this ordinance does not talk about air pollution/air quality monitoring or control measures; neither has it described any punishment for the person/owner who pollutes the surrounding air. Though National Environmental Policy 2013 suggests undertaking the measure of emission tax, it does not implement this measure though this could have been a perfect sector of implementing this law. Moreover, as the procedure of producing bricks severely degrades the topsoil of the area, restrictions should be made more stringent, and alternative options should be encouraged.

Table 7: Summary Table of Preparing Brick and Establishing Brick Kilns (Control) Amendment, 2013 with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Relevance to BDP 2100 and Environmental Pollution
Preparing Brick and Establishing Brick Kilns (Control) Amendment, 2013	2013	<ul style="list-style-type: none"> ▪ The act prohibits burning of fuel wood or any wood in brick making. ▪ The act bans the establishment of brick kilns in residential, business and reserved areas, agricultural land, government or private forests, orchard, sanctuary or wetland, and in ecologically critical area ▪ Restricts collection of soil for brick making from agricultural land, mountains, and hillocks for manufacturing bricks ▪ Collection of soil for brick manufacturing from haor-baors, ponds, canals, beels, river beds, chars and fallow land without permission from appropriate authority ▪ Brick kilns with modern technology have to prepare at least 50% hollow or compressed bricks

Source: CEGIS

2.10. Noise Pollution (Control) Rules, 2006:

As the noise level has increased sharply in recent years due to the use of microphones, loudspeakers, vehicles, horns, generators etc, and the adverse impact on mental and health condition of the exposed population could be noticed, the Noise Pollution (Control) Amendment 2004 was formulated. This act gives authority to all Paurasabhas (municipalities), City Corporations, Capital development authority (RAJUK), Khulna Development Authority (KDA), Chittagong Development Authority (CDA), and Rajshahi Development Authority (RDA) to mark off the areas under their jurisdiction as silent, residential, mixed, commercial or industrial, to implement this law. They should also put signs for marking those areas. In case of union council, they should at least place signs or signboards at 100 meter distance from schools or hospitals. The act also describes the approved standard limit of sound in the added schedule 1 and 2. In the schedule 1, silent area means area upto a radius of 100 meters around hospitals or educational institutions or special institutions/ establishment identified/to be identified by the government. In the silent area it is prohibited to use any kind of horns of vehicles, audio signals and loudspeakers. In case of using amplifier, microphones or loudspeakers in residential area, mixed area, commercial area or industrial area, permission should be taken from appropriate authority which is mentioned in schedule 3 of the act. According to this act, daytime is counted from 6am to 9pm whereas nighttime is counted from 9pm to 6am. The details of the standard for sound in different types of areas are listed in Table 8 according to the schedule-1 of the act.

Table 8: Standards for Sound according to Schedule-1 of the Act

SL. No.	Category of Areas	Standards (in dBa)	
		Day	Night
1	Silent Zone	50	40
2	Residential Area	55	45
3	Mixed Area	60	50
4	Commercial Area	70	60
5	Industrial Area	75	70

According to the act, use of pneumatic horn/hydraulic horn/multi-tuned horn in any kind of vehicle is banned. The standard limit of the sound should be maintained if the selected spot is not designated for picnic. However, in designated picnic spot (selected by District Commissioner), loudspeakers can be used only from 8am to 7pm. However, it is banned to use loudspeaker during the journey, which is a very common practice in Bangladesh. It is also banned to use brick demolishing machine in residential area. Moreover, use of any kind of noise generating machine such as mixture machine is restricted to be used in residential area from 7pm to 7am.

During various election periods it is permissible to use loudspeaker till 2 days before election from the period of announcing the schedule. However, this permission is not applicable for silent areas. Only in residential and commercial areas, loudspeaker can be used from 8am to 8pm.

This act also requires the people exposed to high noise in industries to wear personal protective equipment to reduce the impacts of noise pollution.

If someone uses sound amplifier, microphone or loudspeaker then s/he should take necessary measures so that the level of sound does not cross the standard limit in the neighbouring area. However, using loudspeaker for religious activities, warning people during natural disasters, celebrating national programs declared by government such as Independence Day, victory day, Bengali New Year etc., disseminating emergency information or notice or promotional activities of/by government or authorized organization, circulating news of death or loss etc are exempted from the restrictions of this act. Moreover use of siren/loudspeaker in ambulance, in vehicles of fire brigade, police or defence force is also exempted from this act. Violation of the statute would cause someone a minimum penalization of BDT 5,000 and/or 2 months of jail and maximum penalization of BDT 10,000 and/or 6 months of jail.

Recommendation: This act only superficially talks and recommends about the noise pollution in roads. Considering the situation and road culture of Bangladesh, there should be clearer acts for specific actions, such as there should be some measures to control the use of continuous and unnecessary horns in the road etc. Additionally, inclusion of rules and actions for controlling reckless use of microphone/loudspeaker by the vendors is a time demand.

Moreover, people generally misuse the freedom of using loudspeaker for religious purpose. There should be a time limit for religious activities too. Furthermore, the types of religious activities should also be defined here. Using loudspeaker continuously till midnight for religious activities such as *milads*, preaching (*waaz*), *puja* songs etc sometimes become very disturbing and irritating for the neighbouring people. Using loudspeakers in religious places has caused some violent and racial incidents in recent years. So the exemption of using microphone/loudspeaker should be revised carefully. Similarly, more restrictions should be included in the act for controlling the use of loudspeaker during national events. Using loudspeaker in almost every street to celebrate national events causes immense suffering to the general people. The amendment does not provide any time limitation for electoral campaign which again can also be a cause of public suffering.

It is observed that the enforcement of this law is very weak and this matter should be taken into serious consideration by the proper authority.

Table 9: Summary of the Noise Pollution Control Rule with Relevance to BDP 2100 and Environmental Pollution

Title	Year of Publication	Relevance to BDP 2100 and Environmental Pollution
Noise Pollution (Control) Amendment, 2004	2004	Noise Pollution Control rules specifies the noise standards, defines different zones with respect to ambient noise limits. All the industrial activities, vehicle, etc should comply with the rules

Source: CEGIS

2.11. Environmental Court Act 2010

The 2000 Environmental Court Act supports the Environmental Conservation Act (1995) and the Environmental Conservation Rules (1997) by providing for the establishment of environmental courts for the trial of offences relating to environmental pollution. It includes protocols for the establishment of the court, and defines the court's jurisdiction, appropriate penalties, powers of search and entry, and procedures for investigation, trial and appeal. The Environmental Conservation Act, 1995 and the Environmental Court Act 2000 were amended in 2002 and the Environmental Conservation Rules, 1997 were extended to incorporate ambient air quality and exhaust fan vehicles.

2.12. Clean Dhaka Master Plan 2005

With the aim of developing capabilities and management skill of Dhaka City Corporation in operation of Solid Waste Management, the Corporation prepared the Clean Dhaka Master Plan, with the technical and financial support from JICA. The Master Plan aims at improving solid waste management system of Dhaka City and also its overall technical, institutional and financial capacity, based on social acceptability and technical capability in order to achieve a cleaner Dhaka by 2015. The Plan identified numbers of programs and projects in line with the aim of clean Dhaka and it brings hygiene, protection of surrounding water bodies, and sanitary land filling in solid waste management of Dhaka City. The Plan identified 25 priority projects and programs through the following procedures:

- Primary Collection/Public Involvement
- Secondary Collection/Transport and Road/Drain Cleaning
- Final Disposal
- Legal Aspect
- Organizational Aspect
- Financial Aspect
- Privatization

2.13. Action Plan for Solid Waste Management in 19 towns of Bangladesh based on 3R Principle and Carbon Financing

In line with the National 3R Strategy (Reduce, Reuse and Recycle) for Waste Management, the Department of Public Health Engineering (DPHE) has formulated Action Plan for solid waste management in 19 towns of Bangladesh. The Action Plan is based on the 3R principle and carbon financing. The general strategy behind the Action Plan is mentioned below:

- Raising public awareness through information, education and demonstration projects
- Engaging an affordable mix of appropriate technical options to reduce, reuse, recycle waste
- Building partnership with NGOs and civil societies
- Private sector participation

The Action Plan considers investment from public funding, donor funding and private funding through CDM. The plan adopts 'Cost Recovery' through levying service fee for waste collection, transportation, separation, treatment, recycling and disposal.

2.14. National Sustainable Development Strategy (2010-2021)

The Planning Commission has prepared the National Sustainable Development Strategy (NSDS 2010-2021) to meet the formidable environmental challenges that Bangladesh faces in the way to development. The NSDS has identified five strategic priority areas along with three cross-cutting areas.

Strategic Priority Areas:

- Sustained Economic Growth
- Development of Priority Sectors
- Social Security and Protection
- Urban Environment
- Environment, Natural Resources and Disaster Management

Cross Cutting Areas:

- Disaster Risk Reduction and Climate
- Good Governance
- Gender Issue

The NSDS aims at reducing the industrial water pollution and air pollution caused by the transports, and managing solid waste as key challenge to manage urban environment. The NSDS takes the following strategy for urban pollution management:

- Managing water pollution through: enforcement of environmental rules and regulation, industrial zoning, water quality monitoring, ensure waste reception and facilities in ports, clean up and rehabilitate hot spot areas in Dhaka, Chittagong and Khulna.
- Managing air pollution through: improved mass transport system, replacement of traditional brick kilns by energy efficient brick kilns, mandatory use of dust control measures in construction works, etc.

The strategy only considers pollution in urban areas but does not address trans-boundary environmental pollution, and pollution in major rivers and ecologically critical areas (ECAs), in coastal areas, etc. Soil pollution is very alarming especially in urban fringe areas where industries are discharging effluent directly into the rivers; and in coastal areas which have not been covered in the strategy.

2.15. Ship Breaking and Recycling Rules 2011

The ship breaking and recycling rules has been formulated in May 2011 by taking into consideration the directions contained in the order of the High Court, for managing this delicate industry in a safe and environmentally sound manner. The rule shall be applicable to all types of ship recycling activities, such as beaching, cutting and dismantling, to be administered by appropriate authority under the Ministry of Industry. These rules do not apply to the ships which are grounded or defined as wreck. For the removal of wreck, rules under merchant ordinance, 1983, will be applied. However nothing in this rules shall affect the jurisdiction, function, power or duties required to be exercised, performed or discharged by the existing practices. The rules restrict all ships from entering into the Bangladeshi maritime zone without obtaining permission from SBSRB (Ship Breaking and Ship Recycling in Bangladesh?). It is mandatory to obtain "No objection certificate" from SBSRB to import particular ship for scrapping in Bangladesh. The rule assists the Green Recycling Facility which will ensure the proper environment for the recycling activities i.e. no ship cutting or recycling activities can take place without the containment for loss of liquids or particulate matter and so that accidental or incidental releases of emission can be recovered appropriately.

Main objectives of the Ship Breaking and Recycling Rules 2011 are:

- SBSRB will provide NOC (No Objection Certificate) for importing scrap vessel;
- Customs department in cooperation with SBSRB shall visit the ship at the outer anchorage in order to check the inventory;
- DoE in corporation with SBSRB will examine the Hazardous or toxic materials and its disposal;
- SBSRB shall issue the ship recycling facility plan and establish the TSDF and central incineration plant for common use of hazardous materials; and

- The organization (SBSRB) shall approve training program, supervise, monitor and evaluate the academic training activities.

SBSRB shall develop technical competency guidelines and appoint agencies for the ship recycling yards.

2.16. Bangladesh Environmental Management Project

Bangladesh Environmental Management Project (BEMP) is ongoing and being implemented by the DoE and funded by the Canadian International Development Agency (CIDA). The project (BEMP) is now under implementation with the objective of strengthening the capacity of the Department of Environment for accomplishing institutional planning to enable DoE to fulfil its legislated mandates inclusive of GOB and donor projects. The overall goal of BEMP is to increase the capacity for sustainable environmental management in Bangladesh. This project will strengthen the institutional capacity of the Department of Environment to enable it to carry out its legislative powers, mandates and functions.

Some of the mentionable achievements of this projects are: (i) institutional arrangement and different directorates based on different discipline was suggested and adopted (ii) expansion of DoE office in different districts (iii) capacity build-up and updating six divisional libraries (iv) legal capacity build-up of DoE (v) demonstration project for capacity building and hands on training in different sector such as air and water pollution related sectors (vi) local and international training of the DoE officials etc.

2.17. Bangladesh Environmental Institutional Strengthening Project

The Bangladesh Environmental Institutional Strengthening Project (BEISP) was implemented by DoE from 2006 to 2010. On completion of AQMP the government with the assistance of Canadian government (CIDA) launched Bangladesh Environment Institutional Strengthening Project (BEISP). Under the BEISP, DoE drafted EIA Guidelines for several industrial and development sectors including coal mining, gas (upstream and downstream), pharmaceuticals, cement factories, water and transport sectors. Most of these guidelines are still in draft form and DoE plans to finalize and gazette them. The objective of this project was to strengthen the capacity of DoE by establishing database and transparency in the review process of EIA and clearance certificate (ECC), establishing library and documentation centres, imparting training on industrial pollution control, prosecution, environmental monitoring among others. A Strategic Plan was also prepared. It provides guidance on DoE's direction for the five-year period.

The plan proposes to adhere to six areas of concentration:

- Enhancement of environmental compliance;
- Mitigation of potential environmental impacts through environmental assessment and clearance process;
- Spreading of efforts to address critical urban air quality and water quality problems;
- Facilitation of meaningful stakeholder participation in environmental management;
- Natural resources conservation through identification of ecologically critical areas; and
- Ensuring effective, efficient and accountable DoE's service.

DOE officials are often engaged in different activities to enforce the provisions of laws and rules as provided in the ECA and ECR, thus they need to have adequate knowledge on all aspects of the enforcement regime. Keeping these needs in view, several on-the-job training programs on enforcement were conducted by the project (BEISP).

2.18. Sixth Five Year Plan

The Sixth Five Year Plan (2011-2015) recognizes that mainstreaming the environmental issues in development process is highly required. The plan sets the following targets in the context of Vision 2021.

- Increasing productive forest coverage by 2 percentage points
- Improving air quality in Dhaka and other large cities
- Enacting Clean Air Act
- Treating all urban wastewater by FY15 to clean river waters
- Promoting Zero discharge of industrial effluents
- Restoring and protecting urban wetlands in line with Wetland Conservation Act
- Protecting at least 10% of the wetland as aquatic sanctuary in peak dry season
- *Jalmahal*/wetlands leasing system phased out in favour of pro-poor community based management
- Developing Risk Atlas for at least 7 cities/towns by 2015
- 500 meter wide permanent green belt established and protected along the coast
- Promoting Eco-tourism at least in 15 protected areas and ECAs
- Developing Comprehensive Marine Resources Management Plan
- Completing Land zoning for sustainable land/water use
- Integrating environmental, climate change and disaster risk reduction considerations into project design, budgetary allocations and implementation process
- Canals and natural water flows of Dhaka and other major cities restored

In line with these set targets, the plan takes the following strategies for environmental stewardship to be executed by DoE:

- Environment committees at Division, District and Upazila levels will be activated with the participation of all stakeholders.
- National Environment Council would be headed by the Prime Minister and executive committee of National Environment Council would be headed by the Minister for Environment and Forests; these two council/committee would be activated.
- Formulating the Draft of EIA guidelines for all sectors under the Environment Conservation Act (ECA) 1995 in order to ensure effective enforcement of EIA.
- Amending existing environmental laws and regulations to address new environmental issues
- Strengthening DoE in order to coordinate, monitor, and implement the activities of Environment Policy, Environmental Act, Rules and Environment Management Action Plan.
- Enforcing Polluters Pay Principle to ensure strict compliance of environment legislation.
- Reviewing and redrafting sectoral legislations
- Signing and ratifying a number of International Conventions and Protocols on environment.
- Providing incentives, in the form of tax-rebate, tax-holiday etc. and meeting incremental cost incurred by the Environment-friendly entrepreneurs in/from various forms/sources.
- Mandating Environmental Impact Assessment for each development project which requires approval of the Government.
- Establishing 'National Environment Fund' for providing assistance to the victims of environmental degradation caused by the natural disasters and anthropogenic activities.
- Enhancing national capacity to mainstream poverty-environment-climate nexus in the development of project design, budgetary process, project implementation and monitoring process

The Plan also identifies several programs recognizing the links of environmental issues with other thematic areas. The programs are prepared under the following major headings:

- Controlling Air Pollution
- Controlling Industrial Pollution
- Controlling Noise Pollution
- Management of Wastes

- Generating electricity from waste
- Conservation of Ecosystem
- Conservation of Biological Diversities
- Saving the Rivers
- Protection of the Ozone Layer
- Partnership Program for Environment Protection
- National Bio-Safety Framework
- Declaring Ecologically Critical Areas
- Reduction in the Production and Use of Black Polythene
- Poverty-Environment-Climate-Disaster Nexus Initiative in National Planning Process

The other development sector especially the transportation and urban transport sectors are considering improvement of environment as an objective of the programs identified in the plan.

Achievement of Targets:

The focus of the Sixth Plan's environmental protection strategy was the conservation and maintenance of natural resources, reducing air and water pollution, and liberating encroached rivers, water bodies, forest areas and *khas* land. The plan has seen the following success:

- The target of achieving 20% forest coverage has not been reached. The latest available data puts forest coverage at only 13.14%, suggesting the need for major improvements during the implementation period of the Seventh Plan.
- To establish Green belt along the coasts, about 978 km has been completed of estimated 2,280 km of coast line of main lands and different islands considering the area exposed to sea to save the life and properties of coastal people against the cyclone and tidal surges.
- Raising plantation along the side of the roads and embankments was continued to establish 500 meter wide permanent green belt along the coast. During the plan period about 13,864 km strip plantations were raised and 53 million seedlings were distributed for homestead planting.
- To protect Royal Bengal Tiger, the main flagship wildlife species of Bangladesh, Tiger Action Plan has been prepared for 2009-2017 period and accordingly, different conservation activities have been implemented.
- The Protected Area (PA) coverage is increased to 10.72% from 10% of the total forest area of the country. The number of terrestrial Protected Area has been increased from 19 to 37 for the conservation of biodiversity. However, the areas protected are 2.29 percent which is less than the target of 5 percent.
- Climate Change Trust Act, 2010 was enacted; and as per the Act, Bangladesh Climate Change Trust (BCCT) was established in 2013.
- Clean Air and Sustainable Environment (CASE) project of the DoE has addressed a number of issues. Traditional brick kilns are being phased out, and continuous air quality monitoring stations have been set up in various districts.
- To control water pollution, the DoE has made it mandatory for industries to set up Effluent Treatment Plants (ETPs) to treat their waste before discharging into the water bodies. Enforcement is going on to bring the industries that are generating wastewater, under compliance. Proposed industries are required to obtain Environmental Clearance Certificates (ECCs) to ensure that the anticipated pollution load will be within acceptable limits. It is also mandatory for them to install effluent treatment plants.

Achievement in terms of the Strategies considered:

- Environment committees at Division, District and Upazila levels have been activated.
- National Environment Council headed by the Hon'ble Prime Minister has been activated.

- Drafting of EIA guidelines for almost all sectors under the Conservation Act (ECA) 1995 have been formulated.
- Environmental Impact Assessment (EIA) has been made mandatory for Red Category projects to address adverse impacts.
- Existing environment laws and regulations have been amended to address new issues.
- DoE has enhanced its institutional capacity. The Department carries out its responsibilities through one head office, six Divisional offices located in Dhaka, Chittagong, Khulna, Rajshahi, Barisal, Sylhet and two Metropolitan offices as Dhaka Metropolitan and Chittagong Metropolitan. Of late, the Government has set up 21 new offices at district level with job vacancies for 468 new positions. As a result, the manpower of DoE has been increased to 735.
- 'Polluters Pay Principle' has been adopted in order to ensure compliance of environment legislation.
- Sectoral legislations have been reviewed and re-drafted in light of Bangladesh's commitments expressed through signing and ratifying of a number of International Conventions and Protocols on environment.
- Incentives, in the form of tax-rebate, tax-holiday and subsidies are being considered for implementation.
- Efforts are underway to strengthen the Government's capacity to mainstream poverty-environment-climate nexus in the development project design, budgetary process, project implementation and monitoring process.
- Market initiatives were taken to expand Improve Cook Stoves (ICS) in all over Bangladesh especially Bondhu Chula, to reduce Green House Gas Emission as well as to get health benefit.
- 3R Strategy has been formulated to streamline waste management system.

Seventh Five Year Plan

The major targets taken regarding environment in the 7th Five Year Plan (2016-2021) are listed below:

- To achieve tree cover over 20% of the land surface (with tree density > 70%) and ecologically healthy native forests are restored and protected in all public forest lands (about 16% of land)
- Protection of wildlife and control of illegal trade of wildlife
- Watershed management and soil conservation
- Properly harnessing the benefits of the Ganges Water Treaty 1996
- To save the Sundarbans and the south-west region of the country from salinity intrusion
- To utilize the surface water in the wake of wide-spread arsenic contamination in groundwater
- To hold water of wetlands including *Jalmahals* and rivers in dry season and At least 15% of the wetland in peak dry season is protected as aquatic sanctuary
- Urban wetlands are restored and protected in line with Wetland Conservation Act
- Protection of wetlands including flood flow zone and low lying areas capable of water retention in and around greater Dhaka in line with the existing structure plan
- Introduction of community based pollution control enforcement mechanism; stricter enforcement of environment clearance conditions (ECC)
- Establishment of Division wise Lead Recovery & Recycling Plants
- Undertaking projects for Recovery and Destruction of PCB's & redundant pesticides
- Judicious selection of landfilling sites through undertaking of EIA
- Establish efficient collection system for selected electronic wastes
- Strict enforcement of Brick Kiln Act 2013 for phasing out of traditional brick Kiln
- Implement and enforce the 'Noise Pollution Control Regulation-2006'
- Increase the capacity of sewerage treatment plant of Dhaka city to cover 80- 90% household; Installing common ETPs in around 10 spots in textile zones of greater Dhaka region

- Installing of ETP within the WDF (washing, dyeing and finishing) textile factory premises or connection to a combined ETP for all WDF firms is mandatory under the ECR 97 since these firms belong to Orange-B and Red categories.
- Relocating Hazaribagh Tanneries
- Finalize demarcation of the declared ECAs;
- Declaration of Marine Ecologically Critical Areas
- BIWTA to enforce the 50-metre buffer zone along rivers and canals
- Updating the Environment Policy 1992 and National Environmental Management Action Plan
- Reduce water use and consumption by 25% and reduce wastewater generation in processing activity by 25% of the current level

The strategies for achieving the goals and objectives will be as follows:

- Control of pollution of the rivers in which the main actor will be the Ministry of Environment in collaboration with other concerned agencies
- Prevent further deterioration of water logging, blockade of water-flows and shrinkage of water-bodies by infrastructures like embankment, roads, urban housing projects and industrialization.
- The protected area (PA) coverage will be increased to 15 percent of the total forest land during the 7th Five Year Plan period. Carbon stock will be measured in all potential PAs and programmes for forest conservation along with people's welfare to be taken under Clean Development Mechanism and REDD+ initiatives.
- Moratorium on felling in the natural forests will continue.
- To prevent the extent of damage by cyclones and tidal surges, creation of 500 meter wide permanent Coastal Green Belt along the coast will be continued and remaining vacant spaces will be brought under tree cover
- 5000 ha of Reedlands in Sylhet regions will be planted
- NGOs will be more directly involved in afforestation programme
- Establish and maintain fish and wetland sanctuaries which will comprise complete ban on fishing in certain eco-sensitive areas like Sundarbans, parts of Kaptai Lake, and several sections of the river Halda, selected beels and haor areas and certain sections of the Bay of Bengal etc. Similarly, along the major rivers having parallel channels, selected ones will be preserved.
- Introduce low-sulphur diesel and compatible standards vehicles
- Introduce energy efficient affordable technology

3. Stakeholder Analysis

Attempts have been made to identify key stakeholders involved in the environmental pollution – policy makers, regulators, polluters, inhabitants – form the major such group in general. The group discussed in the matrix below is made up from many Govt and autonomous organisations such as Ministry of Environment & Forest, Department of Environment, Department of Public Health Engineering, Bangladesh Water Development Board, City Corporations of Dhaka (both North and South), Chittagong, Khulna and Rajshahi, Water Supply and Sewerage Authorities of Dhaka, Chittagong and Khulna, Bangladesh Export Processing Zone, etc. The major stakeholders mentioned above plus other stakeholders and their roles are briefly discussed in the following table:

Table 10: Stakeholder Matrix

SI No	Name of the Stakeholder	Relevant Role	Strength and Weakness
1	Ministry of Environment and Forest (MoEF)	Nodal agency for planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programs	<p>Strength: Environmental Acts, Rules and Policies Collaboration with Development Partners</p> <p>Weakness: Shortage of manpower Lack of research cell Lack of integrated database</p>
2	Department of Environment (DoE)	Planning, promotion, co-ordination and overseeing the implementation of environmental programs. Enforcement of Environmental Rules and Regulations	<p>Strength: Environmental Acts, Rules and Policies Collaboration with development partners, local people and NGOs Office establishment up to district level</p> <p>Weakness: Lack in manpower, lab facilities (at district level) Lack of integrated database Conventional monitoring for water quality monitoring</p>
3	Department of Public Health and Engineering (DPHE)	Provide drinking water supply and waste management facilities in cities and rural areas other than Dhaka, Rajshahi, Khulna and Chittagong cities	<p>Strength: Good lab facilities Collaboration and cooperation with development partners, local people, NGOs Relevant plans on water supply and sanitation</p> <p>Weakness: Lack in manpower and laboratory facilities at district and upazila Level Conventional monitoring system of drinking water quality</p>
4	Dhaka City Corporation (North and South)	Provide solid waste management facilities in Dhaka city	<p>Strength: Collaboration and cooperation with development partners, local people, NGOs Good Infrastructure</p>

SI No	Name of the Stakeholder	Relevant Role	Strength and Weakness
			<p>Weakness:</p> <p>No long term plan for further development of waste management In Dhaka city after expiration of Clean Dhaka Master Plan project Land scarcity for waste disposal Lack of skilled man power in waste management Limited equipment and resources for waste management</p>
5	Dhaka Water Supply and Sewerage Authority	Provide drinking water supply and waste water management facilities in Dhaka city	<p>Strength</p> <p>Upgraded system for providing water supply to the city inhabitants and its cost recovery. Digital Map of water supply, sewerage and drainage network</p> <p>Weakness</p> <p>Limited capacity of sewerage treatment</p>
6	Chittagong City Corporation	Provides solid waste management facilities	<p>Strength:</p> <p>As a local government, CCC has great opportunities to work on the environmental as well as development sector of Chittagong city The role of CCC in the education and health care sector is noteworthy</p> <p>Weakness:</p> <p>Dependency on Central Government for Funding Lack of inter-departmental coordination Failure to control the problem of drainage congestion and water logging especially during the rainy season Lack of human resources and lack of functional accountability in the corporation's work. Lack of material and economic resources of CCC</p>

SI No	Name of the Stakeholder	Relevant Role	Strength and Weakness
7	Chittagong Water Supply and Sewerage Authority	Provides drinking water supply and waste water management facilities in Chittagong city	<p>Strength: Improvement in capacity and reducing system loss Digital bill pay system.</p> <p>Weakness: Limited capacity to provide clean water to all city inhabitants Frequent increase of water price causes dis- satisfaction among the users.</p>
8	Khulna City Corporation	Provides solid waste management facilities, takes initiatives to protect rivers surrounding the city (Mayur, Rupsa, etc) from pollution	<p>Strength One of the oldest city corporations/municipalities in the country Master Plan</p> <p>Weakness Limited capacity in dealing with sewerage Clearance of DoE's of a new land fill site is in pending</p>
9	Khulna Water Supply and Sewerage Authority	Provides drinking water supply and wastewater management facilities in Khulna city	<p>Strength Good Collaboration with development partners New Development plan for increasing capacity of water treatment</p> <p>Weakness Lack in integrated planning with collaboration and cooperation of KDA, KCC, etc. Lack of skilled manpower in environmental sector Lack of capacity in treating wastewater</p>
10	Rajshahi City Corporation	Provide drinking water supply and waste water management facilities in Rajshahi city	<p>Strength New Development plan for increasing capacity of water treatment</p> <p>Weakness Lack in integrated planning with collaboration and cooperation of RDA, RCC, etc. Lack of skilled manpower in</p>

SI No	Name of the Stakeholder	Relevant Role	Strength and Weakness
			environmental sector. Lack of capacity in treating waste water
11	Bangladesh Export Processing Zone Authority	Regulatory authority of EPZs, also oversees the environmental protection programs in EPZs.	<p>Strength Strong establishment in terms of infrastructure, legal platform and participation of stakeholders Environmental outreach program to aware its stakeholders</p> <p>Weakness Lacks in law enforcement Lacks in cooperation with DoE Limited availability of Land and technology for setting up ETPs</p>
12	Department of Agriculture Extension (DAE)	DAE is a service oriented Govt organization; provide awareness and train farmers about fertilizer use, pesticide use, advance technology for agriculture. Promote sustainable agricultural practices, Integrated Pest Management, etc.	<p>Strength Establishment up to Upazila level and communication network up to village level Participation of farmers in different planning process</p> <p>Weakness Lacks in manpower Lacks in sufficient establishment at union level No provision of environmental division to make local farmers aware about environmental issues</p>
13	Dhaka Transport Co-ordination Authority	Advises the concerned agencies on an integrated and safe traffic and transportation system for Dhaka and to make necessary arrangements to fulfil the purpose Co-ordinates the traffic and transportation infrastructure development plan.	<p>Strength Special attention of GOB Has mandate to provide technical support to 32 government agencies which are working in development sectors</p> <p>Weakness Lack of manpower</p>
14	Department of Inspection for Factories and Safety	Monitoring and ensuring compliance of labour laws, better working environment, workplace safety, and workers' welfare, health and safety.	<p>Strength Industrial acts and rules</p> <p>Weakness Shortage of manpower Shortage of skilled inspector in the field of environment No collaboration with DoE</p>
15	NGO Forum	A national level NGO works with water	Strength

SI No	Name of the Stakeholder	Relevant Role	Strength and Weakness
		pollution issues	<p>A good network of NGOs and GOs working in the field of WATSAN (Water & Sanitation)</p> <p>Pioneer NGO in WATSAN sector</p> <p>Advance Laboratory facilities</p> <p>Weakness:</p> <p>Limited scope of research facilities</p> <p>Laboratory facilities at field level</p>
16	Bangladesh Environmental Lawyers Association	An association of lawyers works with environmental justice and environmental regulatory issues.	<p>Strength</p> <p>A good network of environmental activists</p> <p>A pool of environmental lawyers</p> <p>Acceptability and trust</p> <p>Weakness</p> <p>Limited research facilities</p>
17	Soil Resources Development Institute (SRDI)	Govt institute with a mandate of soil survey and analysis with the aim of providing necessary information to farmers and other agencies for necessary research and implementation work. It suggests soil management practices applicable for different soil including degraded soil. It also suggests measures to prevent soil degradation and pollution from agricultural practices.	<p>Strength</p> <p>Only 15 regional laboratories</p> <p>Good database on soil quality, formation, and soil profile of the country</p> <p>Initiate digital system to provide information</p> <p>Weakness</p> <p>15 laboratories are inadequate to deal with the present workload</p> <p>Limited research facilities</p> <p>Lack of manpower</p>
18	Bangladesh Garment Manufacturers and Exporters Association (BGMEA)	A trade association of the readymade garment industries in Bangladesh. It mostly does the policy advocacy and awareness campaign to ensure enabling environment for business, worker's right, safety and social compliances. Since it is an association of the garments industries, it has a role in advocating environmental regulation to the industries owners and advocating policy for betterment of the business and worker's right to the government level	<p>Strength</p> <p>Major export earner</p> <p>It has around 4222 member factories.</p> <p>Being a trade association, it has a kind of parental control over its member factories.</p> <p>Good relation with Government and readymade garments industries</p> <p>Weakness</p> <p>It does not have any regulatory authorities</p>
19	Bangladesh Knit Manufacturers and Exporters Association	The trade association of knit manufacturers and exporters. BKMEA mostly does the policy advocacy and awareness growing within its members and workers. BKMEA carries out the following services:	<p>Strength</p> <p>Good network with government, member factories, and international development partners</p>

SI No	Name of the Stakeholder	Relevant Role	Strength and Weakness
		Product diversification & market promotion Consultancy for green industry development Social and environmental compliance Research and development Productivity improvement Fire-fighting technique Civil engineering assistance One stop service point regarding UD/UP other necessary services within the shortest possible time	Weakness Does not have any regulatory authority
20	Bangladesh Agricultural Research Council (BARC)	Govt body under the Ministry of Agriculture to coordinate, monitor and control the quality of research activities in the sector of agriculture, fisheries and livestock. BARC also formulates and implements large scale research plans by its member organizations	Strength BARC is in a position to integrate research plan, coordinate research activities in the sectors of agriculture, fisheries and livestock and make link with environmental issues Weakness No units/department dedicated for environmental issues, agricultural pollution mitigation, etc.
20	Bangladesh Water Development Board (BWDB)	Autonomous Government body (under the ministry of water resources) to plan and implement water management projects/programs to ensure safety from water related disaster	Strengths Water Act, national Water Management Plan and other relevant acts give MoWR and BWDB to plan and implement water management projects in an integrated way Adopted policy of participatory approach of water management and planning Weakness No dedicated department/unit to deal with environmental issues Very much rigid on engineering intervention Less financial resources for operation and maintenance Lack of integration with Department of Environment to take up any environmental restoration project or River Ecosystem Health Improvement Project.

Source: CEGIS

4. Existing Situation/State of Environmental Pollution

4.1. Priority Areas and Hotspot

In the context of the Delta Plan 2100, the baseline studies have been carried out considering priority areas and hotspots to accelerate the process and realize the data gap. The priority areas/issues are listed below:

Priority Area	Hot Spot
Air Pollution	Major cities such as Dhaka, Chittagong, Khulna, Sylhet, Rajshahi, Barisal, Gazipur and Narayanganj
Water Pollution	Major rivers such as Padma, Ganga, Jamuna and Meghna; also rivers around the major cities Rivers around Dhaka and Narayanganj – Buriganga, Shitalakhya, Turag Rivers near Chittagong city – Karnaphuli, Halda Rivers besides Barisal city – Kirtonkhola River besides Sylhet city – Surma Rivers besides Khulna city – Moyuri, Rupsa Rivers across the Sundarbans and Mongla Port – Rupsa and Passur
Soil Pollution	Ship breaking waste contaminated area – Chittagong coast Industrial polluted area – Dhaka, Gazipur
Waste Management	Major cities: Dhaka, Chittagong, Khulna, Barisal, Sylhet, Gazipur, Narayanganj
Noise	Major cities

Source: CEGIS

4.2. Air Pollution

Bangladesh has ranked fourth among 91 countries with worst urban air quality according to the latest air pollution monitoring report of World Health Organization (WHO).⁴ Moreover, three cities of Bangladesh are in the list of 25 cities with poorest air quality among 1600 cities of 91 countries.⁵ Air pollution can be very detrimental to public health and it can even cause premature death. In general, the pollutants in the air mainly affect the lungs of human body and causes irritation and/or respiratory problems. It is assumed that around 20%-80% decrease in air pollution level in Bangladesh would save approximately 1,200-3,500 lives annually. Additionally, 80 to 230 million cases of health problem would also decrease if the air pollution level can be dropped to the mentioned level.⁶ The world-wide scenario of air pollution consequences is no less frightful. According to WHO, air pollution is associated with around 7 million premature death every year⁷. It is expected that the current national environmental policy of Bangladesh includes some new instruments or initiatives like Environmental Auditing, Air Quality Index, and Emission Tax etc.; which, if enforced properly, will definitely help in decreasing the air pollution level of Bangladesh.

⁴ <http://www.thedailystar.net/bangladesh-4th-most-polluted-in-world-23348>

⁵ *ibid*

⁶ http://www.case-moef.gov.bd/index.php?option=com_content&view=article&id=3&Itemid=18

⁷ www.who.int/mediacentre/news/releases/2014/air-pollution/en/

4.2.1. State of Pollution

Air Quality Standard

Recently Ministry of Environment and Forest has revised the ambient air quality standard reviewing the similar standards of neighbouring countries, WHO standard and US standards. In the following table the revised standard has been compared with other international standards.

Table 11: Comparison of Bangladesh’s ambient air quality standard with India, Nepal, USA and WHO

Pollutant	Averaging time	Bangladesh Standard	India Standard	Nepal Standard	USA Standard	WHO Standard
CO (mg/m ³)	8 hr	10	2	10	10	10
	1 hr	40	4	100	40	30
Pb (µg/m ³)	Annual	0.5	-	-	0.15	0.5
SPM	8 hr	200	-	-	-	-
Coarse	Annual	50	60	-	-	20
PM ₁₀ (µg/m ³)	24 hour	150	100	120	150	50
PM _{2.5} (µg/m ³)	Annual	15	40	-	15	10
	24 hour	65	60	-	35	25
O ₃ (µg/m ³)	1 hour	235	100	-	235	-
	8 hour	157	180	-	157	100
NO _x (µg/m ³)	Annual	100	40	40	100	-
SO ₂ (µg/m ³)	Annual	80	50	50	78	-
	24 hour	365	80	70	365	20

Ambient Air Quality of the Country

Recently, Ministry of Environment and Forest has initiated a project named “Clean Air & Sustainable Environment”, with the aim of improving the air quality of the country. Under this project, DoE has established 11 Continuous Air Monitoring Stations (CAMS) in 8 major cities of Bangladesh viz. Dhaka, Chittagong, Gazipur, Narayanganj, Sylhet, Barisal, Khulna and Rajshahi. Among the 11 fixed CAMS, 3 stations are in Dhaka and 2 stations are in Chittagong while the other cities have got 1 station each. The state of the ambient air quality as well as air pollution has been discussed with respect to the concentration of SO₂, NO₂, CO, PM_(10, 2.5), SPM and O₃ recorded in the abovementioned 11 monitoring stations.

Sulphur Dioxide (SO₂): The one year recorded data of 11 CAMS shows that concentration of SO₂ in ambient air was within the standard limit (Figure 1). Among the 11 monitoring stations, highest SO₂ concentration, 30.6 ppb, was found at Khulna CAMS in September. In general, it is obvious from the figure that SO₂ concentration remains high in the months of November to March and remains lower in the months of April to August. The dry periods contained comparatively higher level of SO₂ in the air.

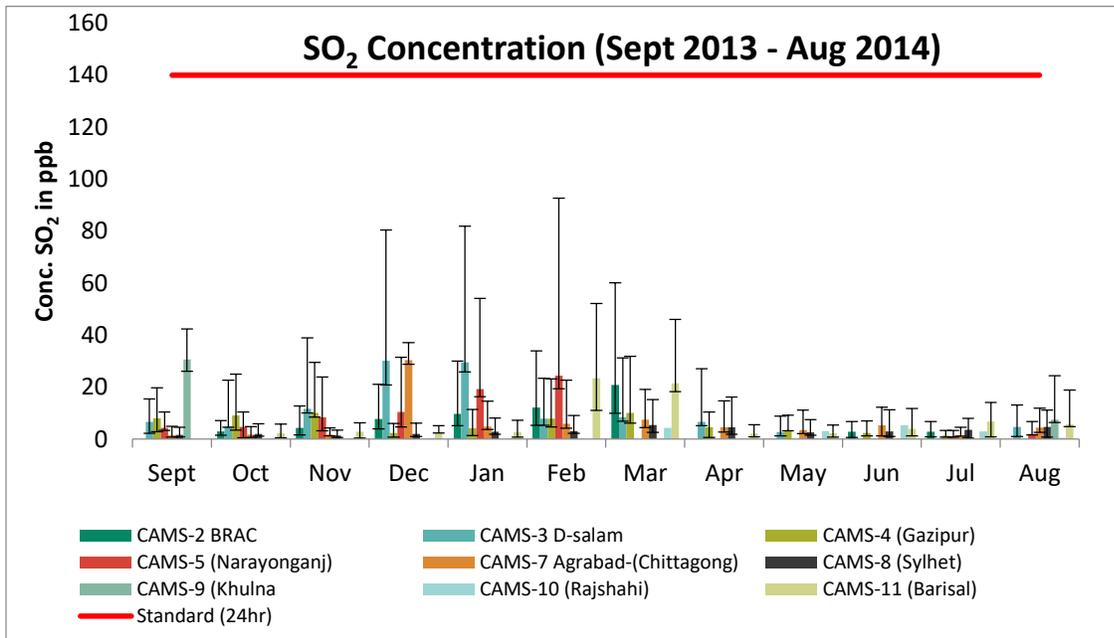


Figure 1: Concentration of SO₂ in major cities of Bangladesh (September, 2013- August, 201)

Nitrogen Dioxide (NO₂)

The standard for NO₂ in Bangladesh is 53 ppb (annual) which was exceeded very frequently in almost all the major cities. Like the SO₂ concentration, the concentration of NO₂ is higher from November to March, which are comparatively drier months of the country (Figure 2). The highest concentration of NO₂ was 191 ppb and found in Dhaka CAMS-2 BARC station during December, 2013. The number of days NO₂ exceeded the standard level is presented in Figure 3. From the analysis it was found that worst situation is in Rajshahi (CAMS 10) where the highest standard was exceeded for the highest number of day (139 day) in a year.

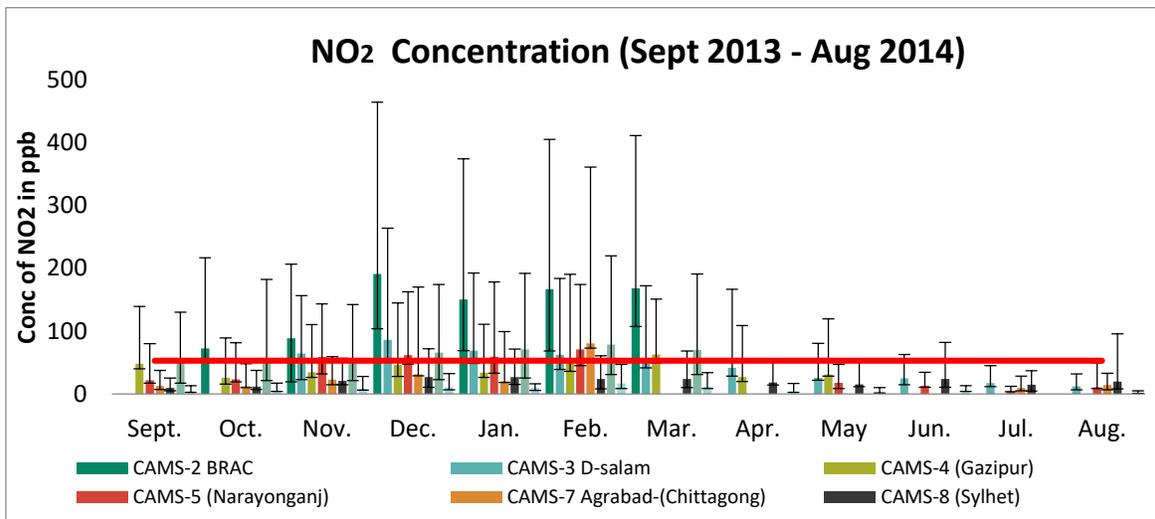


Figure 2: Concentration of NO₂ in major cities of Bangladesh (September, 2013- August, 2014)

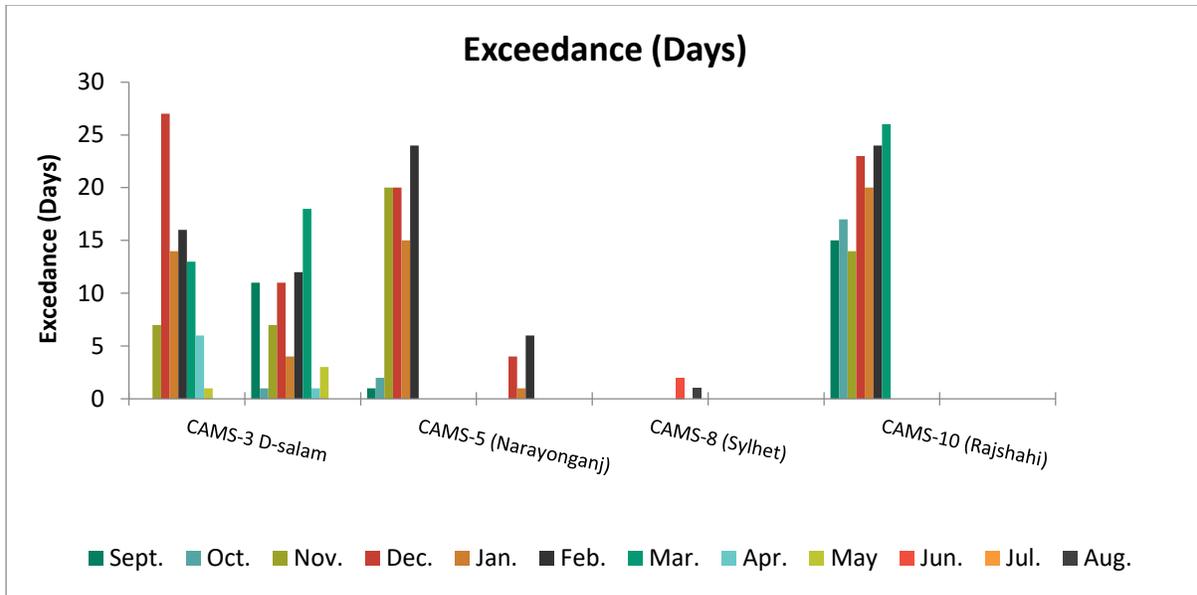


Figure 3: Number of Days-NO₂ exceeded the standard (September, 2013 – August, 2014)

Carbon Monoxide (CO)

Though the monthly averages of daily concentration are within the standard limit, the standard was found exceeding in several days in a month (Figure 4). The monthly maximum and minimum are shown by vertical bar (like error bar) in each column. The maximum occurrence of CO was recorded in CAMS-3 D-Salam Station in Dhaka in January, 2014 whereas the minimum concentration was recorded during July, 2014 in CAMS-5 Narayanganj.

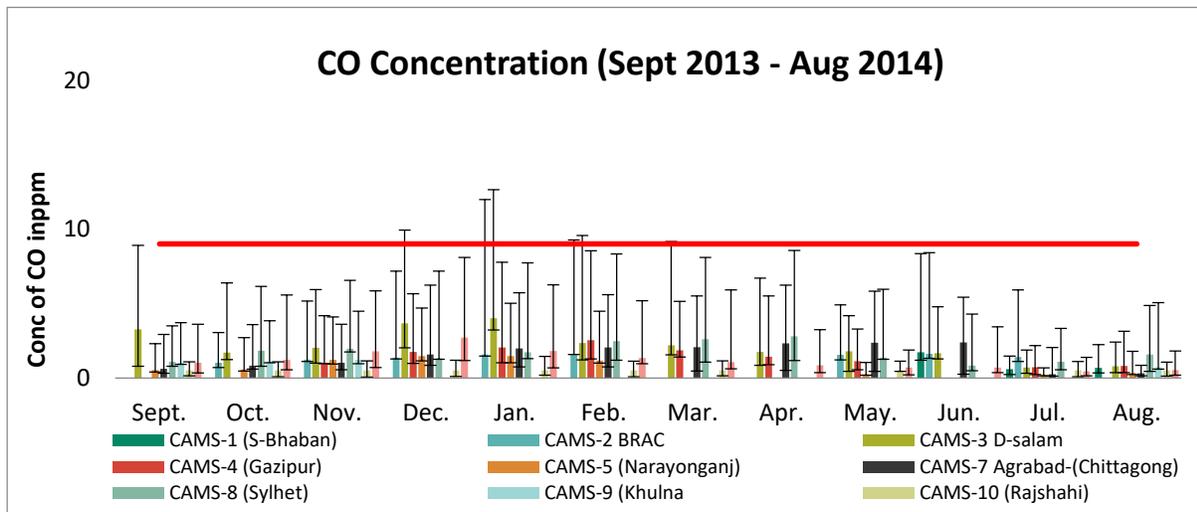


Figure 4: Concentration of CO in major cities of Bangladesh (September, 2013- August, 2014)

Ozone (O₃)

Similar to CO, the concentration of Ozone (O₃) was also found below the standard limit (80 ppb, 8 hour) in all the stations except two exceptional days CAMS 3 (D-Salam) and CAMS-11 (Barisal). The maximum monthly average of daily concentration of O₃ was 25.1 ppb, recorded in CAMS-11-Barisal station during April, 2014 whereas the lowest was 1.38 ppb, found in CAMS-10-Rajshahi (Figure 5).

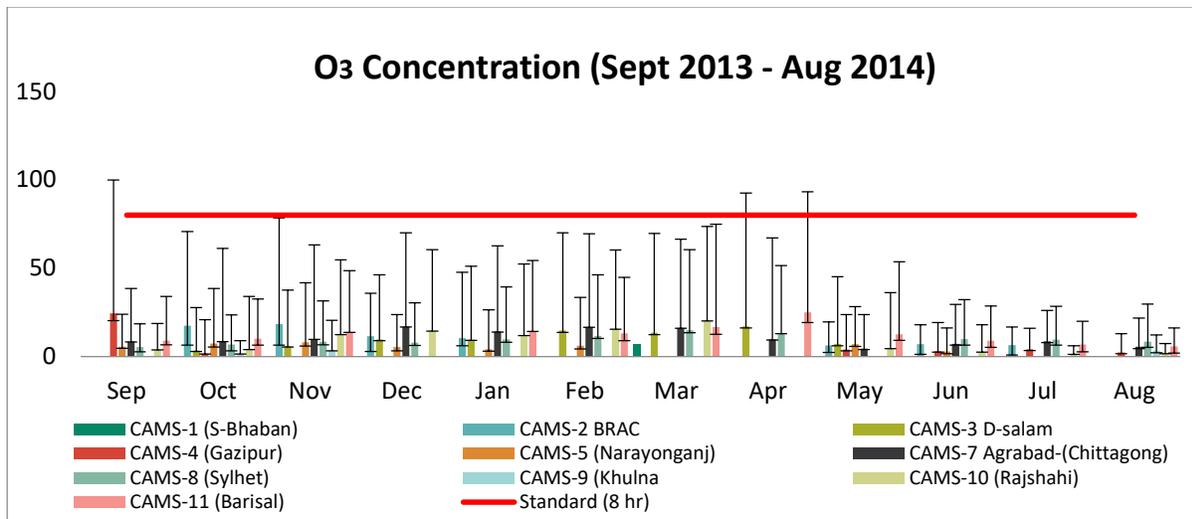


Figure 5: Concentration of O₃ in major cities of Bangladesh (September, 2013- August, 2014)

Particulate Matter (PM_{2.5} and PM₁₀)

Concentration of Particulate Matter in ambient air is highly alarming. The monthly average of daily concentration was found above the standard in the months of November to April. Dhaka, Narayanganj, Gazipur, Chittagong and Barisal are in worst condition. The tendency of exceeding the standard was seen in all cities. However, the highest daily concentration of PM_{2.5} (325µg/m³) was recorded in CAMS-5-Narayanganj in January. In general, during the dry months of the year, the concentration of PM_{2.5} reaches higher, and during the wet periods the concentration becomes lower (Figure 6). It was found from the analysis that the highest number of exceedance of standard occurred in CAMS-4-Gazipur station where the standard was exceeded for 158 days in the months between September 2013 and August 2014 (figure 7).

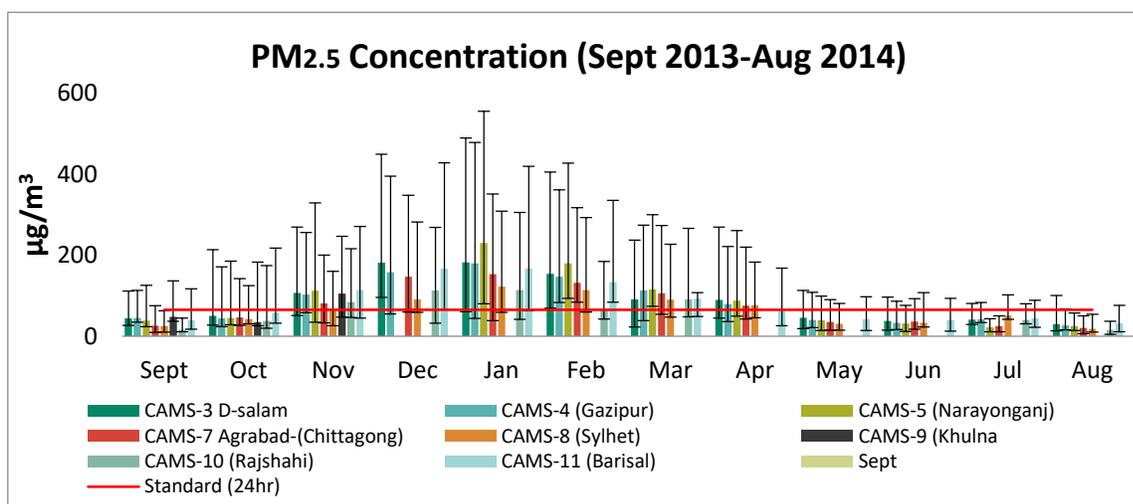


Figure 6: Concentration of PM_{2.5} in major cities of Bangladesh (September, 2013- August, 2014)

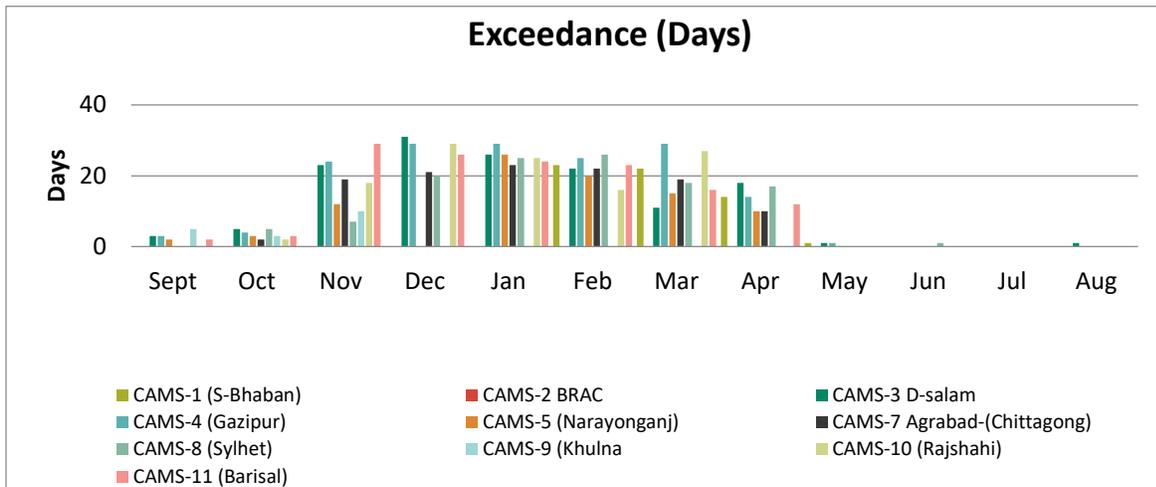


Figure 7: Number of Days-PM_{2.5} exceeded the standard (September, 2013 – August, 2014)

The standard limit for PM₁₀ is 150 µg/m³ (8 hr) in Bangladesh, which was also very frequently exceeded in different stations. The maximum concentration (325µg/m³) was recorded in CAMS-5-Narayanganj stations during January, 2014. Like PM_{2.5}, the seasonal variation of PM₁₀ concentration can also be seen from Figure 8 and Figure 9. The highest number of exceedance day was 158, which was found in CAMS-4-Gazipur station. However, during December, 2013 in CAMS-3 D-Salam station, the standard was exceeded for all the 31 days, which was the highest number of exceedance in a month for PM₁₀.

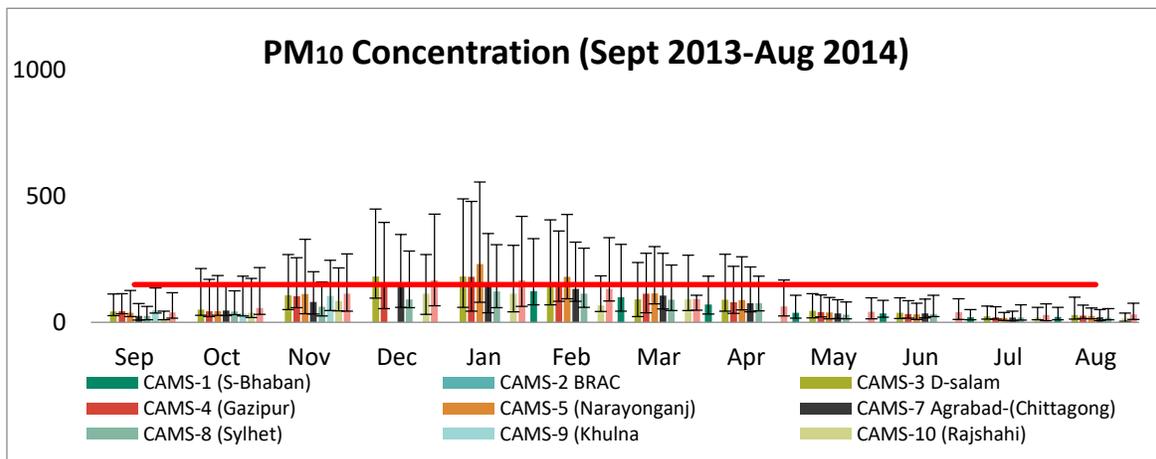


Figure 8: Concentration of PM₁₀ in major cities of Bangladesh (September, 2013- August, 2014)

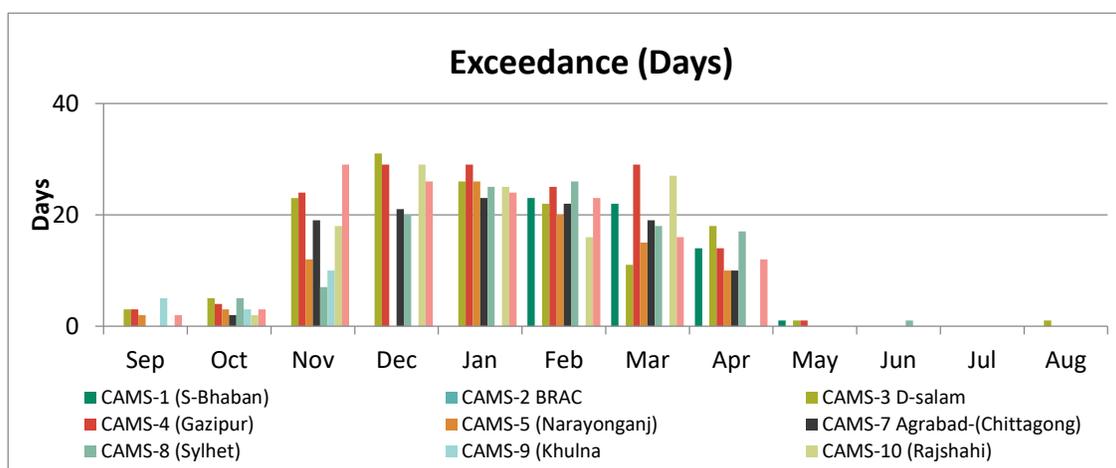


Figure 9: Number of Days-PM₁₀ exceeded the standard (September, 2013 – August, 2014)

Air Quality Index

Bangladesh has also developed an Air Quality Index (AQI), which is basically a quick and effective parameter to portray the ambient air quality relative to the national air quality standard. According to AQI system, the air quality is reported daily and it depicts how polluted the ambient air quality is. Different countries assign different colours and values for the same potential risk. The AQI system of Bangladesh is based on 5 different pollutants such as Particulate Matter (PM_{2.5} and PM₁₀), NO₂, CO, SO₂ and O₃. Bangladesh has upgraded the AQI scheme very recently from a previous version as the previous one did not appropriately consider the values above long term standard concentration and did not clearly assert the impacts on sensitive groups, children and elderly people. For a better and comparative understanding both the previous scheme and present scheme of AQI indexes are presented in Table 12 and Table 13 respectively.

Table 12: Previous AQI scheme of Bangladesh

AQI Value	Level of Concern	Colours
0-100	Good	Green
101-150	Moderate	Yellow
151-200	Unhealthy	Orange
201-300	Very Unhealthy	Red
301-500	Extremely Unhealthy	Purple

Table 13: Present approved AQI scheme for Bangladesh

AQI Value	Level of Concern	Colors
0-50	Good	Green
51-100	Moderate	Yellow Green
101-150	Caution	Yellow
151-200	Unhealthy	Orange
201-300	Very Unhealthy	Red
301-500	Extremely Unhealthy	Purple

Based on the currently approved AQI scheme, the air quality status of Bangladesh from February 17 to March 31, 2014 and from May to August 2014 is presented in the Figures 10 and 11. The AQI is worst in February and March and it improves in May to August. This AQI were calculated by CASE project of DoE. As per the AQI data, air quality in Gazipur is the worst. In the months between February and May, AQI was unhealthy to extremely unhealthy for 100% days. In case of Dhaka for the same period, AQI was unhealthy for 95% days. In general, more than 70% days in the months from February to May, AQI was unhealthy to extremely unhealthy. From May to August, most of the days were of moderate and caution state. Among the eight cities, situation in Barisal from May to August is the worst where 100% days were of moderate and caution state.

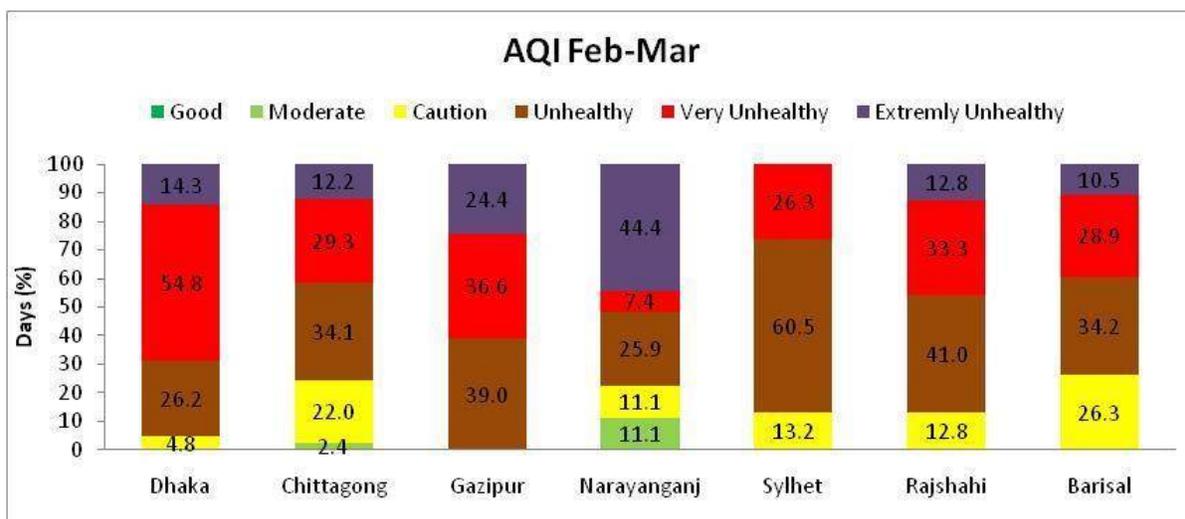


Figure 10 : Air quality status of Bangladesh (Feb 2014 – Mar 2014)

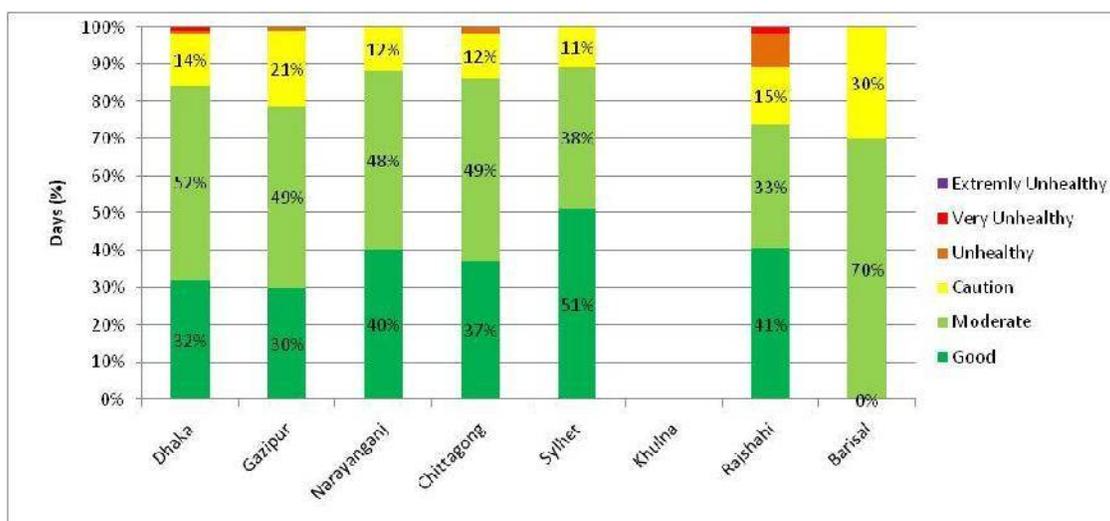


Figure 11: Air quality status of Bangladesh (May 2014 – August 2014)

4.2.2. Sources and Causes of Pollution

The sources of air pollution of Bangladesh can be divided into three major categories such as point, non-point and trans-boundary sources of air pollution.

Point Sources Different types of industries and factories which emit smoke can be considered as point sources of pollution such as brick kilns, pulp and paper mills, textile industries, steels re-rolling mills, power plant (natural gas, diesel and furnace oil based), fertilizer (urea, TSP), cement, plastic, chemical industries/factories and many more. These sources can also be mentioned as stationary sources of air pollution.

Non-Point Sources The major non-point or mobile source of air pollution in Bangladesh is the vehicular transports. Most of the vehicles, especially trucks and buses, which run on the roads of Bangladesh are generally old, overloaded and poorly maintained. A survey conducted by DoE reveals that approximately 90% of the vehicles in Dhaka are defective and emit high level of pollutants into the air. Though the total number of vehicles in Dhaka as well as in Bangladesh is less than the number of total population, use of impure fuel and lube oil, high-sulphur diesel and lack of proper maintenance and traffic congestion, have made the transport sector as the main non-point source of air pollution.

Some of the human activities in our country such as open burning, disposal of solid waste in open places, brick/stone crushing, sand storage for construction activities etc, are also non-point sources of air pollution in Bangladesh.

Trans-boundary Sources Though there is no mentionable government data available, the trans-boundary air pollution issue of Bangladesh is clearly confirmed from some discreet scientific literature that the trans-boundary air pollution impacts the state of air of Bangladesh negatively. A trajectory analysis for identifying the trans-boundary air pollutants in Sathkhira in Bangladesh affirms significant impact on air quality from trans-boundary sources (Saadat, Rahman, Hasan, & Alam, 2013). Another study asserts that PM concentration during winter is adversely impacted by trans-boundary movement of pollutants (Nasiruddin, Division, & Centre, 2009). However, both the study mentions the impact of wind direction and seasonal variation on the trans-boundary movement of the pollutants.

4.3. Water Pollution

Water pollution has been investigated through reviewing secondary data sources, which include information from the National Water Resources Database (NWRD) and Bangladesh Bureau of Statistics (BBS), several published journals and manuscripts, and the documents and reports of different national level studies carried out in different hydrological regions of Bangladesh. To develop an insight on the existing status of water pollution, the prominent sources and causes have firstly been identified through literature review.

Later, the state of water pollution has been investigated, by evaluating the seasonal values of several significant water quality parameters. The state of water pollution has been discussed two-fold, considering an urban river context and major river systems context. The urban river pollution has been assessed through the review of several existing literature, which are confined within the perennial rivers in and around Dhaka City.

To draw the state of river water quality, the pH and DO have been considered. Ministry of Environment and Forest defined four parameters i.e. BOD, DO, pH and Total Coli form as regulatory parameter in the inland water quality standard. Out of the four, DO, BOD and pH data are available. The name of the rivers selected for this thematic baseline study is listed in **Table 14**.

Table 14: List of the selected Rivers and Water Quality Monitoring Stations of BWDB

SI No	Rivers	Adjacent Cities
1	Buriganga	Dhaka
2	Shitalakhya	Dhaka, Narayanganj
3	Turag	Dhaka, Savar
4	Meghna	Chandpur, Barisal
5	Jamuna	Sirajganj

SI No	Rivers	Adjacent Cities
6	Padma	Faridpur, Rajshahi
7	Kirtankhola	Barisal
8	Passur	Mongla, Sundarbans
9	Rupsa	Khulna
10	Moyuri	Khulna
11	Karnaphuli	Chittagong
12	Halda	Chittagong
13	Surma	Sylhet

4.3.1. Water Quality Standard

The obtained values of water quality were compared with the standard values set by the Department of Environment (Table 15) to assess their suitability in compliance with the country's major surface water uses (irrigation and fishing). Reports from a number of recently carried out national level feasibility studies have been reviewed to cluster supplementary information on water quality for different hydrological regions.

Table 15: Water quality standards for Bangladesh

Water quality parameters	Standard value	Water use
pH	6.5 – 8.5	Irrigation
		Fishing
		Recreation
DO (mg/l)	5 or above	Fishing
		Irrigation
		Recreation
BOD	10 or less	Irrigation
	5 or less	Fishing
	3 or less	Recreation
Total Coliform	1000 or less	Irrigation
	---	Fishing
	200 or less	Recreation

Source: Environmental Conservation Rules 1997

4.3.2. State of Surface Water Pollution

For having a comprehensive understanding about the state of pollution in the rivers of Bangladesh, the pollution level of the rivers is analysed here. However, as there are more than 220 rivers in Bangladesh, it is difficult to consider all the rivers in the analysis and as such, it is kept limited to the rivers beside the major cities of Bangladesh. A total of 13 rivers are considered which are situated beside the major cities such as Buriganga (beside Dhaka), Shitalakhya (beside Dhaka, Narayanganj, Ghorashal), Turag(beside Dhaka; upper tributary of Buriganga), Jamuna (beside Rajshahi), Meghna (besideChadpur, Barisal,), Padma (beside Rajshahi, Kushtia), Karnaphuli (beside Chittagong), Halda (beside Chittagong), Moyuri (beside Khulna-Satkhira), Rupsa (beside Khulna), Passur (beside Khulna and Sundarbans), Kirtonkhola (beside Barisal), and Surma (beside Sylhet). The parameters which are considered in this study to understand the river pollution level are pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD5), and Chemical Oxygen Demand (COD).The analysis is based on river water quality data of 2012 and 2011 collected, analysed and published by Department on Environment (Department of Environment, 2012, 2013).

Buriganga River

Only pH level of Buriganga River is within the limit and it varies from 6.4 to 7.9, whereas, the standard level for inland surface water is within 6.5 to 8.5. The standard level of BOD₅ is ≤6 mg/l, whereas the maximum level of BOD₅ in Buriganga River was 48 mg/l at Kamrangir Char in May and the minimum level was found 1.0 mg/l at Hazaribag in September. Analyzing the data of the whole year, it was found that the BOD level was the lowest during the wet months (i.e. July, August, September, and October); though the level of BOD was found pretty much higher than the standard values. However, the level of COD was found below the standard level (200 mg/l) almost throughout the year. The highest and lowest concentration of COD was recorded as 283 mg/l and 5 mg/l at Hazaribag point during December and September respectively.

According to Environmental Quality Standard (EQS), the minimum level of DO for fish should be 4-6 mg/l, whereas, the DO level of Buriganga river, at almost all the points was found near to zero in the first four months of the year, and it increased only slightly during the wet season. The heavy metal concentration in Buriganga is much higher than the threshold limit (Mohiuddin et al., 2011), as seen in Table 16. Heavy metals were also found in fish of Buriganga river (B. Ahmed, Rasel, & Miah, 2013).

The status of other water quality parameters is also alarming at some locations of the Buriganga River. However, there are some issues of reliability in the river water quality data so far available in different published literatures and secondary sources.

Shitalakhya River

It is a distributary of Bramhaputra River. The minimum level of pH was found 6.7 in November near ACI point and the maximum level was found as 8.64 near Demra Ghat during September. In the first three months of the year, no DO was found in this river near Demra ghat. On the other hand the maximum recorded concentration of DO was 6.2 mg/l during February near Ghorashal Fertilizer Factory. The overall level of DO was found better during the month of July. The concentration of BOD was found within the limit throughout the year at the point near Ghorashal Fertilizer Factory. The highest value of BOD was found 16 mg/l at Demra ghat in the month of April and the lowest value was found 2.0 mg/l at Demra ghat during July. COD level was found within the limit throughout the year at all the considered points of this river.

Table 16: Concentration of Heavy Metal in Buriganga River

Seasons	Stations	Pb (µg/L)	Cd (µg/L)	Ni (µg/L)	Cu (µg/L)	Cr (µg/L)
Pre-monsoon	Balughat	62.34	9.21	10.05	145.03	645.26
	Sadarghat	71.09	8.45	8.52	132.18	605.87
	Faridabad	58.17	10.03	8.96	135.65	613.25
Monsoon	Balughat	64.05	8.19	7.62	107.38	586.27
	Sadarghat	62.36	7.08	9.05	201.29	557.16
	Faridabad	72.45	10.15	10.32	187.65	489.27
Post-monsoon	Balughat	70.19	9.05	9.13	175.27	605.13
	Sadarghat	65.28	12.33	7.15	193.82	578.25
	Faridabad	63.15	9.25	8.43	189.57	604.34
Average +/- SD		65.45+/-4.78	9.34+/-1.47	8.80+/-1.02	163.09+/-33.53	587.20+/-44.14

Source: (M. K. Ahmed, Islam, Rahman, Haque, & Islam, 2014)

Turag River

Turag is the upper tributary of Buriganga River. The pH level of this river varied from 6.7 to 8.4 which were within the suggested EQS limit. The DO level was found very low in this river and it was found zero from March to June. However, during the wet season the concentration of DO increased a bit though in most of the cases it was below the standard limit. The concentration of BOD varied from 5.0 mg/l to 38 mg/l in 2012. The maximum concentration was recorded in April at Pagar, Tongi whereas the minimum concentration was recorded in November at north side of the Tongi Bridge. The maximum and minimum concentration of COD was recorded as 290 mg/l and 9 mg/l in December and in October respectively.

Jamuna River

The level of pH varied from 7.2 to 8.46 which were within the EQS limit. The minimum pH was recorded in September at Bahadurabad Ghat and the maximum level was found at Jamuna Fertilizer Factory. DO was measured only at Jamuna Fertilizer Factory point and throughout the year the DO level was found higher than the minimum limit for fisheries. The concentration of DO varied from 5.9 mg/l to 8.5 mg/l. The maximum level of BOD was recorded at 11 mg/l and minimum level was recorded at 2.8 mg/l. However, in case of Jamuna River, the data was not recorded continuously. Therefore, the seasonal variation of BOD could not be ascertained from the available data. No data is available for COD for Jamuna River.

Meghna River

Throughout the year the level of pH was within the EQS limit. The level of pH varied between 6.24 (in September near Bhairab Bazar) and 7.6 (in November at Chandpur). The DO level was found higher than the minimum EQS level for fisheries throughout the year. Likewise, the concentration of BOD was also found within the EQS standard throughout the year. The maximum and minimum concentration of BOD was recorded 3.4 mg/l in October and 0.3 mg/l in July respectively. The COD concentration in the Meghna River varied from 3.0 mg/l to 2.0 mg/l which were also within the EQS limit.

Padma River

Padma is a major trans-boundary river of Bangladesh. The level of pH varied from 6.0 to 7.8, whereas the standard limit for pH is within 6.5 to 8.5. The lowest level of pH was recorded at Pakshi Ghat in October which was a slightly more acidic than the standard limit. The maximum level of pH was recorded at Barokuti Ghat Bank. The concentration of DO was higher than the minimum EQS standard throughout the year and it varied from 5.4 mg/l to 8.26 mg/l. The BOD load varied between 1.15 mg/l and 2.8 mg/l. The maximum load of BOD was recorded in July and minimum load was recorded during November.

Karnaphuli River

Karnaphuli River flows beside the Chittagong City. The Largest sea port of the country is located at the bank of this river. The river has ecological significance also.

According to the published data of DoE, collected at four points in two locations, the river is polluted. Though DO (ranges between 4.4 mg/L - 5.5 mg/L) and BOD (0.8 mg/L - 2.6 mg/L) values were found close to the EQS (≥ 5 mg/L for DO and ≤ 6 mg/L for BOD) round the year, the COD level was found exceeding the standard (200 mg/L) in January to June and October to November. The COD value was found varying in between 4.0 mg/L - 923 mg/L in 2011-2012. The River receives industrial discharge, ship discharge, discharge of sewerage from city and fertilizer and pesticides washout from upstream agricultural lands.

Halda River

Originating from the Chittagong Hill Tracts the Halda flows beside the Chittagong city and falls in Karnaphuli River. The river is declared as ecologically critical area (ECA) due its importance as natural fish spawning ground. According to the water quality data of 2012 and 2011 of DoE, the river water meets EQS. The pH, DO, BOD and COD values were found within the EQS. The pH varies in between 6.8 - 7.6 (EQS is 7-8). DO levels were found varying 1.0 mg/L - 5.6

mg/L against the standard ≥ 5 mg/L (for fish). The lowest value was found in the month of June 2012 which was below the standard but in 2011 the values were 5.2 mg/L – 6.8 mg/L. The BOD was found varying 1.8 mg/L – 0.3 mg/L in 2012 and 1.0 mg/L – 2.4 mg/L in 2011. COD was found varying in between 1mg/L – 4mg/L in 2012 and 2 mg/L to 7 mg/L in 2011.

Moyuri River

Moyuri is one of the major polluted rivers flowing across the Khulna city. A large number of illegal sewerage and industrial wastes discharge into the river. DO was found much below the EQS (for fish), varying from 0 to 2.0 mg/L in 2012 and 0 to 4.8 mg/L in 2011. DO was found dropped to zero in the month of April to June in 2012 and March to April in 2011. BOD was also found above the EQS, varying from 6mg/L to 20 mg/L in 2012 and from 1.8 mg/L to 36mg/L in 2011, while the EQS is only maximum 5mg/L (for fish). COD was found above the standard as well. COD was found in between 46 mg/L and 672 mg/L. In 2011, COD was found higher than the EQS in the months of January to June and also in December.

Rupsa River

The Rupsa River is a river in south-western Bangladesh and a distributary of the Ganges. It forms from the union of the Bhairab and Atrai rivers, and flows into the Passur River. Its entire length is affected by tides. The pH level varies in between 7.13 and 7.88 in 2011 and 2012. DO level was lower than EQS (≥ 5 mg/l) for fisheries during February to June. The maximum DO level both in 2011 and 2012 was 6.8 mg/l but the minimum values were 5.7 mg/l and 4.5 mg/l. In 2012, the maximum and the minimum BOD were 8.0 and 0.4 mg/l respectively, while in 2011, these were 8.0 and 0.6 mg/l. The maximum and the minimum COD was 22 and 20 mg/l respectively while the EQS is 200 mg/l in 2012. In 2011, COD concentration varied from 22 and 225 mg/l.

Passur River

The Passur is one of the major rivers flowing through the Sundarbans. The Mongla Port is also situated at the left Bank of Passur River. A large scale industrial development is taking place along the bank of Passur from Chalna to Chandpai of Sundarbans triggered by the recent development of Port, possible construction of Padma bridge and construction of a mega coal based thermal power plant at the bank of Passur in Rampal.

The river water quality meets the EQS. pH level varies in between 7.71 and 7.88 which is within the EQS. The DO was found in between 6.8mg/L and 4.6 mg/L in 2012 and 2011. BOD was found varying in between 1.2 mg/L and 0.5mg/L in 2011 and 2012. COD value was also found within the EQS.

CEGIS is carrying out a detail environmental monitoring study in Passur River for the proposed Bangladesh-India Friendship Power Plant Company at Rampal. As a part of the study, CEGIS collected and analysed water samples from 13 locations in the Passur round the year in 2014. CEGIS found BOD (1.9 mg/L – 5.0 mg/L) and COD (20 – 540 mg/L) little higher than the result of DoE but still within the limit of EQS.

Kirtankhola River

The Barisal city is located by the bank of Kirtankhola River. The river plays an important role in navigation, trade, economy, livelihood, culture and environment of the Barisal region. In 2012, pH level of Kirtankhola river water varied from 6.0 to 8.2 and was within the EQS. In 2011, pH level varied from 6.2 to 7.8. In 2012, DO level of Kirtankhola River varied from 5.7 mg/l to 7.3 mg/l which was above the EQS (≥ 5 mg/l) for fisheries. In 2011, DO level varied from 4.6 mg/l to 9.7 mg/l. BOD was low round the year in 2012, the max and min were 2.5 and 1.1 mg/l respectively. In 2011, BOD level varied from 0.5 to 5.4 mg/l. In 2012, COD level varied from 36 to 52 mg/l; but in 2011, it was above the EQS (200 mg/l) varying from 18 to 377 mg/l. The river is subject to pollution due to sewerage discharge, and also discharge of industrial effluent.

Surma River

Surma River is flowing beside the Sylhet city. In 2012, pH level of the Surma river varied from 6.5 to 7.79, while in 2011 from 7.3 to 7.9. In 2012, DO content was mostly above the EQS (≥ 5 mg/l) for fisheries. In 2011, DO level varied from

6.3 to 7.9 mg/l. BOD value was also within the EQS. The max and the min BOD were 1.3 and 1.0 mg/l respectively in 2012, while in the previous year, it varied from 1.0 to 1.9 mg/l.

Table 17: Water quality parameters and their values in the selected rivers

SI No	Rivers	Parameters			
		pH	DO (mg/L)	BOD ₅ (mg/L)	COD (mg/L)
1	Buriganga	6.4-7.9	<1	1-48	5-283
2	Shitalakkhya	6.31-8.8	0-6.2	2-16	<200
3	Turag	7.10-8.03	0-<1	5-38	9-290
4	Meghna	6.24-7.6	>6	≤6	2-3
5	Jamuna	7.2-8.46	5.9-8.5	2.8-11	NDA
6	Padma	6-7.8	5.4-8.26	1.15-2.8	NDA
7	Kirtankhola	6-8.2	5.7-7.3	1.1-2.5	36-52
8	Passhur	7.71-7.88	4.8-6.8	0.5-1.2	<200
9	Rupsha	7.13-7.88	4.5-6.8	0.4-8	20-22
10	Moyuri	-	0-2	6-20	46-672
11	Karnaphuli	-	4.4-5.5	0.8-2.6	4-923
12	Halda	6.8-7.6	1-5.6	0.3-1.8	1-4
13	Surma	6.5-7.9	≥5	1-1.3	-0

4.3.3. Sources and Causes of Pollution

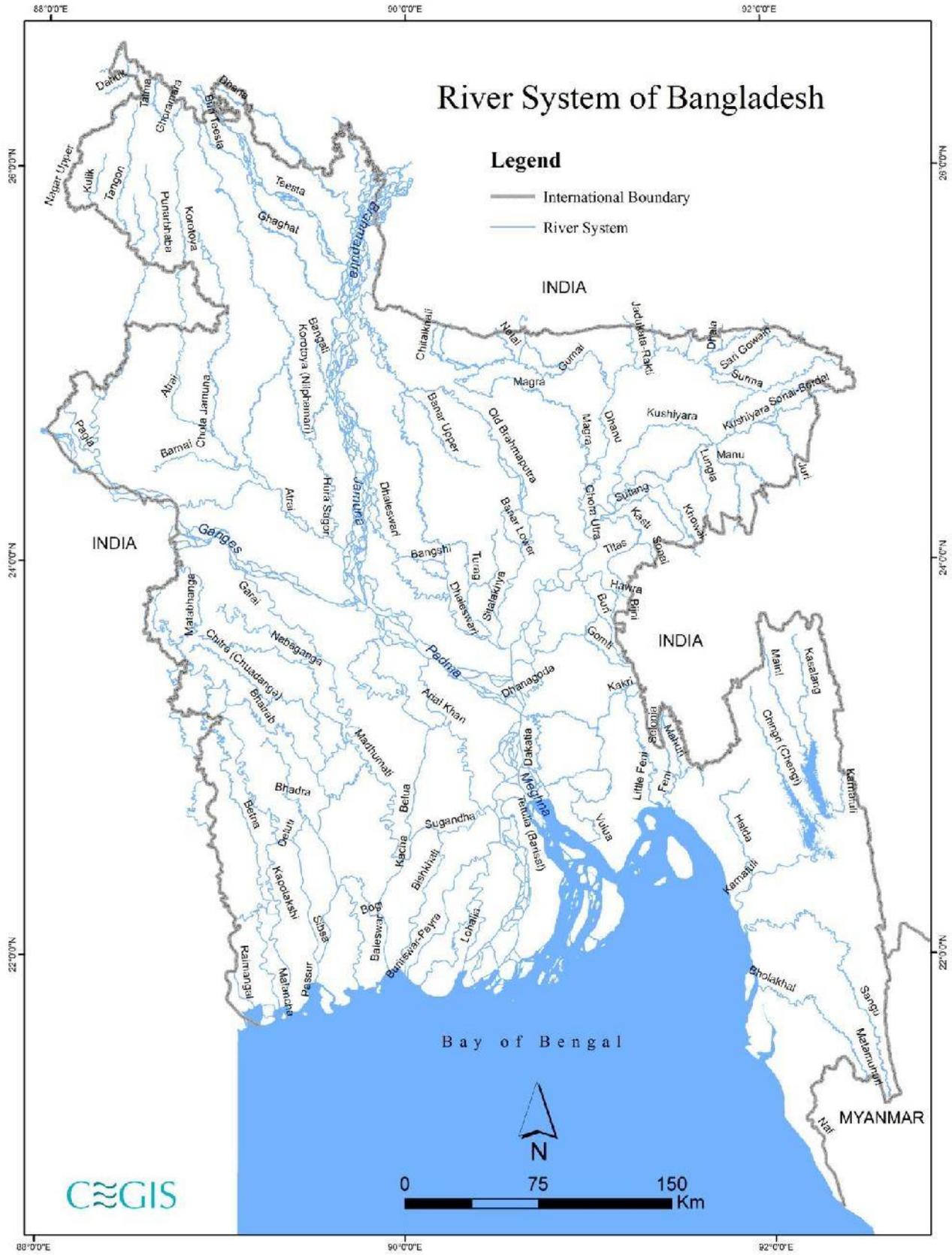
Pollution from Industries

Untreated industrial effluent is the major pollution source in common rivers of Bangladesh. Textile industries, chemical industries, fertilizer industries and power plants are commonly blamed for causing water pollution. It is recognized in most of the policy documents that industries are illegally discharging untreated wastewater directly into the rivers or water bodies e.g. in National Water Management Plan (2001), National Sustainable Development Strategy (2010-2021), National Environmental Policy (2013), etc.

Industries produce waste containing toxic chemicals and pollutants (lead, mercury, sulphur, asbestos, nitrates etc). Some industries do not have proper waste management system and drain wastewater out into adjacent freshwater bodies and cause contamination. The toxic chemicals may change the colour of water, cause eutrophication, change water temperature and thus pose serious threats to several water dependent organisms. The National Water Management Plan listed industries situated in different hydrologic region to compare the pollution load in different hydrologic region (Table 17).

Pollution from Agricultural Activities

Excess use of fertilizer and pesticides ultimately pollute water bodies and rivers. Residue of fertilizers and pesticides ultimately reach to rivers with rainfall runoff. This is very common in rural areas that results in algal bloom and heavy metal contamination.



Map 1: River System Map of Bangladesh

Table 18: Numbers of Industries in Different Hydrological Region

Region	No. of Establishments	Textiles, apparels & tanneries	Paper, paper products & printing	Chemicals, plastics & petroleum	Non-metallic minerals manufactures
North West	4,403	545	113	181	360
North Central	12,133	4,093	707	1,242	733
North East	1,117	55	20	47	132
South East	2,518	346	68	83	549
South West	849	72	39	42	199
South Central	1,408	128	29	77	157
South East	2,506	475	102	231	229
Total	24,934	5,714	1,078	1,903	2,359

Source: State of Environment 2001 (MoEF, 2001)

Pollution from Sewerage

This is becoming a major problem in urban areas and rural areas as well. None of our cities are completely covered by sewerage collection network and treatment facilities. Major portion of sewerage goes untreated and to the rivers. Even after treatment, the sewage water may carry harmful bacteria and chemicals (pathogens, microorganisms and other disease carrying contaminants) which pollute stream water. Most of the rivers near to the cities are polluted due to sewerage discharge. In rural area, indiscriminate discharge of sewerage is creating pollution problems in stagnant water-bodies, canals and rivers. In most cases, people discharge their household sewerage to adjacent water-bodies or open field.

Trans-boundary Pollution

Three largest basins are formed by the Ganges-Brahmaputra-Meghna River system. 92% of the GBM Basins is located outside Bangladesh. Therefore, the water quality that Bangladesh receives is mostly contributed by the upstream activities in the trans-boundary watershed areas. There is no established system for monitoring the quality of water from the trans-boundary sources.

Pollution from Ship

Pollution from ships is becoming very significant due to increasing trend of river and sea traffic. Ship pollution is commonly seen in Buriganga, Passur and Karnaphuli rivers. Accidents in river traffic are also increasing which cause significant damage to ecosystem. Sunken oil tankers, klinker carriers, and other bulk carriers have increased recently in Passur River. The recent incident of sinking of oil tanker on 9 December 2014 in Shela river in Chandpai Range of the Sundarbans forest, resulted oil spill of around 350,000 litre of oil in the Sundarbans. Earlier, during the same year, two other klinker carriers sank in the Harbaria region of Sundarbans' rivers. Apart from the accidental event, discharge of sewerage from ships, ballast water, bilge water, ship wash water, etc are causing pollution in navigation routes and marine areas of the country.

The nature and sources of pollution in major rivers is given in **Table 19**.

Table 19: Nature and Sources of Pollution in Major Rivers

Name of the River	Polluters	Pollutants
Karnaphuli	441 industries and 40-50 oil tankers	Heavy metals, degradable and persistent organic and inorganic compounds, oil, lubricants
Sangu	Fisherman	toxic chemicals
Bhairab	Khulna Newsprint Mills	Heavy metals
Mongla and Passur	Mechanical ships, oil tankers, marine vessels	Oil, grease and other lubricants
Rupsa	Mechanized vessels, Khulna city	Solid and liquid waste
Nabaganga	Sugar mills	Effluents
Mathabhanga	Carew & Company Darshana Sugar mills	Effluents
Kapotakhya	Jessore city	Solid and liquid waste
Shitalakhya	Meghna Cement Factory, Ghorasal Fertilizer factory	NH ₃ , CaCl ₂ , NaOH, H ₂ SO ₄ and lubricants
Buriganga	Five main drains of Dhaka city, 277 tanneries, Passenger and merchant ships	Domestic and industrial waste, chemicals, oil, grease, lubricants
Turag	250 different industries	Heavy metals
Balu	268 different industries	Heavy metals
Bangshi	Different industries	Effluents
Kaliganga	Fabric industries	Effluents
Meghna	Ashuganj Fertilizer Factory	NH ₃ , other chemicals
Brahmaputra	Mymensingh city, industries and factories	Effluents
Jamuna	Sugar mills, Fertilizer factory	NH ₃ , CaCl ₂ , NaOH, H ₂ SO ₄ , lubricants
Haridhaya, Kalagachia and Pahoria	2000 textiles mills and fabric industries	Effluents
Dhaleshwari	Cement factory, other industries	Effluents
Chandana	Sugar mills	Effluents
Surma and Dhanu	Chhatak paper and pulp mill	NaOH, Cl, Hg, Ca, HCl
Kushiyara	Fenchuganj fertilizer factory	CO ₂ , NH ₃ , SO ₂ , oil, CaCl ₂ , NaOH, H ₂ SO ₄ , and lubricants
Tulshiganga	Industries Naogaon municipal area	Solid and liquid waste, effluents
NarodNad	North Bengal Sugar Mills and Jamuna Distilleries	Effluents, Hot water
Padma	North Bengal Paper Mills	NaOH, Cl, Hg, Ca, HCl

Name of the River	Polluters	Pollutants
Karatoa	Panchagar and Setabganj Sugar Mills, Zaz Distilleries	NH ₃ , CaCl ₂ , NaOH, H ₂ SO ₄ , H ₂ SO ₄ , lubricants and Hot water
Jamuneshwari	Shampur Sugar Mills, Rangpur Distilleries	NH ₃ , CaCl ₂ , NaOH, H ₂ SO ₄ , H ₂ SO ₄ , lubricants and Hot water
Kirtankhola	Municipality and industries	Effluent and wastes

Source: BAPA (<http://www.cseindia.org/userfiles/Abdul%20Matin.pdf>)

4.3.4. State of Groundwater Pollution

Geographically Bangladesh is located in an area which is bestowed with ample of groundwater resources. However, over-exploitation, contamination and pollution of groundwater has become a matter of serious concern from the perspective of Bangladesh. As a developing country with huge population and small land area, Bangladesh lacks technical know-how to provide its inhabitants with adequate supply water. Therefore, around 87% of the people of this country is dependent on the groundwater for meeting their daily requirement (BBS, 2010). Moreover, irrigation sector requires a vast amount of water, majority of which is met by groundwater. It is reported that, currently around 79% of the cultivable lands of Bangladesh is irrigated by groundwater and 35,322 deep tube wells, 1,523,322 shallow tube wells and 170,570 low lift pumps are in use in the country to extract groundwater for irrigation purpose (Qureshi *et. al.*, 2015). Due to the associated threats of rapid depletion of groundwater on environment and livelihood, this problem is being referred as a silent hazard recently.

Contamination of Arsenic on groundwater is another serious problem faced by Bangladesh. Though there is no consensus among the scientist about the causes of high arsenic contamination in Bangladesh, it is assumed that natural accumulation of arsenic in the ground is disturbed by modern agricultural practices, groundwater extraction and different anthropogenic activities. An overview of arsenic contamination in the groundwater of Bangladesh (Hossain, 2006) is represented in the Figure 12 below:

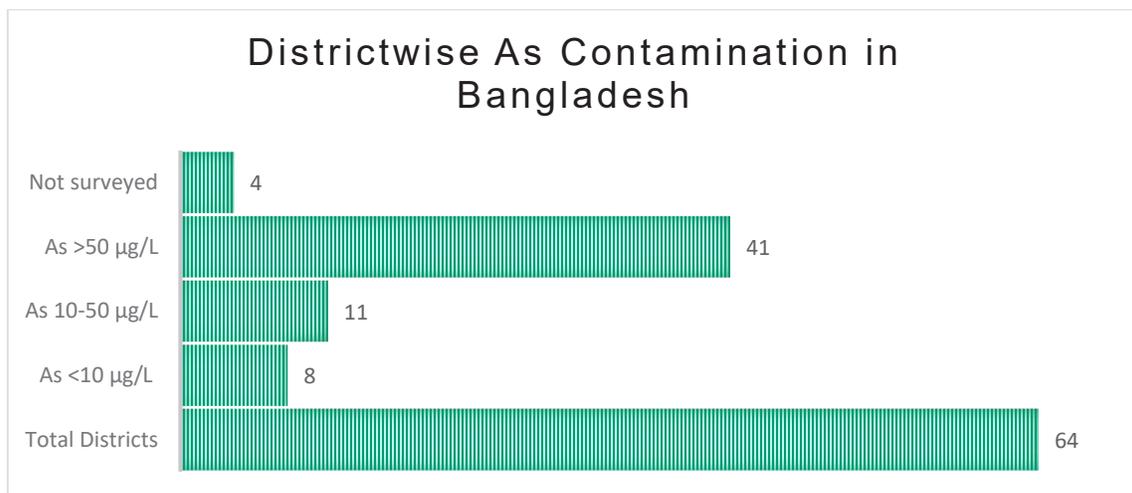


Figure 12: Arsenic Contamination of Bangladesh at a glance

Moreover, effluents and wastes generated from different industries such as pharmaceutical, textile, dyeing and tannery, are constantly getting accumulated either through direct disposal on soil surfaces or by somehow managing to end up in the surrounding water bodies. Due to seepage or movements of the pollutants through the soil layers, these wastes are causing groundwater contamination and changing the normal state of this important natural

resource. Saha and Ali (2001), in their study focused on the contamination of groundwater of Dhaka city from the wastes generated from tannery industries. The study found very high concentration of Sulfide, Lead, Manganese and Chromium in many different groundwater samples, especially the ones collected from around *Hazaribagh* area. Since the tannery wastes are highly rich with these pollutants, the study concluded the industries to be majorly responsible for this contamination in there (Saha & Ali, 2001).

Another study based on Chittagong indicated the presence of heavy metals and As in the groundwater majorly resulted from the leachate of Rowfabad landfill (Hossain, Das & Hossain, 2014). The following Table 21 indicates the concentration of the heavy metals that were found very high in the collected groundwater samples during winter and rainy seasons and compares with Bangladesh and WHO drinking water standard.

Table 20: Seasonal variation of metal concentration in groundwater near Rowfabad Landfill

Metals	Seasonal Variation in Concentration, mg/L		Bangladesh Standard (mg/L)	WHO guideline (mg/L)
	Winter	Rainy		
Cd	0.04	0.02	0.005	0.003
Cr	0.092	0.019	0.05	0.05
As	1.7	0.9	0.05	0.01
Fe	3.26	2.61	0.3-1.0	0.3

Azim et al. (2011), however, found higher concentration of HCO₃ and K when analyzed groundwater samples collected from Matuail landfill site, Dhaka. The important parameters that were chemically analyzed and found to exceed Bangladesh standard are given in Table 22 below:

Table 21: Characteristics of groundwater samples from Matuail landfill, Dhaka

Parameters	Concentration in Groundwater Samples, mg/L				Bangladesh Standard for Drinking Water
	Sample 1 (115 ft depth)	Sample 2 (400 ft depth)	Sample 3 (418 ft depth)	Sample 4 (130 ft depth)	
pH	6.8	7.4	7	6.9	7
COD	3.88	7.76	3.88	3.87	4
HCO ₃	556.32	351.36	263.52	551.78	339
Ca+Mg	190	40	10	177	120
K	25	25	25	15.65	12

Source: adapted from Azim et al., 2011

Lack of study in this sector is a hindrance to get the real picture of groundwater pollution in Bangladesh. However, the results from some individual studies, give us an alarming picture of ground water pollution in the country. Immediate study and government attention is required to understand the real scenario and to overcome the problem in this regard.

4.3.5. Salinity Intrusion

Climate change coupled with the impacts of man-made intervention in rivers is causing increasing salinity in coastal rivers, groundwater and soil. This is a subject of debate whether the salinity intrusion is to be considered as pollution or natural process. However, in Bangladesh, the Ministry of Disaster Management and Relief has defined the Salinity Intrusion as one of the hazards. Under the Delta Plan Preparation, a thematic baseline study on disaster management covers the issue of salinity intrusion. This section of the environmental pollution baseline gives only a brief on salinity

intrusion reviewing the relevant sections of the other two Baseline Reports on Disaster Management and River Morphology & Water Resources.

This is evident that salinity front is propagating towards landward in most of the coastal rivers. Salinity is increasing in the shallow groundwater aquifers of the coastal region. The thematic study on River Morphology identified that salinity is increasing in most of the rivers in south western and south eastern regions of Bangladesh. Reduction of flow from Trans-boundary Rivers, upstream interventions, and climate change induced sea level rise are the reasons behind the salinity intrusion. Coastal ecosystem and livelihood are very sensitive to salinity intrusion. Therefore, this issue should be reflected in the strategic planning for water resources management and environmental management in the coastal region of the country.

4.4. Soil Pollution

4.4.1. State of Pollution

Soil pollution is another environmental pollution that threatens the ecosystem and human health but hardly recognized in different policy documents. There was no authentic monitoring of soil pollution. Soil Resource Development Institute (SRDI) monitors soil quality with respect to soil fertility. Department of Environment regularly monitor air and water quality but does not have any program for soil pollution monitoring. However, various independent researchers, research institutes and academic institutes have conducted many research programs on soil pollution issues. In the following sections, attempts have been made to describe the state of soil pollution with reference to different research papers.

Soil pollution from Industrial Effluent

Bangladesh Bureau of Statistics(BBS) recognizes evidence of soil pollution in the country in its report titled 'Compendium of Environment Statistics of Bangladesh 2009, (Bangladesh Bureau of Statistics, 2010). With reference to a research of FAO, the BBS reports arsenic contamination in soil in the irrigated paddy cultivation field. BBS also refers contamination of other heavy metals e.g. Selenium, Nickel and Zinc in soils of different locations.

Table 22: Arsenic Contamination in Soil of Irrigated Paddy Fields at different locations

SI No	Location	Arsenic concentration in Soil (mg/kg)
1	Gazipur	10.9 – 14.6
2	Bogra	4.9-15.5
3	Dinajpur	11.7
4	Naogaon	24.3-26.7
5	Nawabganj	15.7-20.9
6	Mymensingh	6.0-25.4
7	Rangpur	6.5-11.5
8	Rajshahi	7.8
9	Kachua, Hajiganj, Shaishabari	7.31-27.28
10	Chapai Nawabganj	5.8-17.7

Source : FAO, 2006 in (Bangladesh Bureau of Statistics, 2010)

As observed from the above table, Arsenic (As) concentration is higher in general in the soils of western part of Bangladesh (>30 mg/kg).

Table 23: Concentration of Selenium (Se), Nickel (Ni), and Zinc (Zn) in Soils at different locations

Sl No.	Location	Selenium (mg/kg)	Nickel (mg/kg)	Zinc (mg/Kg)
1	Gazipur	0.37 – 0.27	7.16 – 1.69	17.49 – 3.94
2	Jessore	0.49 – 0.26	27.45 – 6.66	73.63 – 17.30
3	Faridpur	0.45 – 4.27	40.70 – 2.40	96.92 – 24.09

Source : FAO, 2006 in (Bangladesh Bureau of Statistics, 2010)

Soil Pollution from Ship breaking Industries

Ship breaking industries are growing in the coastal areas, especially at Chittagong coast. Pollution from ships is becoming a major threat near Port areas. Ocean-going ships are causing pollution in Passur river and Karnaphuli river and their adjacent coast. Ship wrecks, and sunken bulk carriers are also threatening the ecosystem. The State of Environment, 2001 (MoEF, 2001) addressed that heavy metal concentrations are increasing in coastal and marine waters due to port activities and ship breaking industries. A recent study on concentration of heavy metal in sea bed sediments in ship breaking region observed concentration of Fe, Mn, Cr, Zn, Pb, Cu, Cd and Hg much higher than the safe limit (Siddique, Parween, Quddur, & Barua, 2009).

Table 24: Heavy Metal Concentration in Sea-bed Sediments near Ship Breaking Industries

Location	Fe	Mn	Cr	Ni	Zn	Pb	Cu	Cd	Hg
	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g	µg/g
Salimpur	11932.61	2.64	68.35	23.12	83.78	36.78	21.05	0.57	0.015
Bhatiari	35216.35	8.25	86.72	35.12	102.05	122.03	39.85	0.83	0.02
Sonaichhari	41361.71	6.89	78.36	48.96	142.85	147.83	30.67	0.94	0.117
Kumira	20971.86	2.32	22.89	25.36	119.86	41.57	28.01	0.59	0.05
Sandwip (Control Site)	3393.37	1.8	19	3.98	22.22	8.82	2.05	0.19	0.02
Standard	27000 a	1.17 b	77.2 a	56.1 a	95.5 b	22.8 b	33.0 b	0.115 a, b	0.02 a

Fe=Iron, Mn=Manganese, Cr=Chromium, Ni= Nickel, Zn= Zinc, Pb=Lead, Cu= Copper, Cd= Cadmium, Hg= Mercury

Source: Siddique et al., 2009

4.4.2. Sources and Causes of Pollution

Soil pollution is closely related with water pollution. In the adjoining areas of Dhaka city, Gazipur, Kaliakoir, Tongi, etc, industrial effluent from different industries mostly dyeing, textile, pharmaceutical, and ceramic industries are polluting rivers and canals that ultimately pollute the soil of agricultural field. In coastal areas, soil near ship breaking industries are being polluted due to chemical spillage, oil spillage and dumping of hazardous waste from ship breaking, recycling and building activities. In the port region, especially in Mongla and Chittagong Port areas, pollution from ships also pollutes the soils of the floodplain. Excess fertilizer, chemical pesticides and other chemical inputs of agricultural field also pollute the agricultural soil. Moreover, near the conventional solid waste disposal sites, soils are polluted from the leakage from the waste.

4.5. Noise Pollution

Noise pollution can be defined as unwanted and/or excessive level of sound that may hamper the balance and regular activities of the biotic components of the environment. Along with the severity of air and water pollution,

noise pollution is also emerging to be a serious problem especially in the urban centres of Bangladesh. Though there are rules and acts to control noise pollution, the absence of the implementation of law only deteriorated the condition of noise pollution in the country. The situation is getting worse day by day with the increased level of traffic on the roads and construction works in all the major cities. Though several health hazards and mental conditions are associated with noise pollution, the Government of Bangladesh is indifferent towards the problem. No mentionable projects were undertaken by the government in broad scale to address this issue.

4.5.1. State of Pollution

An overview of the level of noise pollution of major four cities of Bangladesh is given in this section by reviewing existing literature and available data on this issue. The data were collected from different secondary sources such as BBS and different published journals.

Dhaka:

Dhaka is one of the most densely populated cities of the world. Currently around 17 million people are living in Dhaka city. It is estimated that, by the year 2030 Dhaka will be the 6th densest city of the world with a population of 27 million^{8/}. Being the capital and the largest city of Bangladesh, Dhaka faces the highest rush of migration and also the impacts of rapid urbanization. Increasing population and development activities have impacts on the acoustic environment of Dhaka. Noise levels of some of the **selected busy areas of Dhaka city** shows a frightful scenario of noise pollution, where the noise level varies from 70 dB to 106 dB. While the standard acceptable level is 50 dB, the noise level exceeds more than double (100 db+) in the busy areas like Sayedabad Bus Terminal, Bangla Motor, Mahakhali Crossing, Farmgate, Magbazar, Jatrabari, Gabtoli, etc. Even near the BIRDEM Hospital and residential area like Dhanmondi, the noise level reaches around 80 dB. The noise level reached high due to chaotic traffic, too many people on the roads, honking of horns, indiscriminate use of loudspeakers, etc. The detail data of the noise level of some selected areas of Dhaka city is provided in Table A-1 under Annex A.

Similarly, the noise level in the **silent zone** of Dhaka city exceeds the standard level by quite a margin. The silent zone includes ICDDR Hospital, Dhaka Medical College Hospital, Kakrail Mosque, P G Hospital, Shaheen School, Titumir College, Dhakeshwari Temple and other temples and churches, and National Institute of Preventive and Social Medicine (NIPSOM). While the standard noise level is 50 dB, the noise level of the silent zone for hospitals and schools, reaches in excess of 70 dB, except at NIPSOM in 1999, when the value was restricted to 50 dB. See Table A-2 in Annex A, data source BBS.

The noise level in different **residential areas** of the Dhaka city shows a similar trend of exceeding noise standard. Except Gulshan residential area during 2002, none of the selected residential areas meet the standard noise level. However, it is interesting to note that the noise level actually decreased from 1999 to 2002, from a value of 56.6-79.4 dB to 55- 63 dB. If the noise can be controlled like this instance, there is still hope to take care of the problem. Detail noise level is provided in Table A-3 under Annex A.

In **selected mixed areas**, the standard is 60 dB, whereas the noise level varies from 77.5 to 92.6 in 1999, and 75.5 to 80 in 2002 (Table A-4, Annex A). Similarly in **commercial areas** and **industrial areas**, the noise level exceeds the standard level by about 20 to 30% in general; see detail in Table A-5 and A-6 respectively.

From the above discussion and the tables in Annex A, the **average scenario** of different zones of Dhaka may be summarised as follows (also Table A-7 Annex A). It may be noted that none of the zones mentioned in the table meets the standard level of noise.

⁸<http://www.thedailystar.net/rising-population-big-concern-for-dhaka-33081>

Location	Noise Level (dB)		
	1999	2002	Standard
Silent Area	64.80	64.90	50.00
Residential Area	70.50	64.90	55.00
Mixed Area	84.30	81.60	60.00
Commercial Area	86.50	84.00	70.00
Industrial Area	85.60	83.00	75.00

Chittagong:

No intensive study on the overall noise pollution scenario was done by the government in Chittagong. However, from some discreet publications in scientific journals, a brief idea of the level of noise was formed. **Average noise level** of Chittagong is much less than that of Dhaka and varies in the range of 75 to 90 dB. Noise level at some selected locations of Chittagong city is given in Table A-8, Annex A.

The noise level of some **sensitive areas** in Chittagong – mostly, schools, colleges and hospitals, which are all silent zones – also fails to maintain the standard level. The minimum level of noise found in these areas was 59.73 dB in Ispahani Public School and College and the maximum level was found 79.69 dB in Chittagong Municipal Model High School (Table A-9 Annex A).

Sylhet:

Noise level in the sensitive institutions of Sylhet city also exceeds the permissible noise standard. Whereas the level of noise should be within 50 dB, the minimum noise level found to be 75.2 dB in Zindabazar area, and the maximum value found to be 97.3 dB in the Govt Girls High School; detail in Table A-10, Annex A. It is interesting to note that the highest noise area, the Girls School is only few hundred meters from the Zindabazar main point, which is the lowest noise area.

The average noise level of Sylhet city at different time interval and different distance from roadside is given in Table A-11 Annex A. Maximum sound level was found to be 79.09 dB just beside the road side (zero distance) between 3pm-7pm whereas the minimum sound level 48.2 dB was observed 90 metres away from the roadside 11am-3pm.

Khulna:

The noise levels in the residential areas, commercial areas, some busy roads, and different hospitals of Khulna city were collected by Compendium of Environmental Statistics of Bangladesh 2009. The standard level of noise in the **residential areas** during day time (6am- 8pm) is 55 dB which was found in only one residential area *Purbo Baniakhamar* during 12pm- 4pm on working days. None of the other mentioned residential areas could meet the standard noise level for residential area. Noise level in detail for some residential areas of Khulna city is furnished in Table A-12, Annex A.

The standard noise level for commercial area in Bangladesh is 70 dB. During working days none of the mentioned **commercial areas** of Khulna city could meet the standard level of noise. However, some areas during holidays could meet the set standard for noise. The minimum level of noise 58 dB was found in New Market area on holidays between 12pm- 4pm, whereas, the maximum level of noise 89 dB was recorded in Sonadanga Bus Station on working days between 4pm- 8pm. The level of noise in some commercial areas of Khulna city is shown in Table A-13 Annex A.

During working days, the noise level beside the **busy roads** remains very high and the maximum level of noise was recorded as 91 dB beside Khulna-Jessore Road during 8am- 12pm. The minimum noise level 60 dB was recorded during holidays in three different roads; Sher-e-Bangla Road, Klay Road and Ahsan Ahmed Road at two different time periods. The noise level in some important roads of Khulna city is shown in Table A-14 Annex A.

Data obtained from the same source as the above, the level of noise in some of the **hospitals** of Khulna city, which fall under silent zone, is found to exceed the standard limit. Though the level of noise should be below 50 dB according to the standard noise level in silent zones, the minimum level of noise recorded among the hospitals is 58 dB which also exceeds the standard limit. The detail is shown in Table A-15 Annex A.

4.5.2. Sources of Pollution

The sources of noise pollution can be divided into five main categories such as street traffic, aircraft, railroads, industry and construction according to the Compendium of Environment Statistics of Bangladesh, 2009.

Street Traffic:Traffic induced noise can be said as the main sources of noise pollution in Bangladesh. Lack of law enforcement and awareness in this sector is making the situation worse. Excessive and unnecessary use of horns, lack of maintenance of the vehicle, absence of planning during construction of roads, highways, flyovers etc, heavy traffic load on the roads, high density of population in the major cities etc issues are making the traffic induced noise level unbearable.

Aircraft:Aircraft noise is another major source of noise pollution in Bangladesh which mainly disturbs the people living near airport areas.

Railroads:The sound of engine, wheels, whistle of trains, warning signals at crossing create high level of noise. People living beside railroads mainly suffer from this noise.

Industry:Product fabrication, product assembly, power generation, processing etc activities creates loud noise in the industry. As there is lack of awareness and law enforcement about noise pollution, the industries generally do not take any measures to control the noise.

Construction:As Bangladesh is rapidly developing, construction activities are a very common thing here. Construction activities create loud sound, which is another major source of noise pollution in the country. Moreover, due to the absence of mitigative measures, the level of noise in most cases becomes intolerable.

Other Sources:Other sources of noise pollution may include agricultural noise, use of excessive microphones, loud music, sirens, military noise etc.

4.6. Waste and Wastewater Management in Major Cities

Solid Waste Management (SWM) and Sewerage Treatment are one of the major multidimensional problems faced by the urban world of the present time⁹. The problem is much more severe in the developing countries especially the ones with high population density like Bangladesh. In addition to high population density, Bangladesh is facing a rush of rural-urban migration as it is going through a phase of rapid urbanization. The problem is much more intensified as the urbanization process of Bangladesh is not occurring in a planned manner.

Poor management of solid waste and sewerage has severe consequences like failure in drainage system due to water clogging, deterioration of soil quality and soil pollution, air pollution, foul odour, surface water pollution, risk of ground water pollution through leachate percolation (petrified liquid squeezed out of solid waste), spread of

⁹Sujauddin et al., 2008

infectious and vector borne diseases, risk of explosion in landfill areas etc¹⁰. Though SWM and sewerage treatment are daunting problems, they are still not considered as a major concern in Bangladesh. Open dumping, throwing waste here and there and also to water bodies are regular practice here. The relevant databases such as generation, composition, disposal of solid waste etc are not yet developed and the regulation system related to solid waste management is also very weak. Only very recently 'National 3R strategies for waste management' has been developed. However, no effective measures have still been taken to control the uncontrolled disposal and management system of solid waste. Even regulated waste collection and disposal systems by the city corporation are not good enough. However, this section tries to give an overview of the present situation of solid waste generation and management in the major cities of Bangladesh by reviewing existing literatures and analysing secondary data.

4.6.1. Waste Generation

The per capita waste generation rate of whole Bangladesh is not yet clearly known. According to "Waste Concern", a company dealing with solid waste management, the average per capita urban waste generation rate in Bangladesh in 2005 was estimated to be 0.41 kg/capita/day¹¹. The urban rate of waste generation and projected future waste generation rate in urban areas is shown in Table 25a.

Table 25a: Urban solid waste generation rate in Bangladesh

Year	Urban Population (million)	Waste Generation Rate (kg/Capita/day)	Total Waste Generation (Tonne/day)
1991	20.87	0.49	9873.5
2001	28.81	0.5	11695
2004	32.77	0.5	16382
2025	78.44	0.6	47064

Source: Waste Concern, 2004

As waste generation rate is highly dependent on different social parameters and lifestyle, the generation rate differs from region to region and in different social class. The generation rate of waste of different city corporation areas is accumulated in this section from secondary sources.

Dhaka

Being the capital and the largest city, Dhaka plays a role of economic and political hub of Bangladesh. Around 37% of the total urban population lives in Dhaka city and the pressure of rural-urban migration is the highest on Dhaka¹². It is one of the most densely populated cities in the world. According to the project titled "Clean Dhaka Master Plan" (2005) conducted by JICA, the waste generation rate of Dhaka is presented in Table 25b.

Table 25b: Total solid-waste generation rate of Dhaka

Type	2005 (JICA)	2015 (estimated*)
Domestic waste	1950	3028
Business waste	1050	1528
Street waste	200	291

¹⁰Chowdhury et al., 2013

¹¹ Waste Concern Waste Database, 2009

¹² Rahman, H.Z. (2001). "Bangladesh Urban Transition: An Overview."

Note: *estimated on the basis of population growth only

Source: (JICA, Pacific Consultant Internationals, & Co, 2005)

The per capita generation of domestic solid waste and seasonal variation of waste generation according to the income group is shown in Table 25c. From the table it can be seen that on average the per capita generation of domestic solid waste in Dhaka city is approximately 0.340 kg/day. The highest amount of waste is generated by High Income Group (0.513 kg/person/day) whereas the lowest amount of domestic solid waste is generated by the lowest income group (0.260 kg/person/day). No significant variation or pattern is noticed between the waste generation rate in dry and wet season.

Table 25c: Per capita domestic solid waste generation according to income group

Domestic Waste				
Income Group	Income Level (Tk/Month/Family)	Waste Generation Rate (Kg/person/day)		
		Dry Season	Wet Season	Average
Lowest Income Group	3000>	0.314	0.205	0.260
Low Income Group	5000>, ≥3000	0.326	0.345	0.336
Middle-Low Income Group	10000>, ≥5000	0.279	0.346	0.313
Middle Income Group	20000>, ≥10000	0.371	0.428	0.400
High Income Group	≥20000	0.588	0.438	0.513
Weighted Average				0.340

Source: (JICA et al., 2005)

The JICA study estimates that the average business waste generation rate is 1050 t/d. The breakdown of waste generation rate at different sources is given in Table 26a. From the table it can be seen that on average restaurant (23.8 kg/place/day) and hotel (15.3 kg/place/day) generates the highest amount of waste per place/day respectively. On the other hand, in market average per day waste generation rate is 1.1 kg per m². In case of business waste, it is seen that the amount of waste generation is slightly higher (5.7 kg/place/day) during wet season. In case of market waste generation also, the amount is marginally higher (0.4 kg/m²/day) during wet season.

Table 26a: Solid waste generation rate in business sectors

Business Waste				
Sources	Waste Generation Rate			Unit
	Dry Season	Wet Season	Average	
Restaurant	24.0	23.6	23.8	kg/place/day
Shops	0.9	0.8	0.9	
Hotel	11.0	19.6	15.3	
Office	2.4	5.6	4.0	
Market	0.9	1.3	1.1	kg/m ² /day

Source: (JICA et al., 2005)

The country's average rate of street waste generation is 200 ton/day (Table 41). On average 364.5 kg waste is generated per km of the streets of Dhaka city, and 40 kg/km excess waste is generated during wet season than the dry season. The data on street waste generation is represented in Table 26b.

Table 26b: Generation rate of street waste

Sources	Waste Generation Rate (kg/km)		
	Dry Season	Wet Season	Average
Street Waste	344.5	384.5	364.5

Source: (JICA et al., 2005)

Chittagong

The waste generation rate in Chittagong has increased to 1302 ton/day from 282 ton/day within 10 years from 2000 to 2009. This rapid increase in waste generation rate can be associated with the rapid population growth and rapid urbanization process. The population of Chittagong city has increased by 1.23 million within this time. Along with population, the per capita waste generation rate has also increased from 0.26 kg/day in 2000 to 0.55 kg/day in 2009. This per capita increase in waste generation can be linked with the economic growth, improved living standard and increased buying capacity of the Chittagong dwellers. Though the increased waste generation gives a frightful scenario, it is good to note that in Chittagong, collection coverage of the waste has also increased from 48% to 70% within these 10 years. Detail of the waste generation and collection scenario from the year 2000 to 2009 is given in **Table 27**.

Table 27: Municipal solid waste generation and collection in Chittagong (2000-2009)

Year	Population (million)	Waste Generation Rate (kg/capita/day)	Total Daily Waste Generation (ton/day)	Waste Collection (ton/day)	Collection Coverage (%)
2000	2.22	0.26	588	282	48
2001	2.29	0.28	637	312	49.0
2002	2.37	0.29	694	354	51
2003	2.45	0.31	758	409	54
2004	2.52	0.34	827	455	55
2005	2.60	0.38	984	551	56
2006	2.72	0.40	1075	634	59
2007	2.86	0.45	1285	784	61
2008	3.15	0.52	1650	1056	64
2009	3.45	0.55	1890	1323	70

Source: Chowdhury et al., 2013

The composition of municipal solid waste in the landfill is presented in the pie graph below in Figure 12. From the figure it can be seen that the highest amount of the waste comprises food waste. The compostable amount of waste in the landfill comprises 79% of the total waste.

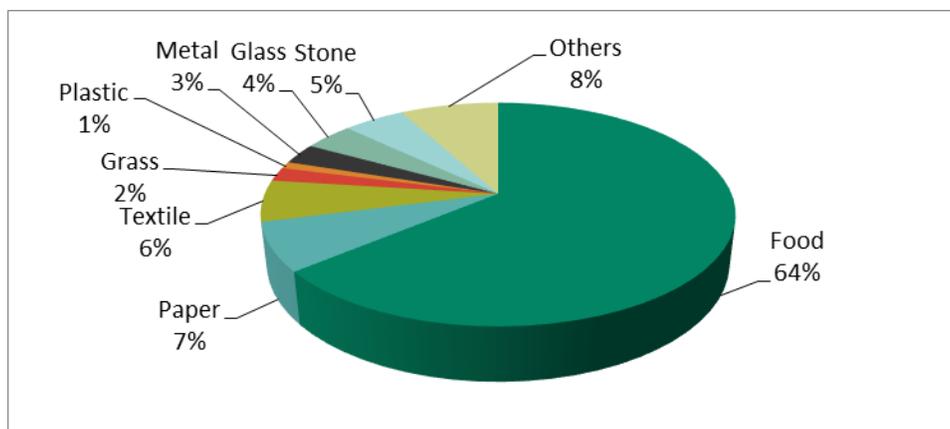


Figure 13 Waste composition in the landfill of Chittagong

(Source: Chowdhury et al., 2009)

Khulna

Khulna City Generates 300-380 tons of solid waste per day that includes 70%- 80% solid waste (Murtaza, 2002). Domestic, retail sale markets, slaughter houses, hotels and restaurants, hospitals are the major sources of waste. Khulna City Corporation (KCC) is the responsible authority for management of these wastes. The KCC has only one landfilling site located in Rajbandh which is conventional. The site is equipped with a limited recycling facility, incineration facilities, and a conventional disposal area. Leachate from the waste disposal creates water pollution and nuisance to the nearest locality. The KCC has a plan of construction of asanitary landfilling area in Labanchora but the project is stuck due to public agitation related to land acquisition.

Other City Corporations

Average waste generation rates in Barisal, Gazipur, Narayanganj and Sylhet city corporations (CC) are 0.16, 0.20, 0.29 and 0.28 kg/capita/day (Table 28). From the comparison it can be found that, after Dhaka and Chittagong, the highest amount of per capita waste is generated in Narayanganj and then Sylhet.

Table 28: Waste generation rate in the other four city corporation areas

City Corporation	Income Class	Waste Generation Rate	
		kg/hh/day	kg/capita/day
Barisal	Low	0.74	0.17
	Lower middle	0.53	0.10
	Middle	0.86	0.17
	High	1.01	0.22
Weighted average		0.80	0.16
Gazipur	Low	0.39	0.07
	Lower middle	0.91	0.22
	Middle	0.87	0.18
	High	1.09	0.24
Weighted average		0.88	0.20
Narayanganj	Low	1.49	0.42
	Lower middle	1.37	0.29
	Middle	1.05	0.25

City Corporation	Income Class	Waste Generation Rate	
		kg/hh/day	kg/capita/day
	High	1.43	0.32
Weighted average		1.29	0.29
Sylhet	Low	1.16	0.21
	Lower middle	1.22	0.25
	Middle	1.39	0.29
	High	1.44	0.30
Weighted average		1.36	0.28

Source: CEGIS Field Survey, 2012(CEGIS, 2013)

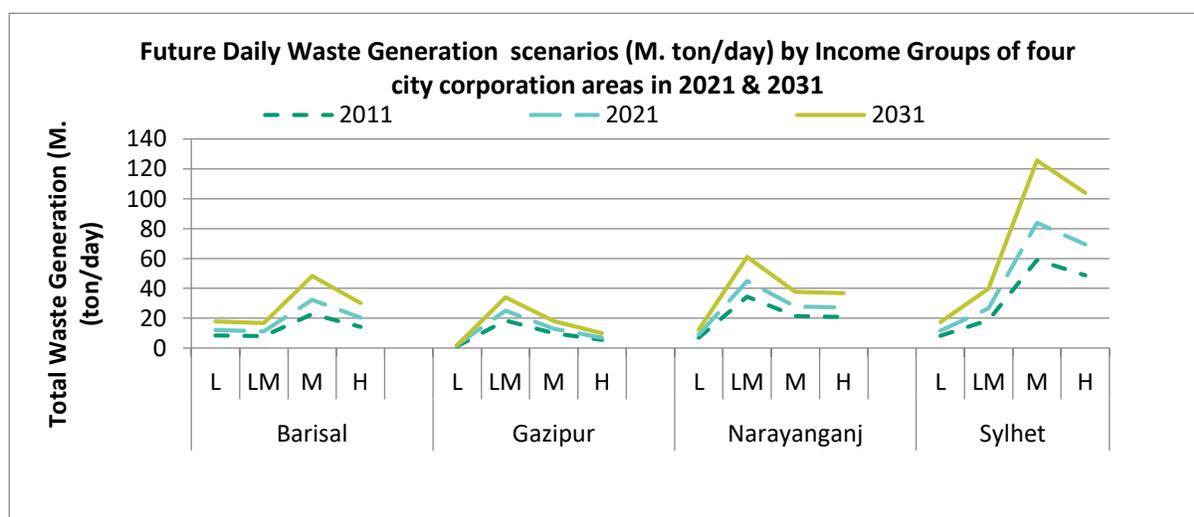
(Note: Here, income of Low income group= Up to BDT 4000; Lower Middle income group= BDT 4001-8000; Middle income group= BDT 8001-30000; High income group= BDT above 30000)

The collected waste generation (kg/capita/day) data were used to predict the future waste generation (metric ton/day) trend of waste in the four above mentioned city corporations. The projection has been done mainly for the year 2021 and 2031. The predicted waste generation rate of the four city corporation areas are presented in Table 29.

Table 29: Projected future population and waste for 2021 and 2031 for four city corporation areas

City Corporation	2011		2021		2031	
	Population	Total waste (m.ton/day)	Population	Total Waste (m. ton/day)	Population	Total Waste (m. ton/day)
Barisal	3,28,278	53	4,66,155	76	6,94,571	113
Gazipur	1,79,037	35	2,38,119	47	3,30,986	65
Narayanganj	2,86,330	84	3,72,229	109	5,06,231	148
Sylhet	4,79,831	135	6,81,360	191	10,22,040	287

Source: CEGIS estimation from Field Survey data, 2012(CEGIS, 2013)



Note: Income class: L=Low; LM= Lower Middle; M=Middle; H=High

Figure 14: Projected waste generation status of the year 2021 and 2031 of four city corporations by different income groups

It is seen from the above figure (Figure 13) that the waste generation rate is the highest in Sylhet among the four city corporations. In general, Low-Middle and Middle income generating groups generate higher amount of waste. In Gazipur and Narayanganj, which are comparatively urban cities, low-middle income group generates higher amount of waste. On the other hand, in Sylhet and Barisal, middle income group generates higher amount of waste.

4.6.2. Waste Management

Practicing Approach and Technologies

The existing solid waste management practice is not sufficient and environment friendly. In Bangladesh, generally three systems such as informal system, community initiative and formal system work side by side in waste management sector. The informal system of solid waste management includes huge informal labour forces who are involved in solid waste recycling trade chain. Community initiatives such as house to house waste collection system were mainly started due to dissatisfaction of waste management system by formal sector. The community based initiatives are mainly conducted by the NGO's or Community Based Organizations (CBO's). CC/municipalities are responsible in the formal system of solid waste management in the urban areas. This formal system is based on conventional waste collection-transportation-disposal method which lacks the concept of sustainable and environment friendly processes¹³.

In the city corporation areas of Bangladesh, the waste management procedure is almost similar. The generalized process flow of the solid waste management system in the urban areas of Bangladesh is explained in **Figure 14**.

¹³ Waste Concern, 2004

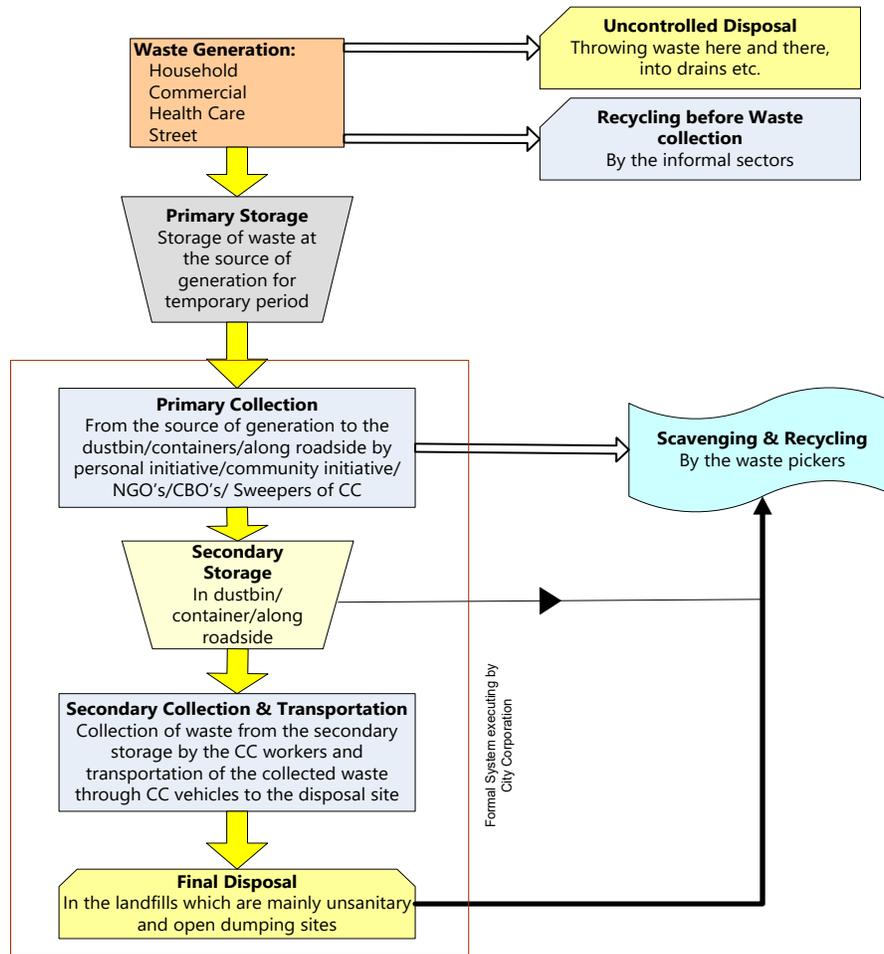


Figure 15: The generalized process flow of the solid waste management system in CC areas

Source: adapted from Waste Concern, 2004 and Chowdhury et al., 2013

Cost Recovery

The cost of the solid waste management of a city corporation comes from revenue and household taxes. But the cost recovery is unclear as it is not mentioned in the household taxes. JICA studied the financial mechanism of Solid Waste Management (SWM) of Dhaka city during preparation of Clean Dhaka Master Plan and identified the following constraints of cost recovery mechanism:

- Financial budget is department wise but not operation wise, that makes difficulties in assessing real cost of waste management.
- Overall SWM cost is unclear. Hence cost recovery measures are difficult to be taken quickly and properly. Unified SWM budget system based on operation-wise cost should be introduced.
- Constraints in management and operation of cost recovery mechanism
- Real cost incurred during the year is uncertain. Financial position is unclear. Current property value is not correct
- Low revenue of DCC
- Many appeals from taxpayers due to in-transparency of tax assessment system of DCC

4.7. Sewerage Management

Only the Dhaka city in the country has limited sewerage management facilities. Water Supply and Sanitation Authority of each city is responsible for sewerage management. In Dhaka only 30% of the city is covered under sewerage network¹⁴. At present the city has only one sewerage treatment plant, which can treat 40,000 m³ sewage per day, even though it has a capacity of treating a waste of 120,000 m³. Only 20% of households of the city are connected with the sewerage network. However, there is no study available that estimates total sewerage production, treatment, capacity of the network, efficiency of the network. A scientific study claims that 70% of the septic tanks in the city are not connected with the sewerage system (Opel, A., Bashar, M. K., Ahmed, M. F., 2012). Recently the DWASA has prepared a 23-year Master Plan for improvement of the sewerage system of the city. The plan considers increasing the sewerage network coverage up to 100%. Under the master plan, the only existing treatment plant in Pagla will be rehabilitated, and five new treatment plants will be constructed in Savar, Tongi, Keraniganj, Purbachal and Gazipur in the third phase, by 2035.

In case of Chittagong, the second largest city of Bangladesh, there is no sewerage system yet. However, JICA has offered in 2014 to provide financial and technical support to Chittagong WASA for a sewerage system.

4.8. Industrial Effluent Management

There are thousands of industries located along the canals and rivers of the major cities/towns. These industries almost completely lack any kind of waste water treatment facilities and in general, the untreated wastes are discharged directly in the canals and river system. More about pollution from industrial effluent is discussed in the section "Pollution from Industries" under the section 4.3.3. Table 20 gives an overview about the extent of industrial effluent pollution alongside the major rivers of the country. In this context, identification of hot spots and integrated short and long term plans is required for sustainable management of the industrial pollution.

4.9. E-Waste Management in Bangladesh

Not much is known about the extent of e-waste and hazardous waste generation and management system of Bangladesh as no inventory has been done yet on these issues. Though some initiatives were taken by some private sectors to know the generation rate of e-waste, in many cases the methodology of their study was not scientifically strong and clear.

As the world is experiencing an era of technological revolution, the use of electronic gadgets is increasing rapidly. In case of Bangladesh, the boom in the ICT sector is very noticeable. The mobile teledensity of Bangladesh is increasing at a very fast rate. While the number of active mobile subscriber was 58.36 million at the end of 2010¹⁵, the number increased to 97.18 million at the end of December 2012¹⁶. Approximately 230,000 computers and 65,000 laptops were sold inside Bangladesh in 2009 alone¹⁷. The uses of other electronic gadgets are also increasing. Bangladesh has started producing electrical and electronic equipment (EEE) in the country very recently. It was found from the study that the lifespan of these equipment (EEE) are decreasing globally with the rapid development in this sector¹⁸. Though there is little information on the rate of usage of EEE in Bangladesh, no authentic information is available on the input

¹⁴ Source: The Daily Star, <http://archive.thedailystar.net/newDesign/news-details.php?nid=249498>

¹⁵ Ahmed, F. R. S. 2011a. E-Waste Management Scenario in Bangladesh. Retrieved from <http://www.unep.org/ietc/Portals/136/Events/WEEE-E%20workshop%20July%202011/01.Bangladesh.pdf>

¹⁶ BTRC (Bangladesh Telecommunication Regulatory Commission). 2013. http://www.btrc.gov.bd/index.php?option=com_content&view=article&id=631:mobile-phone-subscribers-in-bangladesh-january-2012&catid=49:telco-news&Itemid=502

¹⁷ Sarkar P., Hasan M. 2010. Bangladesh. Retrieved from <http://www.giswatch.org/es/node/279>.

¹⁸ Lee J. C., Song H. T., Yoo J. M. 2007. Present status of the recycling of waste electrical and electronic equipment in Korea. *Resources, Conservation and Recycling*. 50: 380–397

or inflow of e-waste into the waste stream of Bangladesh and hence, it is impossible to get the real picture in this field.

A huge informal sector is related in the recycling process of e-waste. There are very less formal facilities related in the sector of e-waste recycling. No separate policy/rules/acts exist for guiding the management of e-waste. Only the National 3R Strategy for waste management mentions the issue of e-waste management and suggests starting the practice of extended producer responsibility (EPR) in the country.

4.10. Hazardous Waste Management

An inventory of hazardous waste management was published by Department of Environment, in 2010 where textile dyeing industries, hospitals and clinics, tannery, pesticides, fertilizers and oil refinery etc were enlisted as possible sources of hazardous waste in Bangladesh.¹⁹ Only recently (2011) a rule titled "Hazardous Waste and Ship Breaking Waste Management Rules, 2011" was gazetted. However, there is no clear information on the generation and management of hazardous waste management in Bangladesh and the law enforcement is very weak in this regard. Consequently, the environment, specially the surface water of Bangladesh is severely degrading.

4.11. Environmental Pollution in Chittagong Hill Tracts

Environmental pollution status in hill tract region is hardly addressed in research and planning documents. Scarcity of safe drinking water is a major problem in the CHT area. Groundwater is rich in iron which has bad health impact. The streamwater which is frequently used by the local and indigenous people is contaminated by faecal bacteria. Shifting cultivation has also impact on surface water quality. There is no recorded data on air quality. Solid waste management, waste water management, sewerage management are only limited to urban areas and even those are also not very effective management systems. As these hilly regions are located at upstream of the watershed areas, knowledge of land use management in these areas are very important. The conventional farming practices, use of fertilizers and pesticides has direct impacts on stream water quality.

5. Ongoing National Scale Programmes and Projects

There are very few projects relevant to environmental pollution management ongoing at national scales. Attempts have been made to collect key information about the projects with the purpose of reviewing and creating a knowledgebase for preparation of the Bangladesh Delta Plan 2100. Fact sheets of the projects collected so far are presented below (Table 30 to Table 37).

Table 30: Fact Sheet of Clean Air and Sustainable Development Project

Name of the Project	Clean Air & Sustainable Development
Project Host	Ministry of Environment and Forest
Funding Agency	International Development Agency (IDA) and Government of Bangladesh (GoB)
Executing Agencies	Department of Environment, Dhaka North City Corporation, Dhaka South City Corporation, Dhaka Transport Coordination Authority
Implementation Period	2009 to December 2014

¹⁹DoE (Department of Environment). 2010a. Hazardous Waste Management in Bangladesh: A Country Inventory. Retrieved from http://www.wasteconcern.org/Publication/HazardousWaste_publication_short.pdf

<p>Project Objectives</p>	<ul style="list-style-type: none"> • To strengthen capacity to plan, monitor, regulate and implement Sustainable Environmental Initiatives (SEIs) in transport and brick making industries • To reduce emissions from the brick making industry • To reduce congestion by improving traffic flows • To lay the foundation for reforming the existing bus operations and to introduce Mass Transit such as Bus Rapid Transit (BRT) in capital Dhaka in line with Strategic Transport Plan (STP) of the government • To provide the institutional and regulatory underpinning for initiating bus sector reform and reduce vehicular emissions • To strengthen the institutional capacity to implement Sustainable Urban Transport(SUT)intervention,and • To enhance the capacity to anchor the implementation of various project components. 	
<p>Major Components and Activities</p>	<p>Component I : Environment</p> <p>A. Capacity building for AQM</p> <ul style="list-style-type: none"> i) Air Quality Cell (AQC) ii) Air quality monitoring, data analysis and reporting <p>B. Brick Kilns Emissions Management</p> <ul style="list-style-type: none"> i) Institutional, legal and regulatory aspects ii) Introducing cleaner technologies & practices through pilots & technical services development iii) Communication Campaign iv) BRT Feasibility Study v) BRT Design Study Public Transport Network Study 	<p>Component II : Transport</p> <p>A. Physical improvement of traffic flow and pedestrian mobility</p> <ul style="list-style-type: none"> i) Campaigns for clean and safe mobility ii) Sidewalks and ancillary road improvements: Mohammadpur, Khilgaon and Tejgaon iii) NMV/MV lane separation: Two major corridors iv) One way streets: Mohammadpur and Old Dhaka v) Foot over bridges (FOBs) <p>B. Traffic Signals Synchronization along Mirpur Corridor</p> <p>C. Synchronization of Remaining Existing Traffic Signals, Installation of Countdown Timers and Solar Panels for Existing Signals</p> <p>D. Feasibility Study for improvement of 41 Junctions</p> <p>E. Junction Improvements and Signalization of new Junctions</p> <p>F. Bus Route Network Rationalization and Franchising</p>

Project Outcome	<ul style="list-style-type: none"> • Decrease in particulate emissions per brick kilns adopting cleaner technologies and practices of 20-30% by the end of project period • Reduction in the GHG emissions per brick kilns adopting cleaner technologies and practices by 15-20% compared to the prevailing baseline status • Improved traffic flow in the locations of project intervention due to reduced congestion. The outcome is to reach 10% increase in vehicular traffic throughout by end of the project particularly for those who use non-motorized vehicles and public transport, especially women • A 10% decrease in the number of traffic accidents in the project areas by the end of the project
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Table 31: Fact Sheet of Market Development Activities for Bondhu Chula

Name of the Project	Market Development Activities for Bondhu Chula
Project Host	Department of Environment
Funding Agency	Bangladesh Climate Change Trust Fund (CCTF) and Deutsche Gesellschaft für International Zusammenarbeit (GIZ)
Executing Agencies	Department of Environment
Implementation Period	April 2012 to March 2014
Project's Objectives	Reduce pressure on forest-resources, reduce indoor air pollution, minimize health risk and reduce emission of green house gases by introducing and enabling a market for advance cooking stove (Bondhu Chula)
Major Components and Activities	<ul style="list-style-type: none"> • Five lakh Bondhu Chula will be distributed all over Bangladesh • Five thousand entrepreneurs (one for each Union Parishad) in entire Bangladesh will be created • Market of Bondhu Chula will be developed
Project Outcome	<ul style="list-style-type: none"> • Up to September 2013 approximately 3.5 lakh Bondhu Chula have been installed • In the same time, approximately five thousand entrepreneurs have been created

Table 32: Fact Sheet of Extension and Modernization of Laboratory of Divisional office of DoE in Chittagong

Name of the Project	Extension and Modernization of Divisional Laboratory of DoE, Chittagong for enhancing capacity of monitoring and examining the impact of climate change
Project Host	Department of Environment
Funding Agency	DoE, total fund 1432.42 lakh
Executing Agencies	Department of Environment
Implementation Period	January 2012 – December 2014

Project's Objectives	<ul style="list-style-type: none"> • Enhancing capacity of activities of monitoring climate change impacts, • Controlling Pollution in Sea • Mentoring and analysis of inland river water quality, air quality, Soil quality • Monitoring, evaluation and documentation • Identification and analysis of microbe and chemical agent in Shrimp and Fish
Major Components and Activities	<ul style="list-style-type: none"> • Infrastructural development of laboratory • Procurement and installation of modern equipment • Human Resources Development & Training for capacity building and on modern laboratory equipment • Monitoring, evaluation and documentation • Monitoring of marine biodiversity • Monitoring and analysis of inland water quality, sea water quality, air quality, soil quality • Microbial and Chemical testing of shrimp and fishes
Project Outcome/Achievement	<ul style="list-style-type: none"> • Completion of 5th and 6th floor of divisional laboratory • Processing of procurement of laboratory equipment

Table 33: Fact Sheet of CDM Using Municipal Organic Waste of Towns (City Corporation/Municipalities)

Name of the Project	CDM Using Municipal Organic Waste of Towns(City Corporation/Municipalities) in Bangladesh
Project Host	DoE
Funding Agency	Bangladesh Climate Change Trust Fund (BCCTF)
Executing Agencies	DoE
Implementation Period	First pilot phased started in April 2010 and was scheduled to be completed in March 2012 (later revised to December 2013)
Project's Objectives	<ul style="list-style-type: none"> • Reduction of Green House Gas (GHG) from the Municipal waste • Introduction of 3R (Reduce, Reuse and Recycle) concept • Awareness building among the city dwellers about 3R concept • Building clean and healthy city in Bangladesh • Providing alternative income generation activities to poor people of urban areas by converting waste to compost fertilizer • Providing additional financial assistance for waste management through selling CER in the international CDM Market • Improving soil quality by using organic fertilizer
Major Components and Activities	<ul style="list-style-type: none"> • Baseline survey for the estimation of the rate of waste generation in the urban areas in Bangladesh • Baseline survey for identification of physiochemical characteristics of waste generated in the urban areas in Bangladesh • Baseline survey for GHG emission in the municipal waste sector; • Preparation of Project Idea Note (PIN) and Project Design and Documents (PDD) for programmatic CDM for 64 districts • Training and awareness building for implementation of 3R concept in waste management system

	<ul style="list-style-type: none"> • Construction of composting plant and transfer station in the project areas • Waste Collection and separation involving civil society and NGOs • Producing compost fertilizer using organic waste through compost plant • Selling Certified Emission Reduction (CER) in the international CDM market
Project Outcome/Achievement	<ul style="list-style-type: none"> • Baseline Survey and Chemical test have been completed • Construction of compost plant for Narayanganj City Corporation started 21 April 2013

Table 34: Fact Sheet of Implementation of 3R (Reduce, Reuse and Recycle) Pilot Initiative (Phase-1)

Name of the Project	Implementation of 3R (Reduce, Reuse and Recycle) Pilot Initiative (Phase-1)
Project Host	DoE
Funding Agency	Bangladesh Climate Change Trust Fund (BCCTF)
Executing Agencies	DoE
Implementation Period	a) Original : April 2010 -March-2012 b) Revised : April-2010 to March-2014
Project's Objectives	<ul style="list-style-type: none"> • To promote 3R initiative throughout Bangladesh. • To raise public awareness about the benefit of waste segregation at source and recycling of waste. • To reduce the amount of waste in land filling areas • To take initiative for the management and recycling of waste by using public-partnership as a tool. • To introduce the 3R strategy in corresponding project areas through exhibition and pilot program. • To create job opportunity for the poor city dwellers. • To train-up and empower the stakeholders engaged with the waste management and recycling process. • To integrate the project initiative with the existing recycling and composting business. • To encourage producers, customers and factory owners already practicing the principles of 3R. • To reduce green house gas emission from land filling activities.
Major Components and Activities	<ul style="list-style-type: none"> • Leaflets- 150,000, Booklets/Fliers -10,000 • Advertisement in TV, Radio & Newspaper • Training – 1250, Workshop (Dhaka-06, Chittagong-04) total10, Seminar (Dhaka-03, Chittagong-02) total 5 • Community focus group meetings/other meetings – 20/08, Purchase of 6 Vacuum Cleaner Trucks. • Purchase of 240,000 Bins of 3 Types(Red, Yellow and Green) • Purchase of 300 Rickshaw Vans • Construction of 06 transfer stations and 03 Compost Plants • Operation & maintenance of transfer stations and Compost Plants (Dhaka & Chittagong) • Purchase and installation of blower • Digital Weighing Scale
Project Outcome/Achievement	<ul style="list-style-type: none"> • Distribution of Leaflets (121000) • Conduct Training (1250) and Workshop (Dhaka-06, Chittagong-04) • Community focus group Meeting/other meetings- 14 Nos

	<ul style="list-style-type: none"> • Purchase of 6 Vacuum Cleaner Trucks. • Purchase & distribution of 180,000 Bins of 3 Types(Red, Yellow & Green) • Purchase of 15 Rickshaw vans
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Table 35: Fact Sheet of Institutional Strengthening for the Phase-out of Ozone Depleting Substances (Phase-VI)

Name of the Project	Institutional Strengthening for the Phase-out of Ozone Depleting Substances ODS (Phase-VI).
Project Host	DoE
Funding Agency	Multilateral Fund (MLF) through United Nations Development Programme (UNDP).
Executing Agencies	DoE
Implementation Period	July 2011 to June 2014
Project's Objectives	Main objective is to follow up the activities of the Ozone Cell as constituted within the DoE under Phase-I to function as the focal point for coordination of all activities related to the implementation of the phase-out action plans specified in the Country Programme.
Major Components and Activities	<ul style="list-style-type: none"> • To meet Protocol obligation • To control ODS import and uses as per requirement of Montreal Protocol • To raise awareness activities • To amend existing rules of ODS as per accelerated phase-out schedule of MP held during 19th MOP • Enactment of new rules for pharmaceutical sector • To assist implement other ODS related projects • To assist foreign mission related to Montreal Protocol • To assist the government on policy related matter • To assist promote use of alternatives
Project Outcome/Achievement	<ul style="list-style-type: none"> • Control ODS import and uses as per Montreal Protocol • Raise awareness activities • HCFC survey for the year 2009 & 2010 has been done and baseline consumption of HCFC has been determined • HCFC Phase-out Management Plan -HPMP Stage-I has been prepared & approved by 65th Ex.Com meeting • International Ozone Day is observed each year on 16 September • Commemorative stamp has been released on 25th anniversary of Montreal Protocol & another commemorative stamp has been released for the achievement of phasing out CFCs from Metered Dose Inhaler productions • Bangladesh has been appreciated & recognized by UNEP for her achievements in Montreal Protocol related activities • Draft of amended "Ozone Depleting Substances (Control) Rules, 2004" is underway for vetting • Assist implement other ODS related projects • Assist foreign mission related to Montreal Protocol • Assist the government on policy related matter • Assist promote use of alternatives

Table 36: Fact Sheet of Conversion from HCFC-141b to Cyclopentane technology in the manufacture of insulation foam in domestic refrigerators at Walton Hi-Tech Industries Ltd, Bangladesh

Name of the Project	Conversion from HCFC-141b to Cyclopentane technology in the manufacture of insulation foam in domestic refrigerators at Walton Hi-Tech Industries Ltd, Bangladesh
Project Host	DoE
Funding Agency	Multilateral Fund (MLF) through United Nations Development Programme (UNDP).
Executing Agencies	DoE
Implementation Period	July 2011 to June 2014
Project's Objectives	<ul style="list-style-type: none"> • The objective of this project is to phase out the use of HCFC-141b in the manufacture of insulation foam for domestic refrigerators in Walton Hi-Tech Industries Limited, Bangladesh. This will result in phasing-out 183.7 MT of HCFC-141b in Bangladesh as per 2009 survey report • The specific objectives are: <ol style="list-style-type: none"> 1. To Provide specific equipment necessary for the conversion from HCFC-141b to cyclopentane technology; 2. To provide incremental operating cost to minimize the loss of the company during the conversion project and to stable the market price of the product 3. To ensure safety and environmental sound technology within the project
Major Components and Activities	<ul style="list-style-type: none"> • Civil and miscellaneous works • Electrical Works for conversion complying with safety regulations • Procurement of new equipment • Retrofit / replacement of existing equipment • Technical assistance from external process expert and training of project personnel • Trial production • Safety audit, and • Commissioning of newly established plant
Project Outcome/Achievement	<ul style="list-style-type: none"> • Civil and miscellaneous works • Electrical Works for the conversion complying with safety regulations • Procurement of new equipment • Retrofit / replacement of existing equipment • Trial production • Commissioning of newly established plant • HCFC-141b has been phase-out for foam production in refrigerator sector in Bangladesh in December 2012, now underway for vetting

Table 37: Fact Sheet on Phase-out of CFC Consumption in the Manufacture of Metered Dose Inhalers (MDIs) in Bangladesh

Name of the Project	Phase-out of CFC Consumption in the Manufacture of Metered Dose Inhalers (MDIs) in Bangladesh
Project Host	DoE
Funding Agency	Multilateral Fund (MLF) through United Nations Development Programme (UNDP).
Executing Agencies	DoE
Implementation Period	July 2008 to June 2014.

Project's Objectives	<ul style="list-style-type: none"> • Main objective of this project is phase-out the consumption of 76.3 ODP Tonnes of CFC-11 and CFC-12 used in the manufacture of Metered Dose Inhalers (MDIs) in Bangladesh by 2013; • The specific objectives of the project are: To phase-out the use of CFC through converting CFC-based MDIs in Beximco Pharmaceuticals Ltd., The Acme Laboratories; and Square Pharmaceuticals Ltd. to HFA based products by providing Technical and Financial assistance under the project.
Major Components and Activities	<ul style="list-style-type: none"> • Development of HFA based MDI product through subcontract; • Procurement of equipment • Clearing imported equipment from the port; • Retrofit; • Training on the use of retrofitted equipment for HFA based MDI production; • Disbursement of incremental operating costs.
Project Outcome/Achievement	<ul style="list-style-type: none"> • Development of HFA based MDI product; • Retrofit for HFA based MDI production; • Launched HFA based MDI in the market; • Disbursement of incremental operating costs; • CFCs have been phased-out from MDI production in pharmaceutical industries in Bangladesh on December 2012.

6. Planning Context

6.1. Present Issues and Challenges

- **Growth of ship building and recycling industries in coastal and marine area recognized as ecologically sensitive area**

The ship building and recycling industries are growing in the coastal area, especially in Chittagong coast of Meghna Estuary. The Meghna estuary and the adjoining coast are also recognised as biodiversity hotspot. The environmental departments of the government are giving emphasis in protecting these areas. On the other hand for the sake of the economic growth, other ministries like Ministry of Industries, Ministry of Shipping, Ministry of Power, Energy and Mineral Resources are promoting industrial development in coastal region.

- **Conflict between development activities and ecologically critical areas**

For example Government has a plan of building a deep sea port at Sonadia Island of Maheshkhali, Cox's Bazar, which is a declared Ecological Critical Area and one of the country's biodiversity hotspot. Similarly, some coal based thermal power plants, ship building industries, and other heavy polluting industries are growing near Sundarbans and its surrounding Ecological Critical Area. The Mongla Port, the Mongla EPZ, several cements industries are already in the ecological critical area where any industrial activities are restricted.

- **Restoration of Polluted Rivers**

Restoration of the heavy polluted rivers like Buriganga, Sitalakhya, Tongi, etc is one of the critical environmental issues. The identified plans and options for restoration so far are not beyond criticism. The flow augmentation and restoring connectivity might spread pollution to other rivers. Again dredging and disposal as well might raise the problem of re-suspension of pollutants (especially heavy metals) absorbed in bottom sediments.

- **Trans-boundary Pollution**

Trans-boundary air pollution is one of the major causes of top dying disease of Sundari Tree in Sundarbans Mangrove. A numbers of brick making industries developed in India along the border of south-western region of Bangladesh are also sources of pollution in Bangladesh as observed by different researches. Bangladesh shares 57 criss-crossing boundary rivers with India and Myanmar. The development and industrial activities happening in the upstream countries also have impacts on the river water quality of the downstream riparian countries. Water quality has not been discussed yet in the trans-boundary river treaties. But if the trend of deterioration of water quality is followed properly in major rivers, it would become one of the most important issues in trans-boundary water sharing.

- **Coal Based Power Generation**

With the aim of reducing high dependency on natural gas, Government of Bangladesh is giving priority on generating 20,000 MW (which is 50% of total generation of 2030) electricity from coal based thermal power plants by 2030. Coal based thermal power plants are historically blamed for causing heavy pollution. Though, the future plants will be of advance technologies and comparatively less pollution causing, these are still issues of environmental concerns.

- **Energy Development and production ensuring Environmental Safeguard**

The natural gas reserve is declining. We need to go for further exploration and mining. The potential gas and coal reserve areas are in places which are already of environmental concern. Socioeconomic issues, land acquisition, subsidence, groundwater level drawdown, groundwater pollution, etc. are the issues that obstructed the further development of coal mining in north-western region which is one of the largest coal deposit regions of the country. Once, the Govt of Bangladesh showed keen interest on exploration of oil and gas in the marine and coastal areas of the country, while the Petroleum Corporation was also keen on oil and gas exploration in the Sundarbans. But the international historical records of severe environmental damage from such activities raised the issue of environmental risk. Energy development ensuring the environmental safeguard is always one of the hot issues. Some environmentalists believe safeguarding environment in mining activities is always a myth that never happened.

- **Guiding Landuse Changes Ensuring Protection of Natural Landscape**

Conservation of natural landscape especially the wetlands, forests, hilly areas, flood plains, flood flow zones, etc is another pressing issue in the context of land use change due to urbanization and industrialization. The growing demand of settlements and industrial development restricts the conservation of natural landscape. The forest lands, wetlands, hilly areas, floodplains, inter-tidal areas are converted to other landuse for meeting the demand of housing, food, and economy as a whole. The legal instruments e.g. Landuse Policy 2001, ECR 1997, etc are not giving any promising results in controlling the unplanned landuse change. The issues related to enforcement of law and governance, transparency, political and business pressures, etc are also related to the issue of sustainable landuse change.

- **Implication of Economic Valuation of Ecosystem Services in Natural Resources Management**

The economic valuation of ecosystem services and its implication in natural resources management is considered effective to achieve the goal of environmental protection. But the ecosystem services are not always easily visible and people are not sometime willing to pay for enjoying the services. The complexity in economic mechanism of valuing the services and its implication, and the social readiness are the barrier for its adoption in natural resources management. However, the recently published National Environmental Policy (2013) recommends for consideration of value of ecosystem services along with the economic values of the ecosystem resources in national development planning.

- **Protection of Forest Resources, Sanctuaries, and Ecological Critical Areas**

Extraction of resources e.g. fuel wood, fisheries, food, roofing and thatching materials, medicinal ingredients, etc are prohibited or limited in forests and wetlands which are declared as sanctuaries and ecological critical areas. These embargos affect forest and wetlands dependent livelihoods. Government is now managing these protected areas through integrated and co-management approach. However, the dependent locals are still blaming the government for loss of their livelihoods.

- **Integration of different government department and private parties**

Integration of different government departments in environmental protection and management is realized by all and recommended in National Environmental Policy 2013 but the effectiveness is still faraway. How this integration can be made effective is still a debate and remains environmental governance issue.

- **Enforcement and Monitoring of law, rules and regulations**

Despite of having a good legislative platform, the effective enforcement and monitoring of laws, rules and regulations are not achieved yet. The issue becomes complex due to its nature and its relation with environmental governance, transparency, public participation, private participation and interaction among relevant government departments. The issue is commonly addressed in every policy and planning document, but no one has been able to find a solution.

- **Pollution from Agricultural Field**

Pollution from agricultural field is a commonly addressed issue. Excess use of fertilizer and pesticides seep into the water bodies and ultimately find their way to the river. One of the major sources of sediments in rivers and particulate matter in air is agricultural lands. Sustainable farming practices e.g. integrated pest management, use of natural fertilizers, optimum use of water for irrigation, etc. are commonly suggested by different policy and planning documents. However, low level of knowledge of the farmers, financial barrier, and lack of necessary technical supports obstruct sustainable farming practices.

- **Availability of land for large scale water and wastewater treatment plant, waste management plant, land filling sites**

Land is one of the limiting resources. Land availability for different development activities is becoming very complex issue in the cities, urban areas and even in rural areas. The present state of environment and the socio-economic development is a challenge for building of large scale water and wastewater treatment plants, solid waste management plants and sanitary land filling sites in urban areas. Land availability will be one of the major issues that need to overcome before building new water and waste water treatment plants, waste management plants and land filling sites.

- **Issue of land availability and appropriate environmental management of dredged spoils**

Government is emphasizing on capital dredging in major rivers and navigational routes. The management of these dredged soils would be a major issue due to lack of land availability and pollution risk from these dredged spoils.

- **Ensuring protection of ecosystem and habitats in channelization of major rivers**

Bangladesh Water Development Board is planning to channelize the Jamuna River with the aim of better management of the river for the purpose of navigation and ensuring safety from natural disasters. But the question arises: how the other habitats e.g. in charlands, shallow mudflats, submergible sand bars, shallow water areas, etc. will be protected and conserved. The diversified fish and aquatic biodiversity largely depend on these diverse habitats.

Table 38: Environmental Pollution Related Issues and Challenges

Sl no	Issue	Challenge
1	Growth of ship building and recycling industries in coastal and marine areas	<ul style="list-style-type: none"> • Safeguarding Environment Conservation Act (ECA) and cleaner technology in ship breaking and building
2	Restoration of polluted rivers	<ul style="list-style-type: none"> • Safe disposal of polluted bed soil dredged from river
3	Trans-boundary pollution	<ul style="list-style-type: none"> • Bringing issue of trans-boundary pollution in political table
4	Coal-based power generation	<ul style="list-style-type: none"> • Adopting cleaner technology in power generation
5	Guiding landuse changes ensuring protection of natural landscape	<ul style="list-style-type: none"> • Implementing landuse policy, land zoning
6	Bringing all waste and waste water in management process	<ul style="list-style-type: none"> • Availability of land for large scale water and waste water treatment plant, land filling sites
7	Cost recovery of wastewater treatment plants, solid waste management plants	<ul style="list-style-type: none"> • Increasing waste management charge (rate), water charge, etc • Enforcing polluter pay principle
8	Impact of channelization of major rivers on ecosystem	<ul style="list-style-type: none"> • Ensuring protection of ecosystem and habitats in channelization of major rivers

6.2. Trends and Forecasts and Drivers of Change

A trend of increasing pollution in rivers and seas, air-sheds and soil is clearly visible. Now most of the rivers passing through the large cities are polluted. In future, this pollution may spread further downstream. Due to increase of population, unplanned development of urban and industrial areas, number of polluted rivers will be increasing. Now, air quality of the city areas are highly polluted; in future same will be seen in the other urban areas like district towns, upazila towns, etc.. Government is taking different initiatives, but the focus is on large city areas. Unsustainable and unplanned development is continued in the other urban areas.

To identify long term and short term policy measures, attempts were made to identify and understand the drivers of change. The following drivers of changes are important, and should be targeted in the planning process.

- **Transportation** – In the air-shed, the oxides of Nitrogen – NO_x concentration is increasing and already exceeded the EQS. The major source of NO_x is the vehicular transports. Improvement of transportation sector, reducing traffic congestions, introducing less polluting alternative fuel, improvement of public transports, etc would bring positive changes in improving air quality. Shifting of major goods transportation from road and rail to river would also reduce pollution as the water transportation is less polluting means of transportation.
- **Sewerage Treatment** – Rivers which are flowing through any city or in its immediate neighbourhood are subject to sewerage pollution. In most cases, major portion of sewerage ultimately falls into the rivers. Sewerage treatment is the driver of change that has potential to make a change in river pollution status.
- **Construction Activities in Mega Cities**– In Dhaka and other mega cities, PM_{2.5} and PM₁₀ are major pollutants that cause degradation of air-sheds. The concentration of PM_{2.5} and PM₁₀ exceeds the standard limit very frequently. The major source of PM_{2.5} and PM₁₀ is construction activities. Efficient environmental management of construction activities to control dust and other pollution will significantly improve the air quality.
- **Central Effluent Treatment Plant (CETP)** – One of the major sources of river water pollution is industry. Legally, all the industries subject to effluent discharge which should be equipped with effluent treatment plant. In practical, most of the industries do not have the ETP or even if they have it, they do not operate it.

Cost of treatment, lack of expertise, lack of available land, etc are the common excuses. However, a joint central effluent treatment plan built by several industries together may solve the issue of land availability, cost and knowledge. In industrial zone, a common central effluent treatment plant is also a suitable solution.

- **Environmentally Safe Operation of Shipping and Transshipments** – Government is giving priority on improving navigational system in the country as the river traffic is increasing in the inland rivers and ports. On the otherhand, ship pollution is becoming a major environmental issue; for example, the rivers Buriganga, Passur, Karnaphuli, Kirtankhola, etc. Navigational routes through Sundarbans are also polluted by ships. Control of ship pollution and ship accident through safe operation would improve water quality of rivers used for navigation.
- **Science and Technological Innovation** – Technological innovation is very much essential in industrial sectors. New innovation of non-polluting technology and their adoption in industries has great potential to improve the environmental quality.
- **Regional Cooperation** – Watersheds do not follow any political boundary. To prevent and control the boundary pollution in trans-boundary rivers, regional cooperation is an absolute necessity.
- **Demography and Urbanization** - Pollution is strongly correlated with growth of population and urban areas. Bringing sustainability in urbanization and population growth would control the pollution and improve the environmental state.

6.3. Future Tipping Points

Ambient environmental standards may be considered (e.g. Air Quality Standard, Water Quality Standard, Standards for metal/heavy metal concentrations in soils, etc.) as the environmental tipping points. The state of environment has already reached the environmental tipping points. Water quality in most of the rivers surrounding the large cities are heavily polluted, the air-sheds in major cities especially Dhaka, Narayanganj, Gazipur, Chittagong, Barisal and Rajshahi are already degraded; heavy metal pollution in soils is becoming another major concern. Therefore the environmental tipping point is already reached. However, for the purpose of the long term planning, the ambient environmental quality standard might be considered as threshold or tipping point.

7. Interlinking with Other Thematic Studies

The Bangladesh Delta Plan 2100 aims at developing baseline report of 19 thematic sectors. These sectors are interlinked with each other. One of the major objectives of the thematic study is to explore the interlinking of the studies with the aim to converge and integrate into Bangladesh Delta Plan. The interrelationship of environmental pollution with other thematic sectors is discussed in this chapter.

7.1. Air Pollution

Air Pollution is closely related with industrial activities, transportation system, land management system, agricultural practices, urbanization, infrastructure, etc (Figure 15). Strategic intervention, technological shift and green initiatives in any of the interlinked thematic sector could bring significant change in the state of air pollution. For example, conversion of petroleum based automobiles into CNG operated automobiles significantly improved air quality of Dhaka city. Now, Ministry of Environment and Forest launched a project titled 'Clean Air and Sustainable Environment' integrating transportation sector, brick making industries and environmental components. Delta Plan also aims at coming up with plans of similar integrated projects.

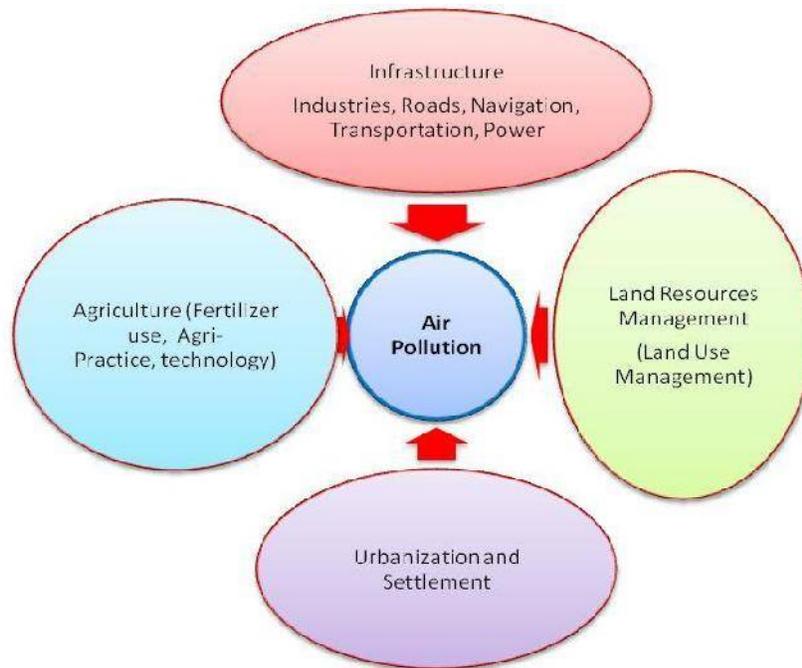


Figure 16: Interlinks of Air Pollution with Other Thematic Study

Therefore, the development plan to be prepared under different thematic studies will consider its possible impacts on environmental pollution. Especially, the strategic plans and planning measures to be identified for the infrastructure sector including roads, navigation, transportation power, land resources and land use management, urbanization and settlement, agriculture and food security, public health, water supply and sanitation, forest and biodiversity, and ecological settings, will consider the objective of improving air quality of the country.

7.2. Soil and Water Pollution

Soil and water pollution is also closely related with thematic studies on water resources, river system management, climate change and disaster management, agriculture and food security, infrastructural development, industrial development, coastal polder issues, etc. For example, loss of connectivity among floodplains, beels and other bodies, and rivers results lost of function of floodplain, beels and other water bodies in purification of river water.

The floodplain, beels and tidal marshes act as Silica (Si) recycling. Biogenic and amorphous Silica enter into these water bodies and get transformed into biologically available Silica, which in turn, comes back to the rivers to increase the growth of primary producers like Diatoms (Diatom represents 50% of total primary production in coastal and marine water (Struyf, Damme, Gribsholt, & Meire, 2005)). This Silica recycling function of tidal marshes, beels and floodplains will be lost due to separation of these water bodies from the rivers by poldering. Weathering of Silicate mineral is the major source of Silica in marine and river water and there is no anthropogenic source of Silica (except a minor amount from washing powder). Therefore biological recycling of Silica through the water bodies is essential for continuation of the primary production in marine and river water.

The Tidal marshes and floodplain also play important role in the removal of Nitrogen and Phosphorous from river water and ultimately prevent algal bloom. Thus coastal polder issues become very important for water pollution management planning.

The river water quality has close interrelationship with the land use management in watershed areas. Thus trans-boundary issues become integral part of the pollution management. The interlinking issues and linkage of water and soil pollution with other thematic sectors are depicted in Figure 16 below.

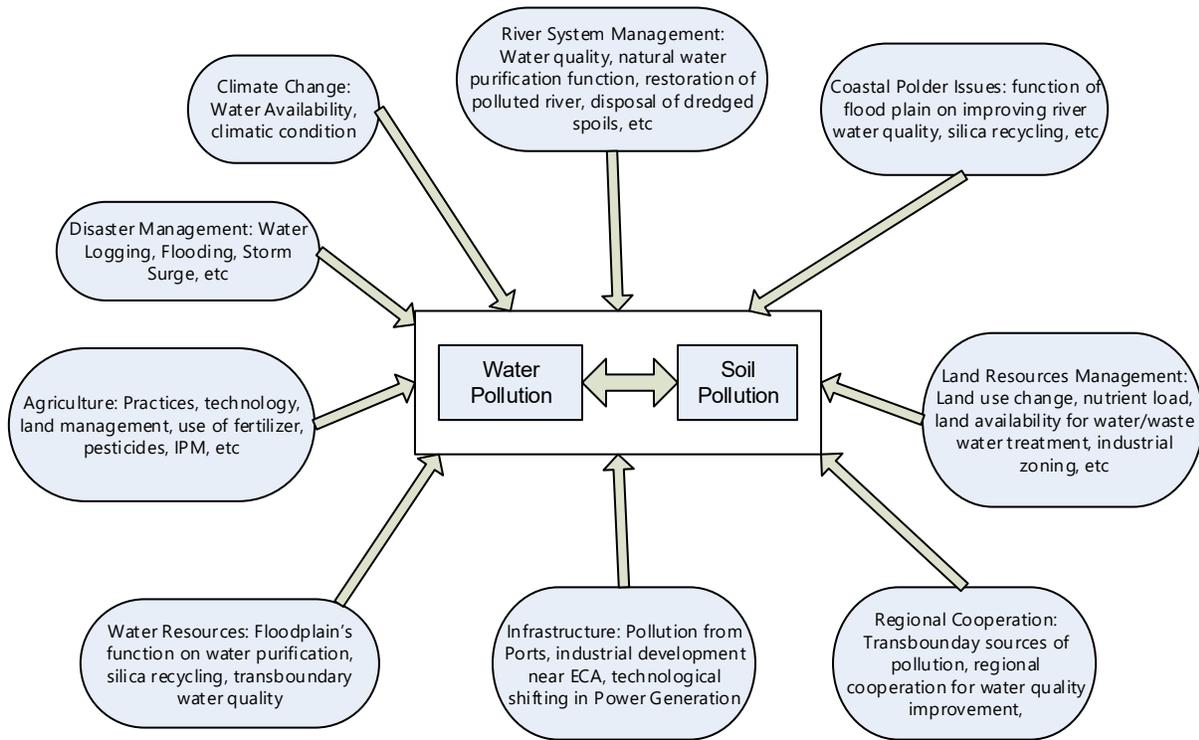


Figure 17: Interlinking of Water and Soil Pollution with other Thematic Sectors

8. Knowledge Gaps

Planning process (in line with the objectives of the Bangladesh Delta Plan 2100) encounters significant gaps in knowledge. The knowledge gap is wider in water and soil pollution sector in comparison to air pollution sector. Department of Environment is maintaining a good database of air quality of the major cities. On the other hand, data on soil pollution is very limited. DoE collects water quality of the major rivers monthly. Unlike to air quality monitoring, there is no continuous monitoring station for monitoring water quality. However, important knowledge gaps revealed from the baseline study are discussed below.

- **Reliable Data of Water Quality of Major Rivers**
 - ❑ Large mismatches among different published water quality data
 - ❑ Limited capacity of DoE in regular collection and analysis of water quality data
 - ❑ Few parameters are tested monthly by DoE in major rivers (not beyond the issue of reliability and uncertainty)
 - ❑ No continuous monitoring locations
 - ❑ Lakh of digital database
 - ❑ No data on quality of water coming from trans-boundary sources
- **Data of Soil Quality**
 - ❑ No data base on soil pollution (SRDI maintains soil fertility data base but not pollution)
- **Data Gaps in Air Quality**
 - ❑ Not all the continuous monitoring stations are working
 - ❑ No data on rural and sub-urban area
- **Emergency Response**
 - ❑ No available real time water quality monitoring setup
 - ❑ No real time modelling system for monitoring accidental spill of chemical, oil, or any hazardous substances
- **Knowledge on Climate Change Related Issues**
 - ❑ Future pollution scenario (water quality, air quality, etc)
 - ❑ Impact of climate change on state of environment (water quality, air quality, soil quality, etc)

9. Opportunities for Preparing Long-term Plan

From the analysis of policy documents, existing literature, suggestion and expectation of different stakeholders and evaluation of the current situation, the following strategic measures have been outlined. The measures may be useful for a long-term plan to incorporate in the Bangladesh Delta Plan 2100 after further evaluation and assessment.

- a) **Pollution Prevention and Control**
 - Capacity building of Department of Environment in enforcement of relevant environmental rules and regulations
 - Land zoning of industries
 - Promoting low/no polluting technology
 - Introduce and promote different environmental improvement initiatives and green initiatives e.g. green building, energy efficient building, zero emission building, green city, etc.

- Introducing environmental audit, energy audit and water audit along with financial audit
- b) Pollution Monitoring**
 - Capacity building of DoE in monitoring, investigating, and examining pollution
 - Improvement, modernization and standardization of divisional laboratories of DoE
 - Development of mechanism of regular monitoring, certification and standardization of different private laboratories
 - Development of laboratories at district level office of DoE
 - Installation of continuous online monitoring system for water quality, air quality and soil quality
 - Capacity building in the offices of DG Shipping, Bangladesh Inland Water Transport Authority, Chittagong Port Authority, and Mongla Port Authority for effective monitoring of ship pollution, inspection, certification and standardization of vessels
- c) Emergency Response**
 - Develop and institutionalization of adaptive mechanism for emergency response to any accidental release/discharge/spill of any chemical substance (liquid and gaseous petroleum, oil, chemicals, etc) with
 - Institutional, legal and financial capacity
 - Knowledgebase:
 - real time monitoring system
 - exposure modelling, real time risk modelling
 - models for forecasting transport of hazardous chemicals, oil, etc after accidental release/spill or discharge
 - Human Resources
 - Equipment and other facilities
 - Capacity building of DG Shipping, Bangladesh Inland Water Transport Authority, Chittagong Port Authority, Mongla Port Authority and Department of Environment to administer and execute emergency response activities
- d) Treatment and Management**
 - Extending the sewerage network to cover 100% area of city area
 - Bringing all sewerage in treatment plant
 - Enforcing 'Zero Discharge of waste water' principle
 - Planning and Implementing Industrial Zoning with central effluent treatment plant for each zone
 - Construction of sewerage network and waste water treatment plant in every upazila town by 2100
 - Enhancement of capacity of existing waste water treatment plant
 - Initiate community based sewerage management system in rural areas
 - Public Private Initiative in water treatment, sewerage treatment, industrial waste water treatment
 - Creation of buffer zone in floodplain areas along the major rivers to allow natural removal of Nutrient Load (N and P) from river water, recycling of Silica (especially in coastal region),
 - Construction of Ship Waste and wastewater treatment facilities at Mongla and Chittagong Port area with waste and waste water collection system from ships
 - Revise the Port's Ordinance to stop harmful polluting activities by ships e.g. oil spillage, discharge of ballast water, bilge water, other wastewater
 - Implement 3R principle
- e) Restoration of Polluted Environment**
 - Improvement of Environmental/Ecological Health of Rivers flowing through or near the cities and urban areas e.g. Buriganga, Sitalakkhya, Turag, Balu, Bongshi, Moyuri (in Khulna), Karnaphuli (Chittagong), etc.
 - Hydrological restoration of major river network
 - Improvement of Environmental/Ecological Health of different lakes/canals flowing through urban areas, major cities, town etc.

f) Strategic Change in other sectors interlinked with Environmental Pollution

- River transport is the least pollution option compared to road and rail transportation. If navigability of the rivers is improved, it would greatly improve the pollution status of rivers. This would be a good environmental improvement initiative and a bulk of goods may also be transported through river crafts.
- Improvement of public transport- metro rail, Rapid Bus Transit, good rail network, good network of navigable rivers
- Introduce energy efficient and low polluting technology in power production, for example – ultra-supercritical boiler technology, clean coal technology, renewable energy-based generation, etc.

g) Financial Mechanism of Pollution Prevention, Control and Management

- Enforce Polluter Pay Principle
- Provision of fiscal and other financial incentives for retro-fitting of for reduction of effluents from industries
- Tax incentives/exemption for importing advance low/no polluting machineries, adopting low/no emission technology in Industrial activities
- Cost Recovery through different instrument like sewerage tax, water tax, pollution tax, etc

10. Conclusion

As different components of the ecosystem and environment interacts with each other and they are interlinked, Delta Plan 2100 would be incomplete if it does not consider all the major aspects of Bangladesh from the view point of deltaic management and environment. If environmental pollution is ignored during the formulation of Bangladesh Delta Plan 2100, the synergic effect of environmental pollution and degradation can become the menace to eventually make the whole plan obsolete. Moreover, the economy and public health condition of a country is closely connected with the level of environmental pollution. The review of the baseline situation of the environmental pollution in this study does not give a satisfactory picture of the state of environmental pollution in Bangladesh. Such severe pollution and degradation is taking place in the country which is accelerated by the unsustainable development process, anthropogenic (man-made) activities and climate change. The relevant policies, strategies and acts were analysed thoroughly to find out the gaps for finding out the sectors where improvement is required. The roles of relevant stakeholders with the theme of environmental pollution were also analysed in this report.

In addition to discussing the present scenario of environmental pollution of different sectors, different relevant ongoing national scale programs and projects were discussed briefly. Moreover, a separate chapter (7) of this report is dedicated to find out how the environmental pollution theme is interlinked with the other themes of Bangladesh Delta Plan. As Bangladesh is a developing country, the environment sector was not valued properly due to other priorities. Therefore, during the course of this study some limitations were faced by the study team, in addition to collection of sparse data in the relevant field. Only recently, the government has taken some initiatives in some specific sectors. Therefore, it was not possible to analyse long term data of the pollution sectors of this country, which could have given a better understanding about the status of environmental pollution.

However, there are some opportunities in case of preparing long-term plan in Bangladesh which are identified from the view of pollution prevention and control, pollution monitoring, emergency response, treatment and management, restoration of polluted environment, strategic change in other sectors interlinked with environmental pollution, financial mechanism of pollution prevention, control and mechanism.

Some specific comments are given below:

1. There are too many laws/acts/rules for administering/ controlling the environmental pollution in the country; also the dealing/ controlling agencies are too many; this only create confusion of who should do what, which delays actual action and implementation of laws and acts. This is a weakness on the part agencies/ organisations responsible for controlling the pollution.

2. Water bodies should be declared as protected areas or ecologically critical areas and must be preserved as such; currently, these are filled up by land grabbers and real estate companies.
3. Bangladesh Water Act 2013: The act requires permit/license for withdrawing large scale of surface or groundwater; however, the maximum amount of water that can be withdrawn is not mentioned in the law. Also, for protecting water bodies, written complaint from the DG, WARPO is required for filing law suit under the provision of this act. This is clearly a hindrance to implement the act.
4. National Land Use Policy 2001 specifies that agricultural land be strictly discouraged for housing, and also restrict of turning agricultural land into housing and other purposes, but due to rural-urban migration, the pressure is increasing and more and more agricultural land are used for housing and other purposes.
5. Dangerous bio-medical waste is dumped near hospitals and river banks, and proper attention should be given to this big problem.
6. Act for Regulating Pollution from Brick Kilns: Except for restricting the use of coal, this ordinance does not talk about air pollution/air quality monitoring or control measures; neither has it described any punishment for the person/owner who pollutes the surrounding air. Though National Environmental Policy 2013 suggests undertaking the measure of emission tax, it does not implement this measure though this could have been a perfect sector of implementing this law. Moreover, as the procedure of producing bricks severely degrades the topsoil of the area, restrictions should be made more stringent, and alternative options should be encouraged.
7. Bangladesh Noise Pollution (Control) Amendment 2014: This act only superficially talks and recommends about the noise pollution in roads. Considering the situation and road culture of Bangladesh, there should be clearer acts for specific actions, such as there should be some measures to control the use of continuous and unnecessary horns on roads. Additionally, inclusion of rules and actions for controlling reckless use of microphone/loudspeaker by the vendors is a time demand.
8. Pollution from industries – stringent rules should be applied for the industries to have effluent treatment plants (ETPs).

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BASELINE STUDY 11

Ecological Settings

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Executive Summary: Study 11

The ecosystem plays an important role in the ecology, economy and livelihood of Bangladesh. However, ecosystem habitats, wetlands biodiversity in Bangladesh have long been facing serious degradation and loss due to many natural and anthropogenic factors. Besides natural causes, factors like overexploitation of resources, lack of awareness, human encroachment, conflicts over natural resource management, pollution, and absence of effective enforcement of laws, are some of the most important factors for the decline in ecosystem habitat and biodiversity of the country.

The objective of Bangladesh Delta Plan (BDP) regarding ecological settings is to develop a long term plan for the sustainable management and conservation of ecosystem which helps conservation of both biotic and abiotic components while enhancing the social and economic benefits of the society. This component of the plan is dedicated to preparation of a management plan for ecosystem, wetlands and biological diversity. The specific objectives of the management plan are as follows:

- Identify the present status of ecosystem and biodiversity
- Know the basic characteristics of bio-ecological zone of the Bangladesh Delta
- Identify the causes of ecosystem degradation
- The species diversity of the existing ecosystem
- Identify the lack of knowledge and problem for biodiversity conservation
- Propose an integrated approach for ecosystem management

This thematic baseline report has been prepared based on secondary information collected through, literature review, consultation with experts from government departments (DoE, FD, DoF and BWDB), and data collected from national and international NGOs (CNRS, IUCN, CBD, BCAS, CMS, and CONCERN).

The findings of the study indicate that in total, 650 species of birds, 126 species of reptiles, 22 species of amphibians, 708 species of freshwater and marine fish, 400 species of mollusks, and over 5,000 species of vascular plants, are found in Bangladesh. These species are found in different parts of the country with multi characteristic ecosystem. A total of 54 species of fish, 8 species of amphibians, 58 species of reptiles, 41 species of birds and 40 species of mammals are listed as threatened wild animals of Bangladesh (IUCN Bangladesh 2000). On the basis of physiographical, hydrological, meteorological, and ecological features, IUCN has delineated 25 bio-ecological zones of the country (Nishat *et al*, 2002). The ecosystems of Bangladesh could be categorized into two major groups, (i) Terrestrial and (ii) Aquatic. The terrestrial ecosystems include homestead, forest, and crop field; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and char sand marine fall into the aquatic category. Each of the ecosystems has many sub-units with distinct characteristics. There are 2 Ramsar sites, 9 Ecological Critically Areas (ECAs), 17 National Parks, 20 Wildlife Sanctuary, 8 Eco-parks and 2 Botanical gardens for protecting ecosystem and its sustainable resources management in Bangladesh (Bangladesh Forest Department). It has been reported in previous studies that there is a total of 3,611 species of angiosperm available in Bangladesh. Out of which, 2,623 species under 158 families belong to dicotyledons and 988 species under 41 families belong to monocotyledons. The overall finding is, it is lack of ecosystem management and knowledge, poor implementation and integration of rules and law regarding ecosystem conservation.

The overall outcome of the baseline study regarding ecological setting will be to preserve and conserve the ecosystem and biodiversity of Bangladesh Delta with special emphasis on continuing services from the natural wetland ecosystem upon which life and livelihoods of people depend. This baseline report would help in preservation of mangrove forests and its gradual regeneration and expansion from a critical ecological function for the delta in terms of ecology and biodiversity.

This report covers the state of biological environment like ecosystem types with its resources, bio-ecological zones, current situations of ecosystem management and past initiatives, problems, gaps, ecosystem services, existing policies and regulations, driving forces, strategy and issues for ecosystem conservation, problems and issues of ecosystem, and possible solutions and future plan which relate to the Bangladesh Delta. The report has also presented the strategy development and implementation arrangement regarding the management of ecosystem conservation in future.

1. Introduction

1.1. Background

Bangladesh is located in the complex interface of the Himalayan and the South-East Asian bio-geographical region. Bangladesh is a land of a varied type of ecosystem which supports rich biodiversity. More than four hundred rivers crisscross the entire country. Most parts of the country are situated in low lying area. Three major river systems originating from the Himalayas provide different ecological scenarios in different zones. The country has also international biodiversity hotspots like Sundarbans, Tanguar Haor, Hakaluki Haor, Lawacha National Park, Sangu Matamuhuri Hill Forest, Saint Martin Island, Sonadia Island, etc. Torrential rains, regular flow from upper Himalayan, Meghalaya hills terrain and regular tidal flow from the Bay of Bengal created an exceptional diversified ecosystem. For these reasons, the ecosystem consequence in Bangladesh is different. The major rivers and their surrounding areas comprise different landforms like floodplain, charland, swamp forest, homestead, canal, *baor*, *haor* and *beels*. The landforms have varied vegetation patterns which create diverse habitats for different wildlife.

The ecosystem of the country can broadly be divided as terrestrial ecosystem (homestead, hill forest, roadside, floodplain, crop field etc.), aquatic ecosystem (sea, river, *haor*, *baor*, *beels*, canal, swamp forest, reedland etc.) and mangrove ecosystem (Sundarbans, coastal floodplain etc.). Most of the ecosystem management activities are implemented through different projects by Department of Environment and Forest, in collaboration with local stakeholders and other NGOs of Bangladesh.

Bangladesh is a country of varied ecosystems with rich biodiversity. A total of 650 species of birds, 126 species of reptiles, 22 species of amphibians, 708 species of freshwater and marine fish, and 400 species of mollusks and over 5,000 species of vascular plants has been recorded in Bangladesh. These species are found in different parts of the country with multi characteristic ecosystem. A total of 54 species of fish, 8 species of amphibians, 58 species of reptiles, 41 species of birds and 40 species of mammals are listed as threatened wild animals of Bangladesh. Despite its size, the country shows distinct geographical variations. These geographical features cause appearance of distinguishable ecosystems across the country. On the basis of physiographical, hydrological, meteorological, and ecological features, the IUCN has delineated 25 bio-ecological zones of the country.

1.2. Objectives

The objectives of the thematic baseline study are:

- To know the present baseline status of ecosystem and biodiversity
- To know the basic characteristics of bio-ecological zone of the Bangladesh Delta
- To identify the causes of environmental degradation
- To know the species diversity of the existing ecosystem
- To know the ecosystem services
- To identify the lack and problem for biodiversity conservation
- To assess the importance of biodiversity and wetlands ecosystem of Bangladesh Delta
- To identify and propose an integrated approach for ecosystem management

1.3. Approach and Methodology for Thematic Baseline Report

This thematic baseline report has been prepared based on information from both secondary and primary sources, which include literature review, consultation with experts from government departments (e.g. DoE, FD, DoF, BWDB), and data collected from national and international NGOs (e.g. CNRS, IUCN, CBD, BCAS, CMS, and CONCERN etc. (**Figure 1**)). The methods used in preparing this report are described below.

Literature review: Different types of secondary sources of information such as scientific report, journal publication, and relevant books information have been reviewed regarding ecosystem.

Stakeholder’s consultation, global and national policy and strategy analysis: Stakeholder consultation meeting has been conducted through workshops and meetings.

Ecosystem profile description with its resources: Different kinds of ecosystem profile such as terrestrial, aquatic has been carried out through secondary information and expert observation.

Strategy designing: Problem wise strategy design has been chalked.

Portfolio development and implementation plan: Priority based future development and implementation plan has been considered for future conservation issues

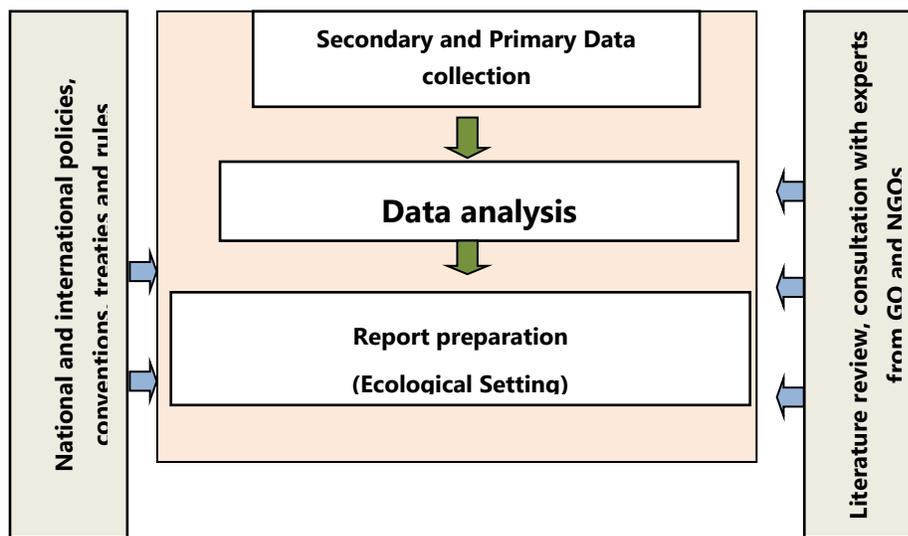


Figure 1: Details of methodology for thematic baseline report

2. Ecosystem Profile

2.1. Bio-ecological Zones of Bangladesh

IUCN Bangladesh divided the whole of Bangladesh into 25 Bio-ecological Zones (Nishat *at el*, 2002) and classified them according to the ecosystem importance, features, and diversity of species (Figure: 2). They are: i) Himalayan Piedmont Plain; ii) Barind Tract; iii) Madhupur Sal Tract; iv) Teesta Floodplain; v) Ganges Floodplain; vi) Brahmaputra-Jamuna Floodplain; vii) Surma-Kushiara Floodplain; viii) Meghna Floodplain; ix) The Haor Basin; x) Chalan Beel; xi) Kaptai Lake; xii) Gopalganj-Khulna Peatland; xiii) The Sundarbans; xiv) Chakaria Sundarbans; xv) The Coastal Plains; xvi) Offshore Islands; xvii) Narikel Jinjira Coral Island; xviii) Sandy Beach/Sand Dunes; xix) Chittagong Hills and the CHT; xx) Sylhet Hills; xxi) The Lalmai-Tipperah Hills; xxii) The Saline Tidal Floodplain; xxiii) Major Rivers; xxiv) Coastal Marine Water, and xxv) Meghna Estuarine Floodplains.

The zonation process has been considered the data of physiography, climate, rainfall, temperature, soil type, flooding depth as agro-ecological zonation process, however BEZ also considered the data and species distribution of flora and fauna of Bangladesh. The earlier initiatives have actively taken the biotic factors into consideration while conducting zonation but not considered the biological community.

Details of the zones are described below.

Himalayan Piedmont Plain

The Himalayan Piedmont Plain occupies parts of Jamalpur, Netrokona, Sherpur, Sunamganj and Sylhet districts. The area is composed of numerous smooth but irregular-shaped ridges with broad and braided rivers. Reeds and grasslands are the characteristic vegetation of this zone. Wildlife species of this zone is also diverse. Although the bird population, like that of mammals, has been affected by the disappearance of its natural habitats, a large number of birds are still found in this zone. This zone, especially its north-western part (i.e. *Tetulia*, *Dinajpur*, *Mahastan Gar*, *Gazni*, *Durgapur*), houses corridors of the Sal (*Shorea robusta*) forest between Darjeling-Shillong and Modhupur tracts. Prominent wildlife species in this zone are: the Indian porcupine (*Hyrix indica*), masked palm civet (*Paguma larvata*), Greater adjutant (*Leptotilos dubius*), Mountain bamboo partridge (*Bambusicola fythchii*), Cantor's kukri snake (*Oligodon cyclurus*) and Russell's viper (*Vipera russellii*). Previously common and presently extinct wildlife species of this zone are: the Swamp deer (*Cervus duvauceli*), Hog deer (*Axis porcinus*), Wild boar (*Sus scrofa*), One-horned Rhinoceros (*Rhinoceros unicornis*), Bengal tiger (*Panthera Tigris*), Wild buffalo (*Bubalus bubalis*) and Samber (*Cervus unicolor*).

Barind Tract

Barind Tract is located in the central and western part of Rajshahi division. The greater part of the tract is almost plain and is crisscrossed by only a few minor rivers. This tract is considered an ecologically fragile ecosystem with extremely low vegetation cover. Though the zone was rich with faunal diversity in the past, it has now noticeably reduced mostly due to various pressures like expansion of human habitat, agricultural extension, unwise use of agrochemicals, and illegal hunting. Among the tree species, Aam (*Mangifera indica*), Litchi (*Litchi chinensis*), Taal (*Borassus flabellifer*), Sissoo (*Dalberzia sissoo*), Sal (*Shorea robusta*) are common. Shamdalan (*Elephantopus roxburgii*), Nil lata (*Thunbergia grandiflora*), Kamella (*Mallotus philippensis*), Shaora (*Streblus asper*) are common shrubs and herbs. Amphibian, Skipper frog (*Euphlyctis cyanophlyctis*) is common and is followed by the Cricket frog (*Limnonectes limnocharis*). Among the mammals, Mouse deer (*Tragulus meminna*), Rufous-tailed hare (*Lepus nigricollis*), Masked palm civet (*Paguma larvata*) are found. Lesser black krait (*Bungarus lividus*), Cantor's kukri snake (*Oligodon cyclurus*), Peacock-marked softshell turtle (*Aspideretes huram*), Gray francolin (*Francolinus pondicerianus*), Eurasian golden oriole (*Oriolus oriolus*), Brahminy starling (*Strunus pagodarum*), Blossom-headed parakeet (*Psittacula roseata*) are other faunal species.

Madhupur Sal Tract

The Madhupur Sal Tract extends across the districts of Gazipur, Tangail and Mymensingh. The boundaries between this region and the adjoining regions are generally sharp and well defined. However, they are transitional in the southwest and in parts of the southeast, where floodplain sediments have buried the dissected edges of the Madhupur tract, leaving small hillocks of red soils as 'islets' surrounded by floodplain soils. This zone is enshrined with high floral diversity. However, over 70 per cent of the sal forest area is either already degraded or encroached. Nonetheless, the important timber species include: the Sal (*Shorea robusta*), Banyan (*Ficus bengalensis*), Tamarind (*Tamarindus indica*), Sada koro (*Albizia procera*), Simul (*Bolnba ceiba*), and Ashwath (*Ficus religiosa*). The prominent fruit-bearing tree species of this zone are: Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*), Litchi (*Litchi chinensis*), Guava (*Psidium guajava*), Lemon (*Citrus medica*), Grapefruit (*C. decumana*), Pineapple (*Ananas sativus*), Sharifa (*Anona squamosa*), Wood apple (*Aegle fnarmelos*), and various kinds of palms still grow in abundance in the wild. Records show that the Bengal tiger (*Panthera Tigris*) and One-horned rhinoceros (*Rhinoceros unicornis*), both of which have become extinct from this zone now, had healthy populations in the past. The Bengal monitor (*Varanus bengalensis*) and other common lizards inhabit in scattered patches of jungle throughout this zone. Among snakes, Madhupur Sal tract is a suitable habitat for cobras. In terms of diversity of bird species, this zone is still relatively rich.

Teesta Floodplain

Teesta floodplain spreads over several different landscapes in greater Rangpur and the adjoining regions. The diversity results from the fact that the Teesta river had occupied and later abandoned several different channels during the last few thousand years including the valleys now occupied by the Mahananda, Punarnava, Atrai, Choto Jamuna, Kortoya and Ghagat rivers. There were large patches of forests in this zone; but they have, in most cases, been ruthlessly cut down. However, this zone is still fairly wooded with many valuable indigenous timber species: the Sal (*Shorea robusta*), Banyan (*Ficus bengalensis*) and Aswatha (*Ficus religiosa*). The fruit-bearing tree species indigenous to this zone are: the Mango (*Mangifera indica*), Guava (*Psidium guajava*), Sharifa (*Anona squamosa*), Tamarind (*Tamarindus indica*), Jackfruit (*Artocarpus heterophyllus*), Badam (*Terminalia catappa*), Date palm (*Phoenix sylvestris*), and Toddy palm (*Borassus flabelifer*).

Ganges Floodplain

The Ganges floodplain basically consists of the active floodplain of the Ganges River and the adjoining meandering floodplains, and is mostly situated in the administrative districts of greater Jessore, Kustia, Faridpur and Barisal. The adjoining meander floodplains mainly comprise a smooth landscape of ridges, basins and old channels. This floodplain is characterized by mixed vegetation. Presence of a lot of stagnant water bodies and channels, rivers and tributaries in this zone support a habitat of rich biodiversity. In the beels and other water bodies, free-floating aquatic vegetation is prominent. Homestead forests, on the other hand, include both cultivated and wild plant species. The dominant floral types are: the Panimorich (*Polygonum orientale*), Jhanji (*Hydrilla verticillata*), Helencha (*Alternanthera philoxeroides*), Topapana (*Pistia strateotes*), Chechra (*Schenoplectus ariculatus*), Shada Sapla (*Nymphaea nouchali*), Kshoredam (*Ludwigia adscendense*), Kolmi (*Ipomea aquatica*), and Dhol Kolmi (*Ipomea fistulosa*), Hijal (*Barringtonia acutangula*), Tamarind (*Tamarindus indica*), and Panibaj (*Salix tetrasperma*). Moreover, grasses are most abundant in the Ganges floodplain and begin to grow as soon as the floodwater begins to recede. The notable grass species are *Cyperus rotunda*, *C. diformis*, *Eleocharis* Sp., *Hemarthria* Sp., etc.

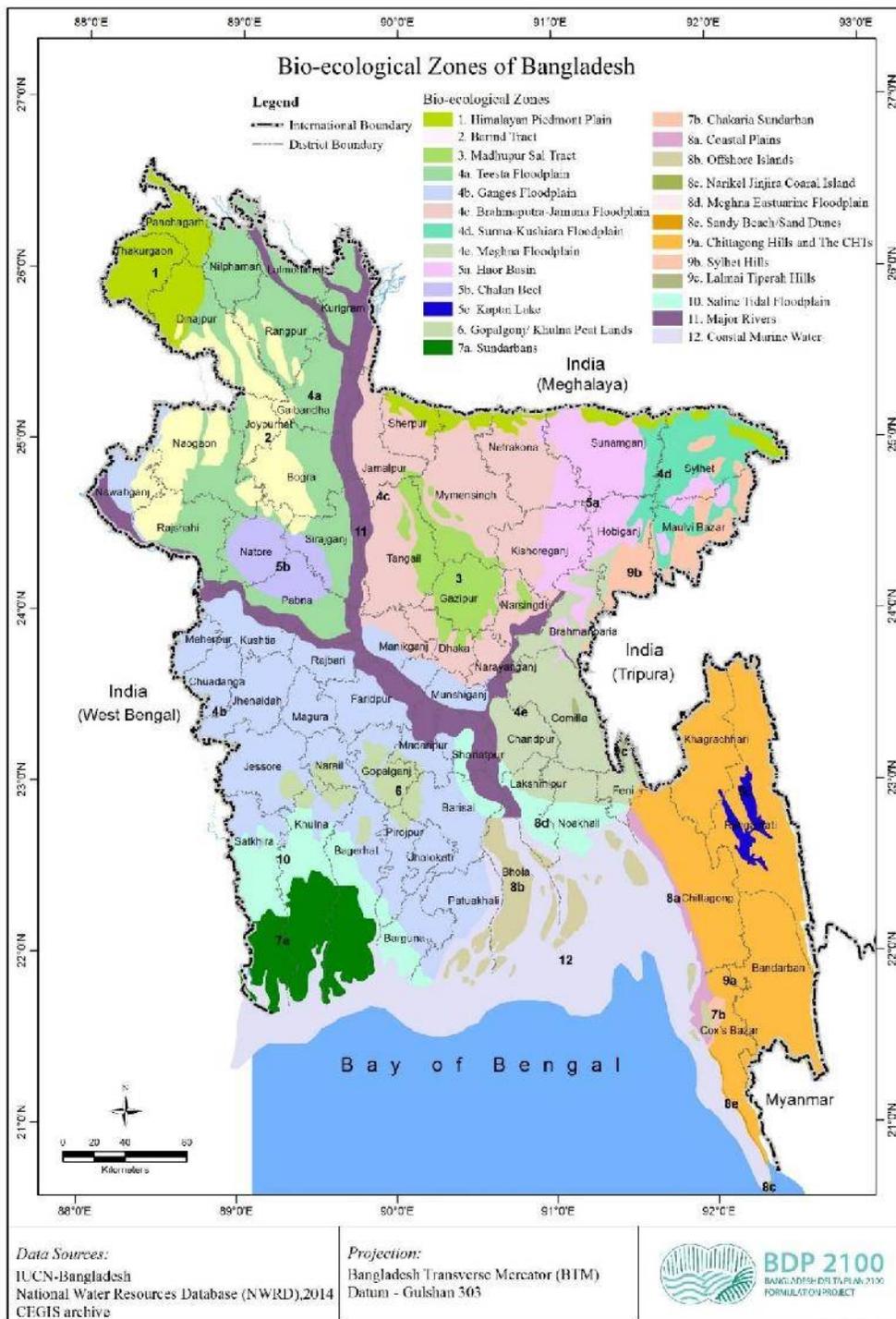


Figure 2: Bio-ecological Zones of Bangladesh

The Brahmaputra-Jamuna Floodplain

The mighty Brahmaputra River is interchangeably known as the Jamuna since the latter’s channel is comparatively new and its course is clearly distinguishable from that of the older Brahmaputra. The Brahmaputra floodplain (situated

in greater Mymensingh and Dhaka districts) comprises the active channel of the Brahmaputra River and the adjoining areas of the 'young' floodplain lands formed around 1780, when the river shifted to its present course (the Jamuna River) to the south of Dewanganj in Jamalpur district. The main river course is strongly braided. It consists of several interconnecting channels, which erode and form new lands on a large scale during each flooding season. Some of the floral species, which are valued as timber producers are: the Banyan (*Ficus bengalensis*), Tamarind (*Tamarindus indica*), Sada koroi (*Albizia procera*), Simul (*Bombax ceiba*) and Aswath (*Ficus religiosa*). The prominent fruit-bearing trees of this zone are: Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*) and Litchi (*Litchi chinensis*). Bushes of reeds and canes are also found here. This zone is similarly enriched with orchids. The Rasna (*Vanda roxburghii*) is commonly found in this zone. A few species of deer, such as Samber (*Cervus unicolor*), Hog deer (*Axis porcinus*), Swamp deer (*Cervus duvauceli*), and Barking deer (*Muntiacus muntjak*) were once found in abundance everywhere in the forests of this zone. Among the bird species, small game birds such as Common peafowl (*Pavo cristatus*), Red junglefowl (*Gallus gallus*), partridges, and several varieties of pheasants were commonly found. The Bengal florican (*Houbaropsis bengalensis*) and snipes are plentiful in the sandbanks and chars of the zone. On the other hand, the most common poisonous snake is the Banded krait (*Bungarus fasciatus*) in this zone, which could easily be identified by its broad black and yellow bands.

Surma-Kushiara Floodplain

The Surma-Kushiara floodplain comprises river draining from the North-Eastern borders towards the Sylhet basin. The relief is generally smooth, comprising broad ridges and basins, but it is locally irregular alongside river channels. The zone abounds in diverse wetlands, small and medium beels and channels, secondary rivers and huge seasonally inundated lands where locals do fishing in the wet season and cultivate rice in the dry season. Patches of degraded swamp forest still exist as remnant of its historic extent. Floral composition is interesting with numerous hydrophytes. The extensive network of the wetlands in this zone, especially in the winter, is inhabited by migratory waterfowls as numerous water birds, ducks, egrets and herons come to visit for wintering and breeding.

Meghna Floodplain

A major part of the Meghna floodplain was created by the deposition of sediments brought in by the old Brahmaputra River, before it changed its course. The rest of the sediments were laid down principally, by the Meghna River itself and by some minor rivers draining from Tiperrah hills. The floodplain is characterized by many broad meandering channels, char and low lying landscape and is mostly affected by seasonal flooding while river bank erosion occur commonly. The luxuriant growth of palm trees is the dominant characteristic feature of the vegetation type of this zone. The Betel nut "Supari" (*Areca catechu*) is most visible as the dominant species in the western portion of this region. This zone has also abundance in several varieties of cane, a good deal of bamboo and thatching grass. Faunal diversity is rich in here than other part of the country. Prominent mammalian species, which are found in this zone are several species of bats, different species of monkeys, pangolins etc. Moreover, several species of raptorial birds are found, which includes, Crested Serpent Eagle and Short-toed snake eagle.

Haor Basin

The Haor basin is an internationally important wetland ecosystem. It is a mosaic of wetlands habitats, including numerous rivers, streams and irregular canals. These Haors and beels provided habitats for various types of aquatic species of plants and animals. These Haors and beels support major subsistence and commercial fisheries while the seasonally flooded lake margins support major rice-growing activities, and abundant aquatic vegetation provides ideal grazing for domestic livestock, and a source of fuel and fertilizers for the local inhabitants. The wetlands are also home to a wide variety of resident and migratory waterfowls including perhaps as many as 100,000 to 150,000 duck and provide a refuge to many other species of wildlife. Keeping in mind all these ecological benefits, the Tanguar

Haor which is located in this zone has been declared as a Ramsar site as well as Ecologically Critical Area (ECA). The Haor basin is the only region in Bangladesh where remnant patches of freshwater swamp and reed lands still exist.

Chalan Beel

Chalan beel is an extensive low land area at the lower Atrai basin in the north-eastern region of Bangladesh spread across the districts of Natore, Pabna and Sirajganj. It is covering the area encompassing the districts of Pabna, Natore, Rajshai, Sirajganj, Noagaon and Bogra. Chalan beel heart is now confined to Singra and Gurudaspur thanas of Natore district, and Chatmohar, Bhanga and Faridpur Upazilas of Pabna district. It consists of a series of beels connected to one another by various channels to form more or less a continuous waterbody during the rainy season. So long the Jamuna remains flooded during the monsoon months, the beel area expands into a vast waterbody with dense aquatic vegetation. It, however, dries out in the winter leaving only patches of 'water-holes' in the central part of this zone. The banks of the beel are vegetated with dense stands of the Kash (*Saccharum spontaneum*), Babla (*Acacia nilotica*), Nol (*Arundo donax*), Dhol kolmi (*Ipomea fistulosa*), Simul (*Bombax ceiba*), and Date Palm (*Phoenix sylvestris*). At present, only seven species of frogs and one species of toad represent the amphibian fauna in the Chalan beel. The Skipper frog (*Euphlyctis cyanophlytis*) and Cricket frog (*Limnonectes limnocharis*) are quite dominant. A total of 34 species of reptiles are found in this zone, of which 10 are turtles and tortoises, 9 lizards and the rest 15 of various species. Of the turtles and tortoises, the Asiatic soft-shell turtle (*Chitra indica*) and Three-keeled land tortoise (*Melanochelys tricarinata*) are globally threatened. A total of 195 bird species from 51 families, on the other hand, are recorded in this zone, of which 140 are resident and 55 migratory. Likewise, a total of 27 species of mammals from 12 families are recorded in the Chalan beel. Of them, the Smooth-coated otter (*Lutra percipillata*) is vulnerable in Bangladesh.

Kaptail Lake

This is an artificial lake created by a dam, which was constructed in 1962 and has since flooded over 68,800 ha of forest valleys and arable land in Chittagong and the Chittagong Hill Tracts (CHTs) districts. This wetland is surrounded by evergreen forests. However the aquatic diversity of this lake is not well known. Aside from the immediate ecological damages such as inundating croplands, villages and forest, the lake has had far reaching ecological consequences, since its creation.

Gopalganj-Khulna Peatlands

This zone occupies a number of low-lying areas between the Ganges river floodplain and the Ganges tidal floodplain in the south of Faridpur region and the adjoining parts of Khulna and Jessore districts. Thick deposits of peat occupy perennially wet basins, but they are covered by clay around the edges and by calcareous silty sediments along the Ganges tributaries crossing the zone. Most of the layers harden irreversibly into coal-like lumps when dry. The soil, in this zone, is potentially strongly acidic and low in essential plant nutrients. The basins are deeply flooded by rainwater during the monsoon season. However, in the basin area close to Khulna, the flooded water is somewhat brackish. Understandably then, the floral diversity in this zone is quite limited. The major tree species found in this zone are: the Bakful (*Sesbania grandiflora*), Hijal (*Barringtonia acutangula*), Barun (*Crataeva nurvala*), Custard Apple (*Limnophila heterophylla*), etc. Moreover, some of the common aquatic plant species observed in this zone include: the Kaoatukri (*Sagittaria guayensis*), Nil Komol (*Nymphaea stellata*), Kolmi (*Ipomoea aquatica*), Hogla (*Typha elephantina*), etc. Due to lack of diversity in vegetation, the variety in faunal species and their population size in this zone are also less. Nonetheless, the dominant mammalian species present here are: the Smooth-coated otter (*Lutra perspicillata*), Five-striped palm squirrel (*Funambulus pennanti*), and Fishing cat (*Prionailurus viverrinus*). Common reptile species in this zone include: the Common Krait (*Bungarus caeruleus*), Common wolf snake (*Lycodon aulicus*), Copper head trincate snake (*Elaphe radiata*), and Spotted pond turtle (*Geoclemys hamiltonii*). Only two species of amphibians are found here, namely the maculated tree frog (*Polypedates maculatus*) and Cricket Frog (*Limnonectes limnocharis*). On the

other hand, due to the presence of floodplains in the surrounding areas, the diversity of bird species is relatively better in this zone.

The Sundarbans

The Sundarbans mangrove forest (Figure: 3) is situated in the southwest of Bangladesh, and extends from the international boundary with India along the Harinbhanga-Raimangal-Kalindi river system in the west and Baleswar River in the east. At present, only the Baleswar River is directly linked to the river Ganges which principally, ensures the in-flow of freshwater in the eastern part of the Sundarban. The Bangladesh Sundarbans now covers an area of about 6017 km², of which 4142km² is island and the remaining 1875 km² is water, in the form of rivers, canals and creeks. However, about 150 years ago, the Sundarbans was twice its present size. About 62% of the forest lies in the administrative districts of Bagerhat, Khulna and Satkhira in Bangladesh. This mangrove tract constitutes 44% of the total forest area in Bangladesh and contributes about 50% of the total revenue derived from the forestry sector. But the most important value of the Sundarbans stems from the protection it affords to millions of people against the ravages of cyclonic storms and tidal waves, which frequently hit the area from the Bay of Bengal. The mangrove of the Sundarbans is unique compared to the non-deltaic coastal mangrove forests. For instance, unlike in the cases of the latter, the Rhizophoraceae is of only minor importance and the dominant species are the Sundari (*Heritiera fomes*) of the Sterculiaceae family, from which the Sundarbans takes its name, and the Gewa (*Excoecaria agallocha*) of the Euphorbiaceae family. Other dominant plant species include: the Passur (*Xylocarpus mekongensis*), Ohundal (*Xylocarpus granatum*), Kankra (*Bruguiera gymnorrhiza*), Keora (*Sonneratia apetala*), Baen (*Avicennia* spp.), Golpatta (*Nypa fruticans*) and Goran (*Ceriops decandra*). Despite the combination of high tidal flow velocity, heavy silt load and low light penetration, a remarkable diversity of finfish and shellfish exists inside the Sundarbans forest and in the adjacent marine zone of the northern Bay of Bengal. These are mainly of marine origin, but several freshwater species have been able to take advantage of low salinity and freshwater conditions in the northern part of the forest.



Figure 3: Sundarbans Mangrove ecosystem presenting Keora vegetation during low tide

Chakaria Sundarbans

The Chakaria Sundarbans used to be a mosaic of newly formed grassy islands, river channels, tidal creeks, aquaculture ponds, mangrove forests and inter tidal mudflats, located in the estuarine system of Matamuhuri and several other minor rivers. However, most of this ecosystem has been destroyed and cleared for shrimp culture. Chakaria Sundarbans is a deltaic mangrove forest of the Mathamuhuri River at Chakaria in Cox's Bazar district. The initial area of the Chakaria Sundarbans was about 18,200 ha. Subsequently, 7,490 ha of land were declared as Reserved Forest and the rest as Protected Forest. A selection system was followed to manage the forest. But it was modified from time to time in order to arrest the deteriorating condition of the forest. At one point, restrictions were imposed on extraction of forest produce. But this could not counter the destruction of the forest. In fact, the forest has been almost completely denuded in recent years.

The Coastal Plains

The coastal plains are underlain by heavy marine or tidal clays but these have been buried under by more sand or silt deposits near the foot of the hills and along the courses of rivers and streams which run across the plains. The eastern coastline, extending from the mouth of the Feni River to the southern tip of mainland along Chittagong, is regular and unbroken and protected along the sea by mud flats and submerged sands. This zone is important for a wide variety of waterfowls.

Offshore Islands

This zone covers Bhola, Hatiya, Sandwip, Ghasiar char, Moulvir char, Shahebanir char, Sonadia Island, Char Bata, Char Kukri Mukri, Nijhum Dweep, etc. Shapes of most of the islands are continuously changing as a result of erosion and tidal surge. Moreover, there are extensive intertidal mudflats composing parts of the islands. Most of these mudflats occur along the inland creeks. There are also large shoals in this area; these may consolidate into large islands by the end of this century. The vast amount of sediment brought down by the Meghna made the estuary shallow for a considerable distance. Among the rich vegetation observed in this zone, there are man-made plantations of mangroves, such as the Keora (*Sonneratia apetala*), and Tiyan baen (*Avicennia officinale*) in the Nijhum dweep, Ghasiar Char and Char Batao. The vegetation in the interiors of Hatiya is similar to that of the mainland and includes: the Sada koroi (*Albizia procera*), Shaora (*Streblus asper*), Gab (*Diospyros peregrina*), Babla (*Acacia nilotica*), Kadam (*Anthocephalus chinensis*), Banyan (*Ficus bengalensis*), Jam (*Syzygium* sp), Mandar (*Erythrina indica*), Sonalu (*Cassia fistula*), Date palm (*Phoenix sylvestris*), Toddy palm (*Borassus flabellifer*), Coconut (*Cocos nucifera*) and various bamboo species.

The Narikel Jinjira Coral Island

The southernmost tip of Bangladesh, the Narikel Jinjira coral island also known as the St. Martin's Island (Figure: 4) is separated from the mainland by the Naaf estuary. There are two well defined lagoons in this island and some 200 fresh water ditches. There are some stunted Mangrove forests in the south-west of the island while the sand dunes support an extensive growth of some herbs and shrubs. All five species of marine turtles, known to occur in Bangladesh have been observed in this area, among them the first three species are known to nest in the area.



Figure 4: Saint Martin's (Narikel Jinjira) Coral Island

Sandy Beach/Sand Dunes

The main feature of this zone is the continuous line of sandy beaches and sand dunes. Although the main existence of this eco-zone extends from the mouth of the Bakkhali River and continues south to the Rengaduma khal in the Cox's Bazar district, a small area does exist in the Kuakata area. The dune vegetation in this zone mostly consists of: the Nil nishinda (*Vitex trifolia*), Sagor Kalmi (*Ipomoea pescaprae*), Baranda (*Panicum repens*), and Jhau (*Casuarina littorea*). Moreover, a rich marine vegetation of algal plants has been found to grow along the coasts. These marine plants, such as marine algae, seaweeds, sea-kelps, etc. are collected during the winter season. Among the lower plant species, *Selaginella* sp., *Lycopodium* sp., and *Polytrichum* are found; *Riccia* and *Marchantia* are also found on moist soil of riverbanks. Prominent amphibian species in this zone include: the Common toad (*Bufo melanostictus*) and Cricket frog (*Limnonectes limnocharis*). This zone is very rich in reptilian fauna, of which the notable ones are: the Green turtle (*Chelonia mydas*), Olive Ridley turtle (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*), Hawksbill turtle (*Eretmochelys imbricata*) and a few species of marine snakes. The dominant bird species in this zone are: the Laggar falcon (*Falco jugger*), Oriental hobby (*F. severus*), and Small pratincole (*Glareola lactea*). The mammalian fauna diversity, on the other hand, is represented by the Small Indian civet (*Viverricula indica*), Bengal fox (*Vulpes bengalensis*), etc.

Coastal Marine Water

There is over 25 million acres of marine area, which comprises the territorial waters and the Exclusive Economic Zone of Bangladesh. The coastline along the Bay of Bengal is 1200 kilometres long including the coastlines of numerous islands, but not measuring minor indentations. A large area in the south, therefore, is the coastal zone, which has its own dynamics and deserves special attention as a very distinct terrain. The coastal area, comprising the complex delta

of the Ganges-Brahmaputra-Meghna river system, has immense biological resources. The river system, while flowing through Bangladesh on its way to the Bay of Bengal, carries an estimated annual sediment load of about 2.0 billion tons; these sediments are subjected to coastal dynamic processes generated mainly by the river flow and tidal wind actions, leading to accretion and erosion in the coastal areas of Bangladesh.

Chittagong Hills and the Chittagong Hill Tracts

The south-eastern hill range of the country is composed of tropical evergreen and semi-evergreen forests which are important watershed areas of the country. The majority of the species in the lower canopy are evergreen, and the upper canopy of the forest is deciduous type. Tropical evergreen forest is found in the valleys of this zone. Knowledge on the diversity of reptiles and amphibians of this zone is rather rudimentary, as few surveys of these animals have been done. This zone possesses the richest avifauna population of the country. While the hills are not very high, generally about 600m- they are ragged and often steep. These hill forests are the most important watershed areas of the country. The tropical evergreen and semi-evergreen forests are not very distinct, and are often intermingled and merged into one another in this zone. The predominant species are: Civet (*Swintonia floribunda*), Garjan (*Dipterocarpus* sp.), Chapalish (*Artocarpus chaplasha*), Chundul (*Tetrameles nudiflora*), and Telshur (*Hopea odorata*). In the lower canopy important species like the Pitraj (*Aphanamixis polystachys*), Toon (*Toona ciliata*), Nageshwar (*Mesua ferrea*), Uriam (*Mangifera sylvatica*) and various *Ficus* species can be found. The undergrowth is usually a tangle of shrubs, in which cane, bamboo and wild banana are the prominent species. Out of 66 families of birds existing in the country, as many as 55 are represented in this zone. Mammalian species is represented by Asian elephant (*Elephas maximus*), Smabar (*Cervus unicolor*), Slow loris (*Nycticebus coucang*), Leopard (*Panthera pardus*), Asiatic wild dog (*Cuon alpinus*)

Sylhet Hills

The Sylhet hilly tracts could be the remnants of Pleistocene terraces with small hillocks, locally known as "Tilla". The average height of these hillocks are 40-60 m, however, the highest peak is around 170 m. Tropical semi evergreen forest is found in this zone, particularly in the valleys. Bamboo is the most dominant vegetation type with at least seven different species. Diversity of other floral species is also very high. Some of the prominent plant species are: Garjan (*Dipterocarpus* sp.) Civet (*Swintonia floribunda*), Chapalish (*Artocarpus chaplasha*), Telsur (*Hopea odorata*), Buddah Narikel (*Pterygota alata*) in the top canopy and Rayna (*Aphanamixis polystachya*), Toon (*Toona ciliate*), Nageshwar (*Mesua ferrea*), Uriam (*Mangifera sylvatica*), Jam (*Syzygium* sp.), Bon chalta (*Dillenia pentagyna*) in the lower canopy. This zone is still relatively rich with faunal diversity. The prominent mammal species present here include: the Hoolock gibbon (*Hylobates hoolock*), Assamese macaque (*Macaca assamensis*), Malayan giant squirrel (*Ratuf bicolour*), Leopard cat (*Prionailurus bengalensis*), and Pig-tailed macaque (*Macaca nemestrium*). The region is popular among bird watchers due to its rich bird diversity. The important bird species found in this zone are: the Kalij pheasant (*Lophura leucomelanos*), Oriental pied hornbill (*Anthracoceros albirostris*), Black-backed forktail (*Enicurus immaculatus*), and Common green magpie (*Cissa chinensis*).

The Lalmai- Tipperah Hills

The Lalmai-Tipperah hills constitute a distinct physiographic unit. It has a distinct rectangular drainage pattern and the soil is more oxidised than the floodplain deposits. The zone faces flash floods during the monsoon. The zone enjoys tropical semi-evergreen forests. The predominant floral species in this zone include: Sal (*Shorea robusta*), Kadam (*Anthocephalus chinensis*), Jackfruit (*Artocarpus heterophyllus*) and Sonalu (*Cassia fistula*). The principal floral characteristic of this zone is present in a large proportion of deciduous species. However, this expanse remains largely evergreen with various species. The diversity of bird and mammal species is still considerably high but these species are increasingly under threat of extinction due to unhindered loss of habitats. Some important mammalian species

includes Indian porcupine (*Hystrix indica*), Rufous-tailed hare (*Lepus nigricollis*), and Indian false vampire (*Megaderma lyra*).

The Saline Tidal Floodplain

Saline tidal floodplain has a transitional physiography, which is located in the administrative districts of Satkhira, Khulna, Bagerhat, Jhalokathi and Borguna. It has a low ridge and basin relief, crossed by innumerable tidal rivers and creeks. Local differences in elevation are less than 1 m. The sediments are mainly composed of non-calcareous clays, though silty and slightly calcareous sediments are found in the river-banks. The soil is non-saline throughout the year over substantial amount of areas in the north and east, but the salinity of soil in varying degrees is found in the dry season in the south west, and remains saline for much of the year in the Sundarbans. The rivers carry fresh water throughout the year to the east and northeast, but saline water increasingly penetrates further inland towards the west, mainly in the dry season, and for most or all of the monsoon season in the southwest. In the northeast, there is moderately deep flooding during the monsoon season, mainly due to accumulation of rainwater on the land when the Ganges distributaries and the lower Meghna are at the high flood levels. Elsewhere, there is mainly shallow flooding at high tide, either throughout the year or only in the monsoon, except where tidal flooding is prevented by embankments. Within embankments, seasonal flooding only occurs through accumulation of rainwater.

Major Rivers

Bangladesh mainly consists of riverine and deltaic deposits of three large and extremely dynamic rivers entering the country: the Brahmaputra, the Ganges and the Meghna rivers. Newly accreted land, if it does not erode quickly, is initially colonized by grass, particularly the catkin grass (*Saccharum spontaneum*). Dense growth of catkin grass can accelerate silt deposition on chars. Jamuna River provides highest amount of char lands. Many of the species' natural distribution, migration and storage primarily function via these rivers into other wetland ecosystems. A diverse range of waterfalls are directly or ecologically dependent on these rivers and its associated ecosystems. However, it is quite alarming that, with the exception of few species of turtles, all other river biodiversity is threatened with extinction.

Meghna Estuarine Floodplains

A huge newly accreted mudflat is the main physiographic feature of the Meghna estuarine floodplains. Deposition and erosion are constantly taking place on the land margins, thereby, continuously altering the shape of the land. During the dry season, in many places the soil surfaces become saline in varying degrees. Monsoon flooding is very common, although, shallow from rainwater or non-saline river water. But all three chars also suffer partial salt water flooding during spring tides. Urighash (*Portaesia coarctata*) is the pioneer plant species in these new lands. However, Forest Department's endeavor of mangrove plantation to consolidate the land, have created many man-made mangroves in these char lands, and species such as Keora (*Sonneratia apetala*) and Bean (*Avicennia officinale*) became common. All the accreted inter-tidal lands are important wintering grounds for migratory waterfowls. Globally threatened shorebirds, like Eurasian spoonbill (*Platalea leucorodia*), Common sandpiper (*Actitis hypoleucos*), spotted redshank (*Tringa erythropus*) and Indian skimmer (*Rynchops albicollis*) use this zone as their wintering habitat. Besides, both Bengal (*Varanus bengalensis*) and Yellow monitor (*Varanus flavescens*) still have healthy population in this area. Similarly, common mammalian species of these zones include, Ganges river Dolphin (*Platanista gangetica*), Jackal (*Canis aureus*), Small Indian mongoose (*Herpestes auropunctatus*), Clawless Otter (*Aonyx cinerea*), Greater Bandicoot Rat (*Bandicota indica*) etc.

2.2. Type of Ecosystem and its Resources

Being a low-lying deltaic country, seasonal variation in water availability is the major factor, which generates different ecological scenarios of Bangladesh. Temperature, rainfall, physiographic variations in soil and different hydrological

conditions play vital roles in the country's diverse ecosystems. The ecosystems of Bangladesh could be categorized into two major groups (i) Terrestrial and (ii) Aquatic. The terrestrial ecosystems include homestead, forest, and crop field; while seasonal and perennial wetlands, rivers, lakes, coastal mangroves, coastal mudflats and chars, and marine fall into the aquatic category. Each of the ecosystems has many sub-units with distinct characteristics as well.

2.2.1. Terrestrial Ecosystem

Terrestrial ecosystem occupies area where the water does not stay permanently. It is a biological environment for mainly terrestrial habitat dependent species, as well as other species those need to pursue their life cycle in terrestrial environment. A terrestrial ecosystem is a unique collection of plant and wildlife species. The major terrestrial habitat patterns in Bangladesh are homestead, backyard, agriculture land, grassland, roadsides and embankment vegetation, fellow land, hills, forest, kanda (particularly along the river side of Haor). Details of the sub-units of the terrestrial ecosystem are described below.

Homestead

In Bangladesh, about 20% of the total land is covered with settlement, much of which is covered with trees. According to National Forest and Tree Resources Assessment 2005-07, the area of rural settlement with tree cover stands at 2.767 million hectares of which about 45% of lands have over 10% tree cover. Homestead vegetation is very important plant community, not only for its plant resources but also as wildlife refuge. This plant community includes two types of plant: those cultivated for their economic value, and those that are self-propagating. Homestead ecosystem is also very important for providing shelter to wildlife. Most of the small mammals and birds still existing in the country are completely dependent on this ecosystem, including agricultural land, for their existence. Most of the houses are vegetated by locally cultivated plants and a big portion of the coverage is occupied by wild shrubs and herbs. Common planted tree species are Supari (*Areca catechu*), Narikel (*Cocos nucifera*), Raintree (*Albizia saman*), Aam (*Mangifera indica*), Mahogany (*Swietenia mahagoni*), Kola (*Musa* sp) etc. Homesteads, which are commonly found near the wetland, favour good growth of wetland trees like Pigtail (*Tricia nudiflora*), Baroon (*Crataeva nurvala*), Hizal (*Barringtonia acutangula*) etc. Bamboo (*Bamboosa* spp.) groves are quite common throughout every homestead. Among the mammals, Bengal fox (*Vulpes bengalensis*), Five-striped palm squirrel (*Funambulus pennant*), Jungle Cat (*Felis chaus*), Tomb Bat (*Taphozous saccolaimus*), Greater bandicoot rat (*Bandicota indica*) Common mongoose (*Herpestes edwardsi*) and Indian flying Fox are found in all village groves, river levees and other bushy areas. Black Drongo (*Dicrurus macrocercus*), Common Myna (*Acridotheres tristis*), Asian Pied Starling (*Sturnus contra*), Spotted Dove (*Streptopelia chinensis*), Red-vented Bulbul (*Pycnonotus cafer*), House Sparrow (*Passer domesticus*), Brahminy Kite (*Haliastur indus*), Black Kite (*Milvus migrans*), Oriental Magpie Robin (*Copsychus saularis*) are found in most of the village groves and homestead forests. Common reptiles are Common skink (*Mabuya carinata*), garden lizard (*Calotes versicolor*), Bronze-backed Tree Snake (*Dendrelaphis tristis*), and Bengal Monitor (*Varanus bengalensis*). Population of amphibians is rich due to the location of huge moist habitats. Indian Bull frog (*Hoplobatrachus Crassus*), Common Toad (*Duttaphrynus melanostictus*) and Cricket frog (*Fejervarya limnocharis*) are commonly found.

Kanda

The site is lower than homesteads, but little higher than the adjoining agricultural fields are locally called 'kanda'. Once the kandas occupied by swamp forest, reed swamps and grass. These swamp forests are mostly composed of hijal, karoch, borun, kash, hogla and pitali. Associated with these are wild rose, ban tulshi, bala dumur and other climbers. Different varieties of herb are: khagra, hogla, baro nal (*Arundo donax*), while the shrubs are tit begun (*Solanum flicifolinum*), dholkalmi etc. Binnya (*Vetiveria zizanooides*) and chhailla grass naturally grow in kanda areas. The common wildlife species found within the Kanda areas is different type of rats, bush and undergrowth vegetation loving birds, insects, Common garden lizard, Bengal Monitor, and Jackal.

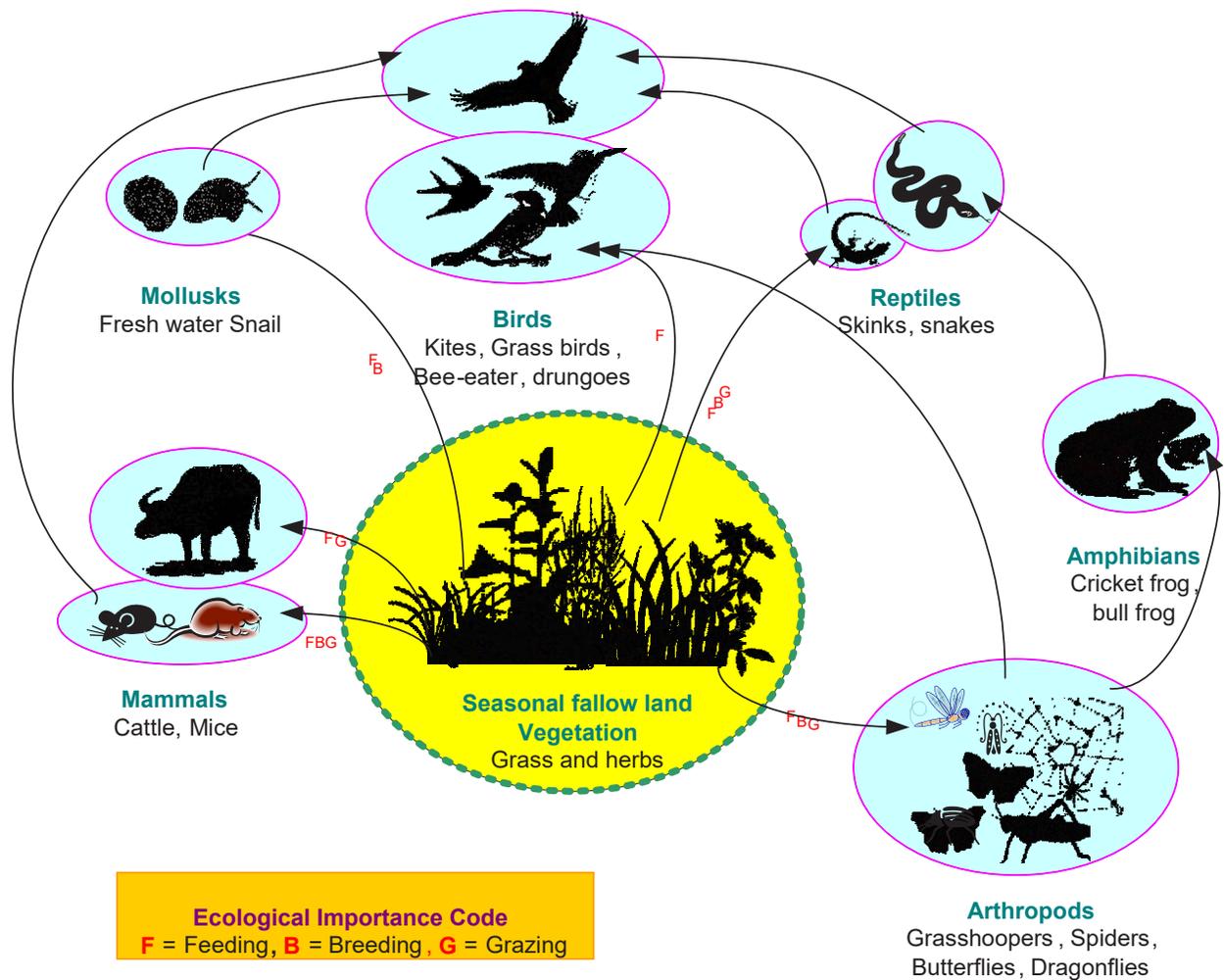


Figure 5: Ecological importance of seasonal fallow land vegetation for different faunal communities along with partial food web

Crop Field

Crop field is mostly utilized for paddy cultivation. But it is different in the context of land type, irrafic (soil is a media of plant growth) and climatic factor. Different land types, crops and cropping patterns are discussed in the agricultural section of thematic reports. The major weed species growing with the crop in this area are *Heliotropium indicum*, *Sagittaria sagittifolia*, *Commelina benghalensis*, *Rumex dentata* *Cotula hemispherica*, *Rottboellia protensa*. Cyperaceae, Poaceae are the dominant families in this community; however, a large number of other unrelated families, e.g. Amaranthaceae, Euphorbiaceae and Asteraceae are also present.

Road and Embankment

The potential sites for planting trees are road and embankment sides of terrestrial environment. The most dominant plants found there, are mahogany, rendi koroï, neem, arjun, chambul, shrish, kadom, shishu, raj koroï, babla, bhat. Coastal embankment plantation has long been in practice in southern Bangladesh. The village road and the highway provide a good habitat for woody and fruits yielding plants. Many species of wild plants are grown along the road and embankment sides naturally. These plants are very good for supporting birds, reptiles and insects.

Forest

The forest in aerobic condition is considered for forest ecosystem. There are many kinds of forest in terrestrial environment. Forest is an important habitat of many species of wildlife, plants and other natural resources. A detail on forests of Bangladesh is discussed in the forest and biodiversity section of this report.

Hills

Chittagong Hill Tracts (CHT) is still considered as one of the richest forest areas of Bangladesh. This area is different from other areas of Bangladesh due to its unique geographic and social structures, which is characterized by hilly topography and inhabited by different indigenous communities. The indigenous culture, lifestyle and livelihood are mostly related to forest and forest resources. Unfortunately, over the past several decades, unsustainable use of these resources has led to the loss of biodiversity, degradation of the overall environment and ecosystems, as a whole. The hills are covered with trees, medicinal shrubs and herbs. The common plant species found within the area are Garjan (*Dipterocarpus turbinatus*), Telsure (*Hopea odorata*), Shialbatna (*Quercus velutina*), Goda (*Vitex pubescens*), Civet (*Swintonia floribunda*), Chundul (*Tetrameles nudiflora*), Arsol (*Vitex peduncularis*), Bans (*Bmboosa* sp.), Segun (*Tectona grandis*) and Chapalish (*Artocarpus chaplasha*). The important species in the lower canopy are like the Pitraj (*Aphanamixis polystachys*), Toon (*Toona ciliata*), Nageshwar (*Mesua ferrea*), Uriam (*Mangifera sylvetica*) and various *Ficus* species.

2.2.2. Aquatic Ecosystem

Aquatic habitat is characterized by anaerobic conditions. Aquatic ecosystem is an important habitat for wetland dependent birds and fish. The aquatic ecosystem is a habitat of submerged, free floating, and rooted floating vegetation. Submerged plants are the true aquatic plants that can maintain their entire life cycle under water except the flowering period, which occurs above the water surface. Some are rooted to bottom and some are freely suspended. These plants start growing with the rise of water level and persist as long as water is present. *Hydrilla verticillata*, *Aponogeton natans*, *Myriophyllum tuberculatum*, *Potamogeton pectinatus* and *Ottelia alismoides* are most common in this vegetation type. Free floating vegetation consists of plants that are most commonly found floating freely on and collecting nutrients from the water; most of them can also survive for a certain period with their roots on or in moist soil. Species of this group includes water hyacinth, Khudipana (duck weeds, *Lemna* spp.), *Spirodela polyrhiza*, indurkani pana (*Salvinia* sp.) etc. Rooted floating plants have very long stalk and they root deeply in soil with floating leaves and flowers. Rooted floating plants make one of the most dominant plant types in the wetland areas in the Haors. At the species level nil shapla (*Nymphaea nouchali*), *N. rubra*, *Nymphoides cristatum*, *Nymphoides indicum*, *Ludwigia abscondens* and *Hygroryza aristata* are the most common. Reeds swamps usually occur on the periphery of the homestead and also in the deeply flooded canal in Haor areas. Reeds are emergent vegetation and consist of tall grasses that grow in the fairly deeply flooded areas but dry out during dry season. Reeds, when submerged during the rainy season, act as a shelter for a number of fishes and prawn species. The reed land areas of the northeast Haor region of Bangladesh are an important habitat for a number of globally threatened birds and mammals.

Wetlands are permanently inhabited by fewer mammalian species than are upland ecosystems. However, the association of some mammals with wetlands is very strong. A good number of endangered Ganges River Dolphin is present in deltaic rivers. Eurasian Otter is also present in mangrove forest and swamp forest along the Surma, Kushiyara and its tributary rivers system.

There is no good overall abundance estimation of the Ganges River Dolphins. Their total world population has been crudely estimated to be 4000-5000. Smith *et al.* (1998) observed 38-58 dolphins in the Brahmaputra river of Bangladesh, from the divergence of the old Brahmaputra to just upstream of the confluence with the Ganges River (190km), and 34-43 dolphins in a 113km segment of the Kalni-Kushiyara River, a tributary of the Meghna (Smith *et al.*

1998). Approximately 222 km of Karnaphuli and Sangu Rivers and connecting Sikalbaha-Chandkhali Canal, Smith *et al* (2001) observed at least 131 dolphins. At the far downstream end of their range in the Sundarbans of Bangladesh, Smith *et al.* (2006) estimated that the dolphin population inhabiting waterways of the mangrove forest was 225 individuals. There has been a dramatic decline in the extent of occurrence area of occupancy of Ganges River Dolphin as well as in the quality of their habitat especially in the Ganges river basin. This decline has been related to the construction of barrage, dams, large embankments scheme, dredging, fisheries bycatch, directed hunting, water pollution and ship traffic since the late 1950s. Bangladesh delta is the home to thousands of resident and migratory water birds with important bird habitat and area. The Tanguar Haor, Aila Beel, Hakaluki Haor and Hail Haor are considered as Important Bird Area (IBA). A large number of these birds use the aquatic vegetation for shelter, food and nesting. Every winter, the study area is home to about 200 species of migratory waterfowls, including 100,000 to 150,000 ducks and other species. Keeping in mind all these ecological benefits, the Tanguar Haor has been declared a Ramsar site. Wetlands are extremely productive ecosystems which provide crucial habitat and feeding and breeding grounds for many species of reptiles and amphibians. Many reptiles make their homes in the swampy wetlands. Snakes, lizards, turtles are all reptiles that live in the wetlands. A study of National Conservation Strategy Implementation Plan claimed a total of 35 reptile species were recorded in Tanguar Haor area, of which 10 are turtle and tortoise, 8 lizards and 17 snakes. Several species of freshwater turtle breed in haor and rivers. Some species prefer the cool, damp habitat. Common frog found within the study area are Skipper frog, Indian Cricket frog, pegu Rice frog, Leaping frog, Indian Bull frog etc. Aquatic ecosystems have many sub-units with distinct characteristics as well. Details of sub-units of aquatic ecosystem are described as below.

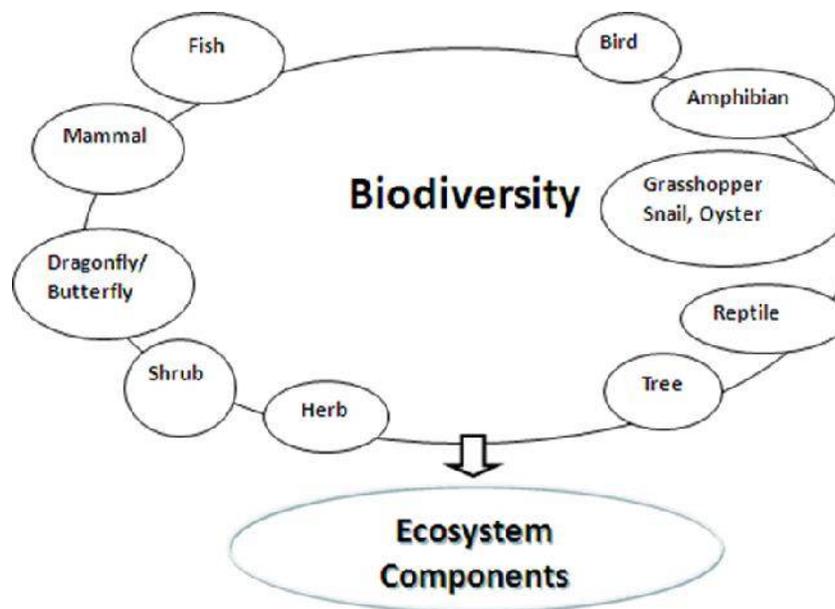


Figure 6: Different components and inter linkage of an ecosystem

River

The majority of the natural ecosystems of Bangladesh are wetlands. Intricate networks of rivers that drain into and inundate Bangladesh have created many riverine ecosystems in the country. Bangladesh is a land of many small and large rivers densely criss-crossing like a net covering almost the entire country. Hence, the rivers are the most important component for any ecosystem sustainability. Many species of fish, invertebrates, algae and birds depend on riverine ecosystem. The riverine ecosystem supports to complete the life cycle of different species of tern, skimmer, duck, otter and the Ganges River Dolphin (Figure 7).

Floodplain

Floodplain is actually a habitat which is flooded by river water during high tide or any other flooding time, and carry silt. Except Barind Tract, Hill Tracts, Madhupur Shal Tract, Akhaura Trase, all are under floodplain ecosystem. The composition of plant and wildlife is almost same in the floodplain ecosystem. Floodplains are the landforms which are inundated in each monsoon. Vegetation of the floodplains is changing its forms with fluctuation of water level. This type of seasonal wetland is dominated by grass and rooted floating plants. During dry season, floodplains are converted into agricultural fields. Flood plains are the main location for agriculture in Bangladesh and are highly variable in the nature and depth of flooding. The floodplains, situated close to the coasts, are more influenced by the saline waters of Bay of Bengal.



Figure 7: Different species of wildlife supported by the GBM's riverine ecosystem

Charland

The river channel is continuously shifting within its active floodplains, eroding and depositing large areas of new charlands in each flooding season. A good succession of plants and animals in new charlands has been observed. Chars are good habitats for some of the avian fauna and amphibians because of noise and disturbance-free condition. Charland support good number of avifauna like cisticola, prinia, wablers, grassbirds, larks, pipits and munias. Charlands also support numerous mollusks which are the feed for water birds, fishes and other aquatic faunal species. The pattern of succession depends on how long the charland has been permanent. At the species level, Chan

(*Iperitia cylendrica*), Nol (*Phragmites karka*) are the first introducers whereas Mutha (*Cyperus* sp), Kolmi (*Ipomoea* sp), Binna (*Vetiveria zizanioides*) Durba (*Cynodon dactylon*) are the second level successors. At the terminal succession, there are some bushy plant species like Dholkolmi (*Ipomoea fistulosa*). A major part of these charlands are seasonally inundated in monsoon and deposit more sand on land surface. During dry season, large portions of the land are used for paddy, maize, kaun, sugarcane and groundnut cultivation.

Haor

Haor is a local Bengali word used for freshwater wetlands of the north-eastern Bangladesh in the true sense of the word. They are the back swamps or bowl shaped depressions between the natural levees of rivers. They are flooded to a depth of as much as 4-6 meters during the rainy season, and in most cases during monsoon two or more Haors become linked and form large water bodies. During the dry season most of the water drains out except some shallow lakes locally called *Beels*. Haors are important reservoir of wetlands' renewable and non-renewable natural resources in the northeast region of Bangladesh. Geographically, Haor region is located in between two major ecosystems/biomes. One is Meghalaya-Assam-Tarap hill ranges in India and the other is Brahmaputra-Meghna river systems in Bangladesh. These hill ranges are covered with mixed evergreen forests from where Haors receive most of its freshwater through thousands of hill streams locally known as Chharas. The Haors in the north-eastern parts of Bangladesh are probably the most complex of seasonally inundated wetlands. They switch between a vast basin of water during the monsoon and a well-networked system of smaller wetlands including beels and khals in the summer. Surface water is the most severely impacted natural resource in the country. The Haor basin is well known for its rich biodiversity. There is little doubt that the seasonally inundated wetlands are amongst the most productive ecosystems. Among the Haors, the Tanguar Haor has been declared a Ramsar site and an Ecologically Critical Area considering its ecological value. The largest Haor in the country is the Hakaluki Haor, which extends over 18,000ha. During the rainy season, the haor consists of more than 80 inter-connected beels. The rich fish resources of Hakaluki support one of the largest inland fisheries in the country. Tanguar is an important "mother fisheries area", where many species breed during the rainy season. Haor swamps and marshes are particularly rich in aquatic plants with enormous diversity. Biomass productivity of these submerged plants is observed to be too high. Agriculture, fisheries and animal husbandry are three pillars of Haor economy from time immemorial.

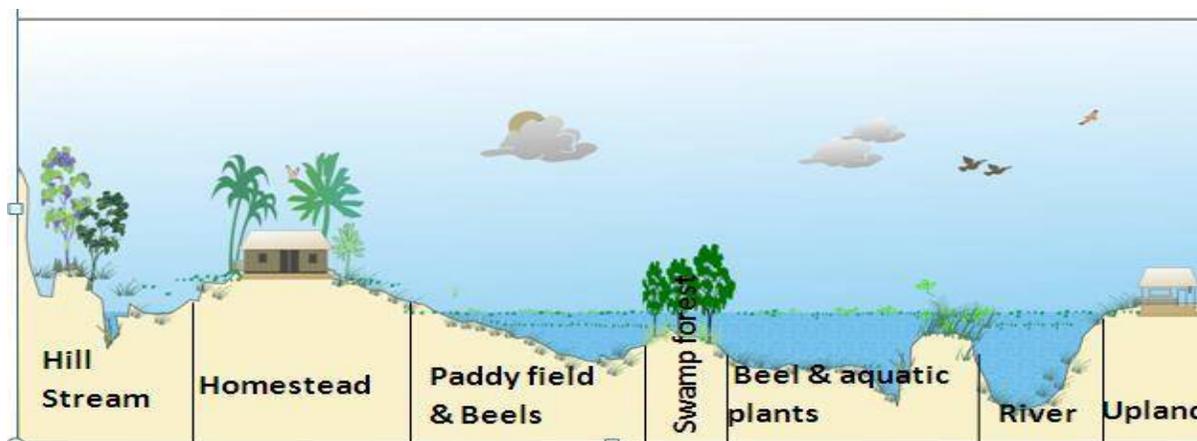


Figure 8: Haor Ecosystem during the peak monsoon

Swamp Forest

Haor is the habitat of fresh water swamp forest with flood-tolerant evergreen trees. A fully developed stand exhibits a closed canopy with mature trees standing ten to twelve meters tall. *Barringtonia acutangula* (Hijal) and *Pongamia*

pinnata (Koroch) occur in varying proportions to form this vegetation type. *Crataeva nurvala* (Barun), *Trewia nudiflora*(Pitali) are frequently present, while *Salix tetrasperma* (Bias) is rarely observed. These trees mostly produce their seeds in the monsoon period and disperse them through water; seedlings grow in great quantities. In addition, woody shrubs such as *Phyllanthus reticulatus* (chitki), and climbers are found. Swamp forest is adapted to monsoon flooding for three to four months, to depths of 0.5 to 2.5 meters. Remnant swamp forest patches are now restricted to sloping areas, helping to protect homesteads from wave erosion, while some are recently replanted areas. These patches vary from a few plants to several hectares of more than a thousand trees. Depending on local conditions, particularly the extent of human disturbance, the luxuriance of the vegetation varies, from sparse low trees with undergrowth grasses, as at Rangchi and Rupnagar in TanguarHaor, to dense closed canopy with poor undergrowth, as at Pashua Beel in Gurmar Haor, at Tahirpur and Sunamganj District. Fresh water swamp forest emerges due to flat low lying land becoming inundated due to rainfall runoff and inflow from surrounding river system. In swamp forest, the water table is typically very close to the surface.



Figure 9: Ratargul Swamp Forest at Goianghat, Sylhet

This continuous inundation gives rise to a habitat that is floristically distinct from the surrounding forest. This type of vegetation can be seen in the different beel area of Haor. Some birds and mammals use this forest type as resting and nesting place. However, there is a great concern for this swamp forest habitat due to over logging, and suspected seepage from upstream reservoirs resulting in significantly changed circumstances for many swamp forest species. The common undergrowth is *Alpinia* (Tara), *Calamus guruba* (Bet), *Schumannianthus dichotmus* (Murta) and *Phragmites karka* (Nal). In addition, woody shrubs such as *Phyllanthus disticha* (Chitki), *Rosa involucrate* (Jangli Golap), and *Asclepias sp*, *Ficus heterophylla* (Bhui Dumur) and some climbers are found.

Table 1: Dominant plant species identified in various Swamp Forests

Name of the Swamp forest	Location	Dominant Species
Ratargul Swamp Forest	Goyanghat, Sylhet	Karoch (<i>Millettia pinnata</i>)
Katogora Bagh	Sonamorol Haor, Dharmapasha, Sunamganj	Hijol (<i>Barringtonia actuangula</i>)
Rangchi	Tanguar Haor, Sunamganj	Hijol (<i>Barringtonia actuangula</i>)

Mangrove

Mangroves are a unique ecosystem hosting incredible biodiversity: migratory birds, marine creatures and reptiles, in addition to associated species of flora. They function as natural water treatment system; as spawning grounds for fish, and provide several resources to local communities who directly or indirectly depend upon them for their livelihoods and sustenance. The Sundarbans is of global importance as the largest mangrove forest in the world. Intact mangroves form a natural coastline buffer against floods, storms or other natural disasters such as tsunamis and hurricanes protecting the coasts from erosion.

The Bangladesh part of the Sundarban extends over an area of about 6,017 km², between 89°00' & 89°55' east and 21°30' & 23°30' north, of which 4,142 km² is island and 1,875 km² is water. This area was declared as Reserved Forests in 1875 and was handed over to the Forest Department (FD) for management. Since then, the FD is managing this area as the Sundarbans Reserved Forests (SRF). It is the largest contiguous block of mangrove forest remaining in the world. Early management focus during the British Rule and the Pakistan period was revenue collection. Since the last two decades, this goal has shifted towards environmental and socio-economic issues. However, the importance given by the government towards natural resource management is insignificant. A part of the Bangladesh Sundarbans, an area of about 1,39,700 ha under three wildlife sanctuaries, was designated as the 798th World Heritage Site (WHS) by UNESCO in 1997 and classified as natural heritage.

The floristic composition of the Sundarbans is rich compared to many other mangrove areas of the world. The Sundarbans mangroves of Bangladesh are dominated by the Sterculiaceae and Euphorbiaceae. Sundari (*Heritiera fomes*), Gewa (*Excoecaria agallocha*) and Goran (*Ceriops decendra*) are the three most important commercial species in the Sundarbans. Sundarbans is the habitat for Royal Bengal Tigers and according to Tiger census 2015, there are 106 tigers are residing in Sundarban of Bangladesh (FD, 2015) whereas in 2004 the population was 440. Wildlife poaching and illegal trade of wildlife and their parts are increasing.

Coastal and Marine Ecosystem

Bangladesh is situated at the head of the Bay of Bengal. The coast is characterized by a vast network of rivers (24,000 km in length) covering an area of 9,380 square kilometres, a large number of islands between channels, a submarine canyon (Swatch of No Ground), the funnel shaped part of the northern Bay of Bengal. The area of the sea that makes up the Bangladesh Exclusive Economic Zone (EEZ) is estimated to be about 1, 125,000 km². and spreads up to 200 nautical miles. Bangladesh is best known for its extensive coastal and marine ecosystems. A huge number of offshore islands are scattered in the Bay of Bengal. Saint Martin's Island (Nairikel Jingira) is the only coral bearing island of Bangladesh, and therefore it is of significance in the context of coastal and marine ecosystems. Estuarine flood plains, sand dunes and beaches characterize the coastal ecosystems of Bangladesh. The Meghna flood plains of Noakhali and Lakshmipur districts are inundated by r seasonally, which attracts a wide variety of birds, including the migratory ones. Rare species of birds including the Globally Critically Endangered Spoon-bill Sandpiper and Indian skimmer (*Rhynchops albicollis*) visit this ecosystem including Sonadia Island (Figure 10), they globally hotspot of Spoon-billed Sandpiper. The beaches and sand dunes also attract sea turtles. This extensive open water ecosystem extends southwards into the Bay of Bengal. The coastline of Bangladesh is 714 km long and can be broadly divided into three regions: the eastern region (Pacific type), the active delta of the central region, and the stable deltaic western region (Atlantic type).

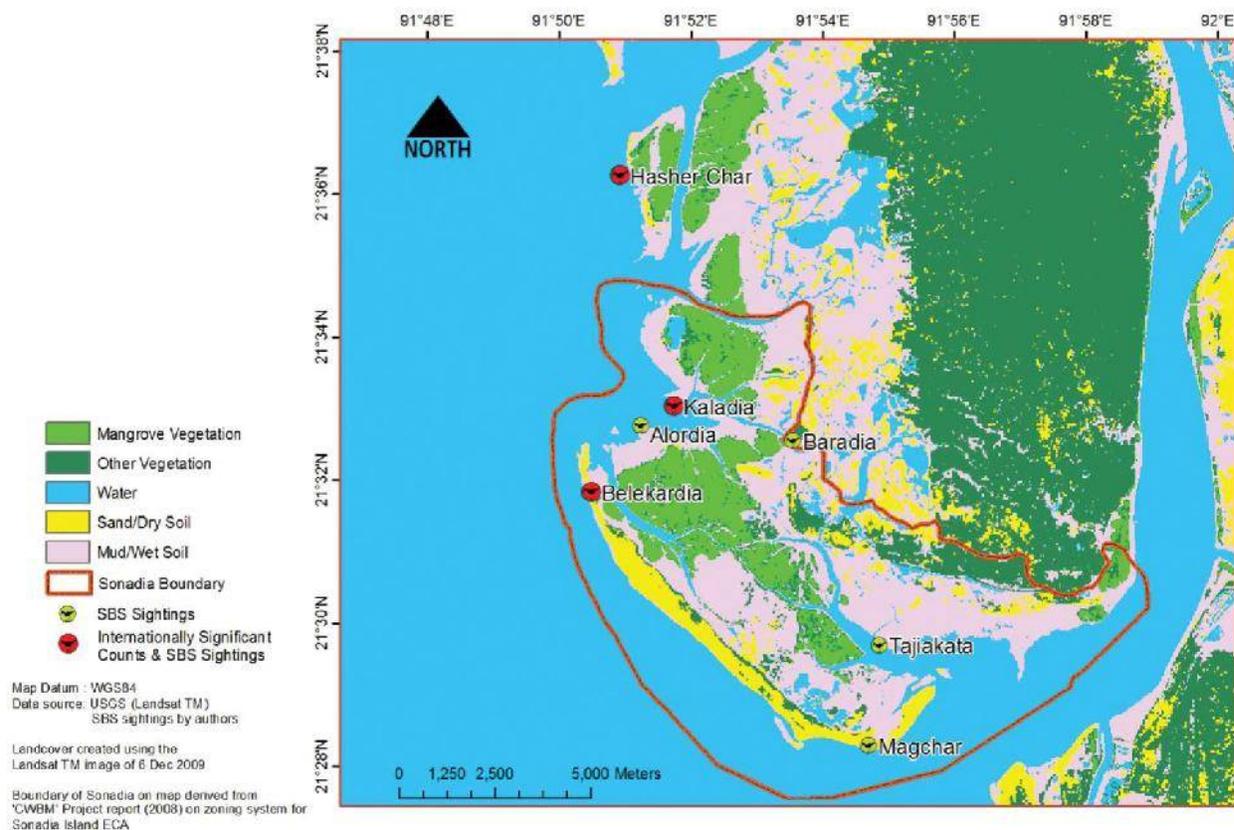


Figure 10: Sonadia Island, Cox's Bazar, Bangladesh, the map shows habitat characteristics of the island and internationally significant shorebird and Globally Critically Endangered Spoon-billed Sandpiper (SBS) sites

The shallower part of southern continental shelf off the coast of the Sundarbans, Patuakhali and Noakhali is covered by silt and clay; and extensive muddy tidal flats have developed along the shoreline. Some of the shoals and sand ridges present on this part of the continental shelf, show an elongation pattern pointed towards the Swatch of No Ground. Surface hydrology of the Bay of Bengal is basically determined by the monsoon winds and to some extent by the hydrological characteristics of the open part of the Indian Ocean. Fresh water from the rivers largely influences the coastal northern part of the Bay.

Bangladesh declared her first Marine Protected Area, Swatch of No Ground, which is a shelf canyon that deeply incises the Bengal shelf near the Ganges–Brahmaputra river mouth, cuts the forest beds of the subaqueous river delta and acts as temporary centre between the river mouth and the Bengal fan. The canyon is a 300 m deep and 18 km wide depression with step-like micro-terraces running in NNE-SSW direction. The depth to the seafloor topography varies from 900 to 1459 m with 100-150 m thick levee sediments deposited on both the edges of the canyon as seafloor swells spreading over a distance of 10-20 km. In the area north of the 20°07'N latitude, the canyon is characterized by a gentle step-like slope towards the western flank and a steep slope towards the eastern flank, while in the area south of the 20°07'N lat., the morphology of the canyon is vice versa. The anatomy of the canyon suggests that with turbidity sediments flow in a semi-circular manner within it. When the muddy sediments strike the flank within the canyon, a part gets bounced-off in an orthogonal direction to the semicircular turbidity flow leading to the formation of step like small terraces on the other flank of the canyon. The canyon is associated with a low gravity field of about 15 mGal and weak magnetic field of the order of 30-40 nT. The model study revealed that the submarine canyon is not associated with any structural discontinuities such as faults and folds. Hence, it is contemplated that the

submarine canyon is a morphological feature formed by major river flows and underwater currents in the northern Bay of Bengal. Swatch-of-No-Ground is a highly biologically productive area created by upwelling currents and supports large groups of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*), pantropical spotted dolphins (*Stenella attenuata*) and spinner dolphins (*Stenella longirostris*), as well as a possible resident population of Brydes whales (*Balaenoptera edeni*).

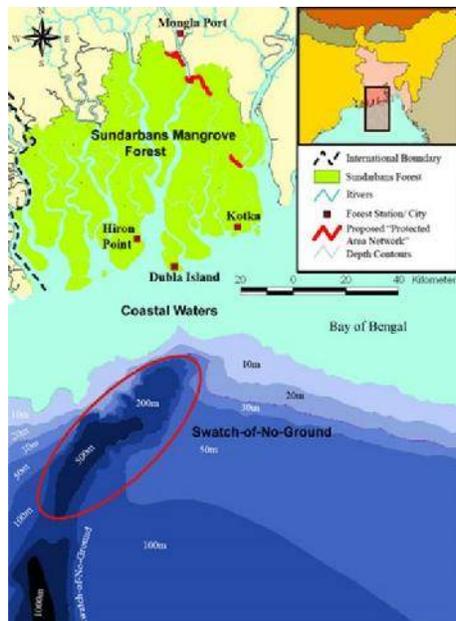


Figure 11 Swatch of No Ground is Bangladesh's first marine protected area. It is located in the Bay of Bengal at the head of a submarine canyon. It spans approximately 672 square miles (1,738 square kilometers) and is more than 900 kilometers in depth in some locations. The area is a key breeding and spawning ground for dolphins, whales, sharks and turtles. The marine protected area was established for the long-term protection of cetaceans that inhabit waters offshore of Bangladesh

Source of image: <http://whalesandmarinefauna.wordpress.com/2014/11/02/swatch-of-no-ground-declared-protected-zone-bangladesh/>

3. Existing Status and Management Practices of Ecosystem

3.1. Existing Situation and Status

Ecosystems are the major habitat for birds, plants, fish and other biotic component including human being. Tanguar Haor is characterized by approximately 141 fish species, including some exotic species which represents more than half of the country's freshwater fish species. Bangladesh Government has taken plans and initiatives to conserve important ecosystems. Different areas such as forests, important wetlands, and bird sites are declared as protected areas, sanctuary, IBA, ECA and Ramsar site. The government has taken massive plan to restore the natural environment and heritage of the Sundarbans, other forests, and Haors by conserving their resources and fish production, and ensuring them as secured zone for biodiversity. The GOB has already declared some of the Haors as 'Ecologically Critical Areas (ECA). CWBMP, IUCN and CNRS revealed that the situation of some wetlands in the Haor areas have improved mainly because of project interventions. There are 2 Ramsar sites, 9 Ecological Critically Areas, 17 National Parks, 20 Wildlife Sanctuaries, 8 Eco-parks and 2 Botanical Gardens for protecting ecosystem and its

sustainable resources management in Bangladesh. International ornithological organization Birdlife International has spotted 20 areas that are listed as Important Bird Area (IBA) in Bangladesh.

The Bangladesh Government has recently announced 'the Swatch of No-Ground', a spawning and breeding area of many endangered oceanic species, as the first marine protected area or first protected marine area of the country. The Swatch of No-Ground, an 1738 km² area with an average depth of 900 meter and located in the southern side of the Dublachar island in the Bay of Bengal, is a key breeding and spawning ground for dolphins, whales, sharks and turtles. At least, five globally endangered dolphins and eight species of whales including the fin whales, hunchback whale, common sperm whale and killer whale and Bryde's whale breed and reside in the area. The Ministry of Environment and Forest issued a circular in 2012 announcing the area as protected under the Wildlife (Conservation and Security) Act, 2012 which would restrict fishing and other offshore commercial activities there. The initiative would ensure long-term protection of the cetacean (the dolphins, whales and porpoises) species inhabiting in the offshore waters of Bangladesh.

Bangladesh possesses rich diversity of species, particularly for angiosperms and avifauna. It has been reported from previous studies that there is a total of 3,611 species of angiosperm available in Bangladesh. Out of which, 2,623 species under 158 families belong to dicotyledons, and 988 species under 41 families belong to monocotyledons. As no systematic and complete survey has recently been conducted, it is very likely that the total number of angiosperm species may reach up to 5,000. A total of 653 fish species are recorded, of which 251 are freshwater fish belonging to 61 families and 402 are estuarine and marine fish, including sharks and rays. A total of 650 bird species have been reliably recorded in the country. The country is also inhabited by 34 amphibian and 154 reptile species. The mammalian species diversity in Bangladesh is represented by 121 species of mammals, many of which are now endangered.

Bangladesh's forests ecosystem has decreased significantly in terms of both area and quality over the last few decades. Degradation of swamp forests continued till mid eighties of the last century. In addition, the declaration of TanguarHaor as a Ramsar Site has helped to protect one of the remnant swamp forests in the country. NGOs and local communities took initiative to re-establish some of these forest patches. Over the last three decades, massive topographic condition and natural water flow direction, which have often resulted in loss of connectivity, enhanced drainage and reclamation of wetlands, and in other areas, water logging; all have affected the local surface water regime. The critical point of such development activities in the wetlands led the transformation very rapidly and at a massive scale. In the Ganges-Brahmaputra floodplain area, about 2.1 million hectares of wetland have been lost for Flood Control, Drainage and Irrigation projects (FCDI). A short scenario of different ecosystem practice is shown Table 2.

Table 2: A short scenario of ecosystem practice in Bangladesh

Name of the Ecosystem	Sub-unit	Existing management practice	Importance	Success	Failure	Future threats
Terrestrial co-system	Forest	FD through declared PA, WIS, NP, RF etc.	Wildlife and wild plant habitat, Wood, livelihood	Co-management approach	Weakness in management practice; Lack of implementation of law, conflict between surrounding people, forest	Over population, over resources collection, monoculture, corruption

Name of the Ecosystem	Sub-unit	Existing management practice	Importance	Success	Failure	Future threats
					cover area reduced	
	Roadside and Embankment vegetation	Social forestry through FD	Erosion protection, wind protection, timber and fuel wood, wildlife habitat	Wood and fuel wood production, reduction of pressure on natural forest, natural disaster like coastal cyclone protection	Poor monitoring system, dependent on exotic species	Invasive species and monoculture
	Homestead vegetation	Personal management	Wood, fruits, fuel, wildlife habitat	Increase in fruits production and vegetative cover	Wildlife hunting	Reducing wild species
	Agriculture land (AGL)	Most of the AGL under personal management	Rice, fish, vegetable aquatic plants, wildlife habitat	Food security and production	Over use of insecticides, chemical fertilizer	Water pollution, poisoning in food, lack of organic fertilizer
Aquatic ecosystem	Hoar wetland	A few number of Hoar (Hakaluki Haor, Tanguar haor, Hail, Paganar Haor) management by DoE through various project implementation	Bird (migratory & resident), capture fish, Turtle agriculture	Ramsar Site, ECA, Fish sanctuary	Over-fishing, insufficient manpower for management	Upstream flow, Transponder river
	Mangrove	FD	Wildlife	Ramsar	Tiger and	Fresh

Name of the Ecosystem	Sub-unit	Existing management practice	Importance	Success	Failure	Future threats
	forest		habitat, Wood, Fish, honey, shrimp,	site, World heritage site, ECA, Wildlife Sanctuary	deer poaching	water flow, Salinity, Thermal power plant, navigation, oil spills
	Swamp forest	FD conserving few forest patch specially the Ratargul swamp forest	Habitat of wildlife and swamp vegetation	Reserve Forest (Ratargul)	Old tree felling	Over-fishing, insufficient manpower for management
	River	Certain parts of Padma, Buragaurang, Andarmanik, Shabajpur channel, Illahsa, and Meghna river declared as Hillsha breedingground and dolphin sanctuary	Capture fish, wetland birds, dolphin, irrigation, freshwater flow, vegetation health	Increase Hilsha production	Illegal fishing still occurring	Climate change, salinity, river morphology
	Bezels	Personal and Lease holder	Capture fisheries, breeding ground	Increase culture fish	Converted as Agriculture field, decreases fish species richness	Decrease fish species diversity and beel area
	Pond	Personal	Culture and capture fisheries	Increase in culture fish	Connectivity loss from natural wetland	Decrease fish species diversity
	Marine	Recently (Swatch of No Ground) South Bay of Bengal declared as sanctuary)	Marine fish and animals, wildlife	Increase in fish export	No intensive research	Navigation, Pollution, over-fishing

Table 3: Number of species identified in various Groups of plants (in numbers)

Plants group	World	Sub-continent	Bangladesh
Bacteria	8,050	850	470
Algae	40,000	7,175	1988+
Fungi	72,00	14,500	275
Lichen	13,500	2,223	data not available
Bryophytes	14,500	25,00	248
Pteridophytes	10,000	12,00	195
Gymnosperms	650	67	7
Angiosperms	2,50,000	17,527	3,611

Source: Encyclopaedia of Flora and Fauna of Bangladesh (2007)

Table 4: Diversity of faunal Species in Bangladesh compared to World and Subcontinent (in numbers)

Taxonomic group	World	Sub-continent	Bangladesh
Protozoa	31,250	2,577	175
Porifera (Sponge)	4,562	500	29
Cnidaria (Coral, Jelly Fish)	9,916	842	102
Ctenophora (Planktonic marine animals)	100	12	10
Rotifera (microscopic aquatic animals)	2,500	330	76
Gastrotricha (Nematodes)	3,000	100	4
Platyhelminthes	17,500	1,622	126
Nematoda	30,000	2,850	176
Mollusca	66,535	5,072	479
Echinodermata	6,000	765	46+
Arthropoda	987,949	68,389	5000+
Fish	21,723	2,546	653
Amphibians	5,150	248	34
Reptiles	5,817	460	154
Birds	9,026	1,232	650
Mammals	4,629	397	121

Source: Encyclopedia of Flora and Fauna of Bangladesh (2007)

Human interference in the wetlands has been damaging the fragile ecosystem and to the long-term sustainability of the wetlands. For instance, in the southwest brackish water coastal plains of Bangladesh, the farmers used to have a single paddy crop during monsoon when surface water salinity depleted due to heavy rainfall, and the field was left for grazing for rest of the months. The practice of this culture evolved and was enriched by local knowledge for centuries. However, during the last two decades, this practice has been abandoned to provide space for more profitable shrimp farming. As a result, natural ecosystems have been changed for such conversion, rapid siltation of the channels and continuous inundation of land with saline water. In Haor areas, large scale settlement was initiated in the mid-20th century from surrounding densely populated regions, and since then, the resources of the Haor basins are being exploited. Continuous exploitation of aquatic vegetation and plants like Makhna, Singara, Lotus, Waterlily, and Hogla, has been seen which are required for the habitat for fish and migratory birds in the Haor areas. Similarly, embankment

constructed for FCDI projects, reduced floodplains and made obstacles to fish movement and migration from rivers and bevels to the remaining floodplains for feeding and breeding. As a result, many fishermen have lost their livelihood.

As a whole, degradation of wetlands has caused several problems, including extinction and reduction of wildlife, extinction of many indigenous wild and domesticated rice varieties, loss of many indigenous aquatic plants, herbs, shrubs and weeds, loss of natural soil nutrients, loss of natural water reservoirs and of their resultant benefits, increase in the occurrence of flooding and degeneration of wetland based ecosystems, occupations, socio-economic institutions, and cultures. However, some noteworthy endeavours can be mentioned both from government and NGO sectors in restoration of wetland habitat in the country. CBAECA (CWBMP), CREL (IPAC) projects have been working in several inland and coastal wetlands to protect biodiversity, involving local communities. MACH was another project where ecosystem protection approach was used to conserve the habitat and its resources. Sunamganj CBRMP programme of LGED is also working on fisheries restoration and ecological resource management.

The area of settlement, and consequently, homestead vegetation, is growing gradually for the last few decades with population growth, resulting in loss of other ecosystems. However, the quality of the homestead ecosystem has declined rapidly, because of commercialization of the land. Species diversity drastically reduced with rapid increase of commercially valuable species. Loss of plant species diversity also reduces the quality of wildlife habitat by reducing food sources and other microhabitats essential for supporting the integrity of the food chain.

Table 5: National status of inland and resident vertebrates of Bangladesh

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

3.2. Ramsar Site

The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilization of wetlands, i.e., to stop the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational values. Wetlands are vital for human survival. They are among the world's most productive environments, cradles of biological diversity that provide the water and productivity upon which countless species of plants and animals depend for survival. Wetlands are indispensable for the countless benefits or "ecosystem services" that they provide for the humans, ranging from freshwater supply, food and building materials, and biodiversity, to flood control, groundwater recharge, and climate change mitigation. The Convention uses a broad definition of wetlands. This includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, oases, estuaries, deltas and tidal flats, mangroves and other coastal areas, coral reefs, and all human-made sites, such as fish ponds, rice paddies, reservoirs and salt pans.

The attention of the international conservation community to the international significance of the wetlands of the Haor basin for their waterfowl populations was first drawn at an International Regional Meeting on Conservation of

Wildfowl resources held in Saint Petersburg in September 1968. (Ramsar Criteria Annex: A-2) Bangladesh has two Ramsar Sites namely a) Sundarban Mangrove Forest and b) Tanguar Haor.

3.3. Protected Area (National Park, Wildlife Sanctuary, Eco-park, Botanical Garden, IBA and ECA)

Protected Area:

Protected Areas include Wildlife Sanctuary, National Park and Game Reserve. Their definitions in the Bangladesh Wildlife (Preservation) Order, 1973 (henceforth, Wildlife Order) is as follows: Wildlife Sanctuary means an area closed to hunting, shooting or trapping of wild animals and declared as such under Article 23 by the government as undisturbed breeding ground primarily for the protection of wildlife inclusive of all natural resources such as vegetation soil and water (paragraph (p) of Article 2). Game Reserve means an area declared by the government as such for the protection of wildlife and increase in the population of important species wherein capturing of wild animals shall be unlawful (paragraph (c) of Article 2). Article 23 of the Wildlife Order has provisions for declaration of Protected Areas and also has regulations prohibiting activities in the Protected Areas.

National Parks:

National Park comprises comparatively large areas of outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery, flora and fauna in the natural state to which access for public recreation and education and research may be allowed (paragraph) (p) of Article 2).

Table 6: National Parks of Bangladesh

Sl. No.	National Parks	Location	Area (ha.)	Established	Specific Characteristics
01	Altadighi National Park	Naogaon	264.12	24-12-2011	Deciduous Forest
02	Baroiyadhala National Park	Chittagong	2933.61	06-04-2010	Hill Forest
03	Bhawal National Park	Gazipur	5022.00	11-5-1982	Deciduous Forest
04	Birganj National Park	Dinajpur	168.56	24-12-2011	Deciduous Forest
05	Himchari National Park	Cox's Bazar	1729.00	15-2-1980	Hill Forest
06	Kadigarh National Park	Mymensingh	344.13	24-10-2010	
07	Kaptai National Park	Chittagong Hill Tracts	5464.00	9-9-1999	Hill Forest
08	Khadimnagar National Park	Sylhet	678.80	13-04-2006	Hill Forest
09	Kuakata National Park	Patuakhali	1613.00	24-10-2010	Coastal forest
10	Lawachara National Park	Moulavibazar	1250.00	7-7-1996	Mixed evergreen Forest
11	Madhupur National Park	Tangail/ Mymensingh	8436.00	24-2-1982	Deciduous Forest
12	Medhakachhapia National Park	Cox's Bazar	395.92	8-8-2008	Hill forest
13	Nababganj National Park	Dinajpur	517.61	24-10-2010	Deciduous Forest
14	Nijhum Dweep National Park	Noakhali	16352.23	8-4-2001	Mangrove
15	Ramsagar National Park	Dinajpur	27.75	30-4-2001	Deciduous Forest
16	Satchari National Park	Habigonj	242.91	15-10-2005	Mixed evergreen forest
17	Singra National Park	Dinajpur	305.69	24-10-2010	Deciduous Forest

Wildlife Sanctuary:

Sanctuary is an area where hunting, killing, shooting or trapping of wild animal is prohibited and managed for the protection of all natural resources, such as vegetation, soil and water, primarily, for undisturbed breeding of wildlife and declared as such by the Government by official gazette under section 13 of this Act.

Table 7: Wildlife Sanctuary of Bangladesh

Sl. No.	Wildlife Sanctuary	Location	Area (ha)	Established
01	Chadpai Wildlife Sanctuary	Bagerhat	560.00	29-01-2012
02	Char Kukri-Mukri Wildlife Sanctuary	Bhola	40.00	19-12-1981
03	Chunati Wildlife Sanctuary	Chittagong	7763.97	18-3-1986
04	Dhangmari Wildlife Sanctuary	Bagerhat	340.00	29-01-2012
05	Dudhmukhi Wildlife Sanctuary	Bagerhat	170.00	29-01-2012
06	Dudpukuria-Dhopachari Wildlife Sanctuary	Chittagong	4716.57	6-4-2010
07	Fashiakhali Wildlife Sanctuary	Cox's Bazar	1302.43	11-4-2007
08	Hajarikhil Wildlife Sanctuary	Chittagong	1177.53	6-4-2010
09	Nagarbari-Mohanganj Dolphin Sanctuary	Pabna	408.11	01-12-2013
10	Nazirganj Wildlife (Dolphin) Sanctuary	Pabna	146.00	01-12-2013
11	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	42087.00	20-9-1983
12	Rema-Kalenga Wildlife Sanctuary	Hobigonj	1795.54	7-7-1996
13	Sangu Wildlife Sanctuary	Bandarban	2331.98	6-4-2010
14	Shilanda-Nagdemra Wildlife (Dolphin) Sanctuary	Pabna	24.17	01-12-2013
15	Sonarchar Wildlife Sanctuary	Patuakhali	2026.48	24-12-2011
16	Sundarban (East) Wildlife Sanctuary	Bagerhat	31226.94	6-4-1996
17	Sundarban (South) Wildlife Sanctuary	Khulna	36970.45	6-4-1996
18	Sundarban (West) Wildlife Sanctuary	Satkhira	71502.10	6-4-1996
19	Swatch of No-Ground Marine Protected Area	South Bay of Bengal	173800	27-10-2014
20	Teknaf Wildlife Sanctuary	Cox's Bazar	11615.00	24-03-2010
21	Tengragiri Wildlife Sanctuary	Barguna	4048.58	24-10-2010

Eco- Park:

"Eco-Park" is an area of natural ecological habitat of flora and fauna with outstanding scenic beauties which is managed for providing recreational facilities to the visitors and which is declared as such through official gazette notification under Section 19 of this Act.

Table 8: Eco-park of Bangladesh

Sl. No.	Eco- Park	Location	Area (ha.)	Established
01	Banshkhali Eco-Park	Chittagong	1200	2003
02	Borshijora Eco-Park	Moulavibazar	326.07	2006
03	Dulahazara Safari Park	Cox's Bazar	600	1999
04	Kuakata Eco-Park	Patuakhali	5661	2005
05	Madhabkunda Eco-Park	Moulavibazar	265.68	2001
06	Modhutila Eco-Park	Sherpur	100	1999
07	Sitakunda Botanical Garden and Eco-park	Chittagong	808	1998
08	Tilagar Eco-Park	Sylhet	45.34	2006

Botanical Garden:

“Botanical Garden” is an area where different native and exotic plant species are conserved or managed for education, research and conservation and improvement of source of gene pool introducing from another habitat and which is declared as such through official gazette notification under Section 19 of this Act

Table 9: Botanical garden of Bangladesh

Sl. No.	Botanical Garden	Location	Area (ha.)	Established
1	National Botanical Garden	Dhaka	84.21	1961
2	Baldha Garden	Dhaka	1.37	1909

Important Bird Area:

BirdLife International has identified and categorized twenty Important Bird Areas (IBAs) in Bangladesh (IBA Criteria Annex: A-1) major among those being AilaBeel, Hail Haor, Hakaluki Haor, Tanguar Haor and Pana Beel.

Table 10: Important Bird Areas (IBAs) of Bangladesh

Sl. No.	Site Name	IBA Criteria
01	Aila Beel	A1, A4i, A4iii
02	Ganges-Brahmaputra-Meghna delta	A1, A4i, A4iii
03	Hail Haor	A1, A4i, A4iii
04	Hakaluki Haor	A1, A4i, A4iii
05	Hazarikhil Wildlife Sanctuary	A3
06	Himchari National Park	A3
07	The Jamuna-Brahmaputra Rivers	A1, A4i
08	Lawachara/West Bhanugach Reserved Forest	A1
09	Madhupur National Park	A3
10	Muhuri Dam	A4i
11	Pablakhali Wildlife Sanctuary	A1, A3
12	Patenga Beach	A1, A4i
13	Rajkandi Reserved Forest	A3
14	Rampahar-Sitapahar Wildlife Sanctuary	A3
15	Rema-Kalenga Wildlife Sanctuary	A3
16	The Sangu - Matamuhari	A3
17	Sonadia Island	A1, A4i
18	The Sunderbans(East, South, West Wildlife Sanctuaries)	A1, A4iii
19	Tanguar Haor and Panabeel	A1, A4i, A4iii
20	The Teknaf Game Reserve	A1, A3

Source: BirdLife International 2004

Ecologically Critically Area:

Ecologically Critical Area (ECA) refers to ecologically defined areas or ecosystems affected adversely by the changes brought through human activities. The Bangladesh Environment Conservation Act (BECA), 1995 has provision for declaration of Ecologically Critical Area (ECA) by the Director General of the Department of Environment in certain cases where ecosystem is considered to be threatened to reach a critical state. In April 1999, the Director General of the Department of Environment (DOE) officially declared nearly 40,000 ha, within seven separate wetland areas as ECAs. These sites are Hakaluki Haor, Sonadia Island, St Martin's Island, and Teknaf Peninsula (Cox's Bazar Sea Beach) but not their buffer zones. Tanguar Haor, Marjat baor (oxbow lake) at Jhenaidaha and outside of Sundarbans Reserved Forest at 10 sq. km extent all of which were deemed to meet the 'urgency criterion' required by BECA, i.e.,

they were "threatened to reach a critical state". The ECA area encompassed by the site contains biodiversity of global significance. Over 800 species of wildlife have been identified from the ECA areas, more than 20 of which are globally threatened.

The Government of Bangladesh has declared the Tanguar Haor as an Ecologically Critical Area (ECA) in 1999 considering its critical condition as a result of over exploitation of its natural resources. Birdlife International has included the TanguarHaor as an IBA of Bangladesh. The Tanguar Haorwetland system is the last remnants of fresh water swamp forest in Bangladesh. Baikka Beel is about 100 hectares of wetland in the eastern part of Hail Haor near Srimangal, a tea growing town in Moulvibazar District about 200 km northeast of Dhaka. On 1stJuly 2003, after a detailed planning process, the Ministry of Land decided to preserve it as a permanent sanctuary.

Table 11: ECA area and its location

Name	Type	Area (ha)	Year declaration
The Sundarbans (10km periphery buffer around the forest)	Mangrove Forest	-	1999
Teknaf Peninsula	Sandy Beach	10465	1999
St. Martin's Island	Coral Ecosystem	590	1999
Sonadia Island	Sand dunes	4916	1999
Hakaluki Haor	Wetland	18383	1999
TanguarHaor	Wetland	9727	1999
Marjat Baor, Jhenaidah	Oxbow Lake	200	1999
Gulshan-Baridhara Lake	Urban Wetland	-	2001
The rivers (Buriganga, Turag, Sitalakhya and Balu) around Dhaka city		-	2009

Source: Bangladesh Forest Department, 2014

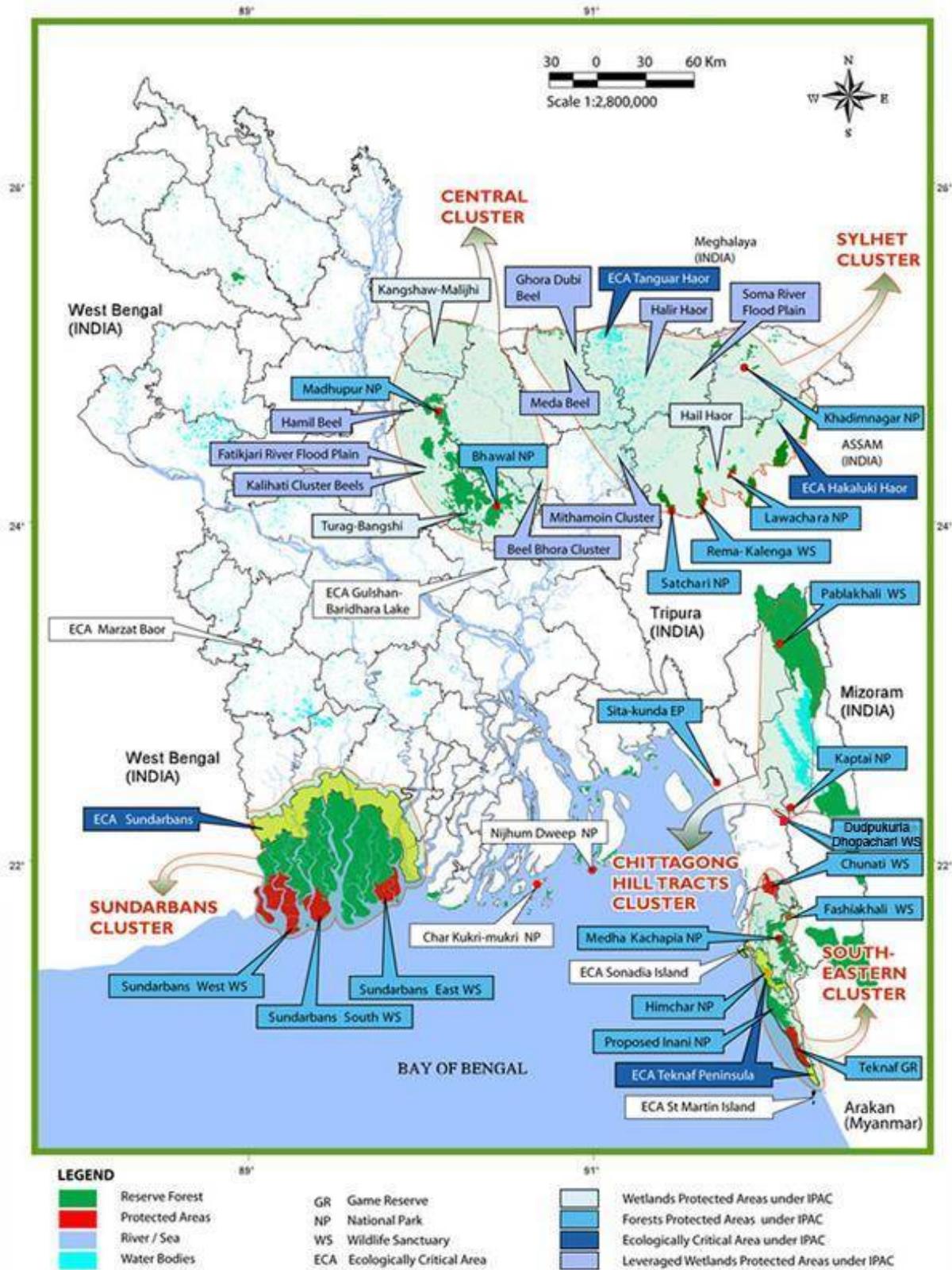


Figure 12 Protected areas of Bangladesh

3.4. Threats to Ecosystem in Bangladesh

The coastal zone including the world's largest mangrove ecosystem, the Sundarbans, is facing a serious threat of loss of biodiversity due to change of climate, oil spills pollution and navigation. There are numbers of threats causing as drivers to ecosystem and its resources loss, among which some are direct and dynamic while the others are indirect. Direct threats include changes in land use, habitat destruction, introduction of invasive alien species etc. On the other hand, indirect threats are economic system and policy of the state, unsustainable exploitation of resources and weak management system, gaps in spatial information, lack of public awareness etc. The following sections describe how these drivers contributed in deteriorating the ecosystem

3.4.1. Direct Threats

The pressures that brought changes in the land use in both terrestrial and aquatic environments include, demand for increased agricultural lands, collection of fuel wood, and non-timber forest products by the local communities. More and more natural habitats are converted into human habitations due to high growth of population and economic activities. As a small country with high population and limited natural resources, it is obvious that the competition for these resources is immense. At present, the country has 85,000 hectares of agricultural lands, of which 1% is being converted annually to other land use patterns. Urbanization is another major concern for the country, causing rapid reduction in agricultural lands. Development of infrastructure such as communication networks, flood control and irrigation infrastructure are also bringing rapid change in the land use.

Fragmentation and loss of habitat

Ecosystem fragmentation, especially in forest areas, has been recognized as one of the major causes of biodiversity loss. Furthermore, the more fragmented the ecosystem is, the higher the exposure to land use change and human pressures. Fragmentation of habitat is extensive and continues to occur at a rapid rate across the country. Habitat fragmentation typically reduces total habitat area, size of individual habitat patches and proximity of habitat patches, and it can increase the amount of habitat edge. Changes in habitat patch size, proximity of habitat patches, and the amount of edge-habitat can also affect wildlife populations by negatively affecting reproductive success, survival, and/or immigration rates in the remaining habitats.

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

Change in hydrological regime

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

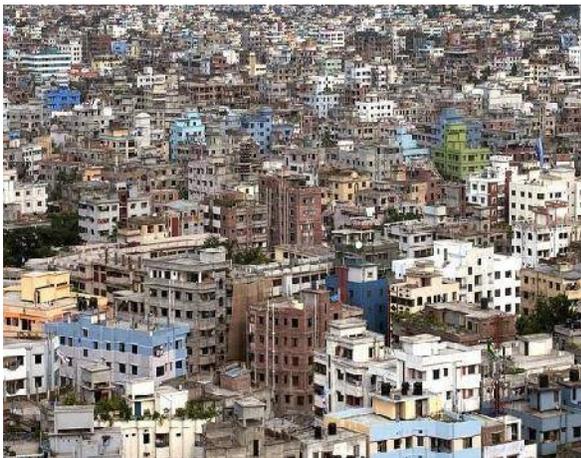


Figure 13 Different types of ecosystem threats in Bangladesh

Pollution

With the increase of industrial units across the country without having effective waste management practices, the pollution level for both terrestrial, as well as aquatic habitat, is rising. Many of these industries are dumping their wastes directly into the neighbouring agricultural fields or water bodies (rivers, canals, ditches etc.). The situation is extremely harmful for water bodies of the country leading to degradation of ecosystem through depletion of floral and faunal resources. The situation is further worsened because of the release of untreated sewage from most of the

cities. Agricultural run-off, growing use of agricultural chemicals such as fertilizers and pesticides, are the major sources of pollutant across the country posing potential threat to the genetic resources to be faded out. Coastal areas are not immune to the impact of activities such as ship breaking and ship building business. Moreover, Bangladesh is going to establish Thermal Power Plant, Deep Seaport in different areas of Bangladesh; it could be future challenge for mangrove, marine and river ecosystem.

Uncontrolled tourism

The development of unplanned and uncontrolled tourism is becoming one of the major threats for the degradation of biodiversity at hotspots. For example, the biodiversity of St. Martin's Island, Lawachara National Park, Ratargul Swamp Forest, Madhabkundu Eco-park and Sundarban have been facing continuous threat from poorly managed tourism.

Unsustainable agricultural practices

Some agricultural practices, using irrigation and overuse of pesticides and chemical fertilizer, are not environment-friendly and sustainable. Introduction of high yielding varieties (HYV) coupled with hybrid seeds are causing sharp decline in the country's genetic resources of crop varieties. Changes in agricultural system are the main causes of genetic erosion in agricultural biodiversity. Out of more than 10,000 rice cultivars only 22 are mostly now in use, leaving behind the vast genetic resources accumulated through the painstaking work of our farmers. Moreover, agro and veterinary chemicals can have unexpected consequences, for example the adverse impacts of the drug diclofenac on vultures was not anticipated and took a decade to identify and prove.

Urban expansion

The unplanned urbanization is now a major threat to Bangladesh. The Dhaka city and the surroundings expanded alarmingly. There is no sustainable eco friendly plan to cope with the situation; even the building code is not followed properly. As a result the available wetland of the city and the surrounding open places changed drastically over the years. Due to wetland encroachment, the city dwellers are facing lot of environmental problems. It has been observed that such types of urbanization process are also going on in other big and small cities of Bangladesh.

Invasive alien species

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

Climate change and sea level rise

Bangladesh is one of the most vulnerable countries to climate change, variability and extreme events. The country is suffering from severe impacts because of its low-lying nature, dense population and nearness to the Bay of Bengal. The lowlands and particularly wetlands are vulnerable to sea level rise which is considered as an effect of climate change. The impact of climate change on biodiversity of Bangladesh is incalculable as large part of coastal region including Sundarbans is under threat of being inundated. The increased salinity in Sundarbans and the estuarine region is changing the species composition of freshwater fishery; as many fresh water fish, wildlife, plants are sensitive to salt water. Climate change over the past 30 years produced numerous shifts in the distribution and abundance of species worldwide. The climate change, as well as sea level rise, has already resulted salinity intrusion and produced shifts in the distribution of some species, such as amphibians, grasses, migratory birds and butterflies. Coral reefs are threatened by the bleaching that occurs with changes in ocean temperature and chemistry. A wide range of mammals, birds, amphibians, reptiles, crustaceans, and above all the Royal Bengal Tiger will face extinction in Bangladesh, because, for some of the species there will be no suitable climate-habitat combination anywhere to

survive. In other cases they may be unable to reach distant regions where the climate is suitable. Other species may survive elsewhere only to face new threats, notably if the new area is covered by crops or urban sprawl. For the situation as mentioned above, biodiversity conservation demands to be the number one adaptation option for addressing climate change risks in Bangladesh.

3.4.2. Indirect Threats

Economic systems and policies

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

Lack of Knowledge and awareness

Lack of information and knowledge generally leads to gaps in awareness. It seems that, most of the people do not even know the existence of so many species, ecosystem functions and web chain of organisms. Even they do not know that there are laws which banded hunting and trade of wild animals. There are also laws that protect certain species and ecosystems as well as laws which meant to control environmental pollution.

Legal and institutional systems that promote unsustainable exploitation

A number of laws and rules have come into force in the last four decades those are directly or indirectly addressing the issue of environmental protection, ecosystem and biodiversity conservation. Bangladesh Environment Conservation Act 1995 is one which has a clear mandate to conserve overall environment along with biological diversity and ecosystems. To fulfil the mandate of the Environment Act, the Department of Environment (DoE) is not yet strengthened enough with adequate working force and other facilities. To deal with the three basic obligations of the Convention on Biological Diversity (CBD) viz., conservation of biological diversity, sustainable use of its components with fair and equitable sharing of benefits arising out of uses of genetic resources, the institutional setup at the policy level is not mainstreamed and sensitized. Outdated management system is still very strong and playing a great hindrance for moving ahead towards knowledge-based conservation and management of biodiversity in Bangladesh. Overall, there is a lack of integration of environmental considerations (Ecosystem-base Adaptation) in planning, resulting in the absence of a truly integrated land and water resources management. Due considerations on environmental issues were farsighted off for the development activities in roads and highways, polders and embankments, etc. Excessive climatic uncertainty, fishing and over-exploitation of coastal resources, water quality deterioration, huge groundwater withdrawal, mangrove destruction for shrimp pond excavation, rampant rural poverty, institutional and legal limitations, repeated cyclones and storm surges etc. are some of the major problems which need to be addressed on a priority basis to conserve the biodiversity in Bangladesh.

3.5. Factors on Ecosystems Change

The ecosystem of Bangladesh has a wealthy biodiversity which is declining rapidly due to land use change, climate change, sea level rise, climatic event, invasive species, over exploitation of natural resources, pollution etc. For a small country like Bangladesh, the species richness is relatively large but population size of most of the species has declined drastically. Demographic, economic, social, political, cultural, technological and other indirect drivers are behind the continuing loss of biodiversity and its habitat. The local ecology is disrupted due to the sedimentation of rivers, canals and water bodies. Many species of fish, birds, amphibians, reptiles and mammals have become or are on the verge of becoming extinct due to over fishing and ecosystem destruction. Indiscriminate use of pesticides causes poisoning and results in the decline of wetland species. The major rivers bring in large concentrations of pollutants from agricultural pesticides and industrial wastes which damage fish spawning and nursery areas, cause death of fish and lead to possible changes in tropic structure. High levels of pesticides can be found along the coast, especially near

towns and ports. Moreover, pollutants from the substantial and largely unregulated ship-breaking industry pose an unquantified hazard to coastal and marine life. Development in the coastal zone is set to continue to threaten ecosystems and biodiversity. The rapid growth of the domestic tourism industry has harmful impacts in St Martin's Island and Cox's Bazar due to waste pollution, camp fire, vehicle movement, collection of shells and corals. A deep water port has recently been proposed for Sonadia Island ECA; whereas the Sonadia Island is an important habitat for sea turtle breeding ground and main site of wintering Spoon-billed Sandpipers. In addition, a thermal power plant is proposed to be established near Sundarbans which would also be a threat to Sundarbans ecosystem in future.

The following factors are changing the ecosystem and diversity:

- Loss of habitat
- Tree cutting from natural and homestead forest (deforestation)
- Unplanned urbanization and industrialization
- Lack of proper mitigation and monitoring for industrial projects
- Loss of habitat due to intensifying agriculture
- Introduction of HYV and degradation of habitat through pollution
- Reduction or diversion of water supply
- Increase in disturbance by human activities (Population pressure)
- Invasive plants and predators
- Climate change, sea level rise and salinity intrusion
- Poor implementation of laws, rules relating to diversity conservation
- Land use change and lack of knowledge and awareness

The Delta basin acts as the great freshwater reserves of the country backed by upstream flow. But due to massive intervention in the hydrology for flood protection and water management, this has changed the situation enormously. This intervention has also impacted on fisheries resources and the quality of soil and water. The ecological attributes like groundwater recharge and discharge are diminishing, and not in balanced condition. The vegetation communities are changing from diversity to mono-invasive. Indications of negative impacts are noticed in the freshwater aquatic food-chain and webs. Sustainable harvest of wetlands resources benefits its regeneration and productivity but it does not happen because of careless behaviour of the habitants. Similarly, rational harvest of fish fauna and mollusks also helps the health of population, and to produce more. Thus, it can be stated that native flora and fauna including swamp forest of the Haor basin in the north eastern Bangladesh, has largely deteriorated due to anthropogenic factor.

3.6. Ecosystem Services

As one of earth's most productive ecosystems, Delta's wetlands, directly and indirectly, support millions of people by providing tangible and non tangible services. Wetlands in Bangladesh are such unique ecosystem hosting large stock of goods and services. Millennium Ecosystem Assessment report (MEA, 2003) categorized the ecosystem services into four classes: (a) provisioning services such as food and water; (b) regulating services such as flood and disease control; (c) cultural services such as spiritual, recreational, and cultural benefits; and (d) supporting services, such as nutrient cycling, that maintain the conditions for life on Earth. Biological diversity in the wetland ecosystem plays key role in producing and regulating ecosystem services in the watershed area.

Following the above-mentioned MEA report, ecosystem services of wetlands are summarized in Figure 14. A provisional service of wetlands includes rice, fish, thatching material, fodders etc. Regulatory services of wetlands are regulation of regional climate, hydrological cycle, and waste assimilation/water purification, fish breeding ground, facilitating pollination of terrestrial and aquatic plants. The cultural services include tourism, seasonal village fairs, research and education. Deltaic wetlands in Bangladesh provide environmental and social values: habitats for many plants and animals, including threatened and endangered species; flood storage and groundwater recharge; water

pollution filtration and sediment trapping, and soil protection from erosion. These environmental benefits also provide societal benefits. Human benefits from wetlands are recreation, open space, agriculture, fisheries, and economics. Furthermore, this ecosystem provides educational and aesthetic values and can be a tourist attraction. The disruption of valuable ecosystem must cease, the diversity of remaining ecosystem must be retained, and where possible rehabilitation, protection, restoration and re-creation of ecosystem must be attempted. It is, thus, critical that the importance of ecosystem and their conservation be demonstrated to be essential to the well being of the human life and livelihoods of people in delta regions, as well as to the whole country.

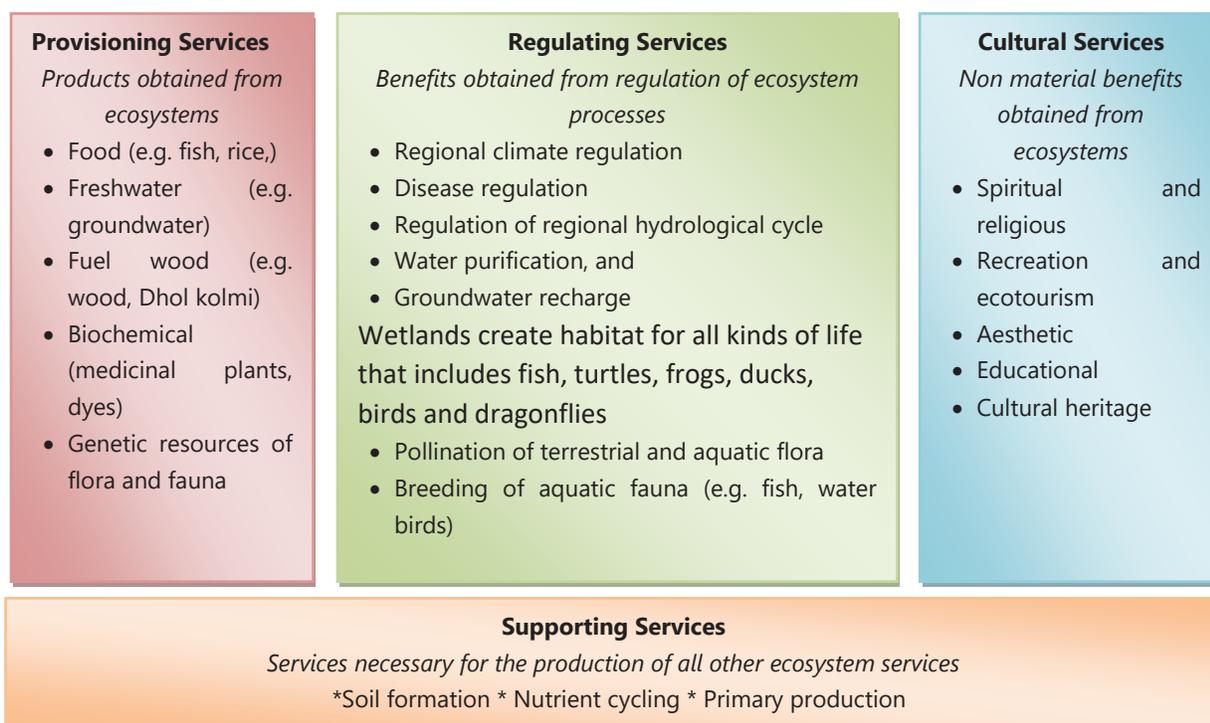


Figure 14 Ecosystem services of wetlands in Bangladesh

The basic ecological functions and attributes of the ecosystem are:

- ❖ Maintenance of essential ecological processes and life-support systems
 - Aquatic ecosystem performs these functions in various ways: some maintain and improve water quality, some regulate flows to reduce flooding and may augment late summer stream flows, and some recharge groundwater supply. Wetlands are important as reproduction and staging areas for migratory birds, as spawning and nursery grounds for fish, and as habitat for a great many invertebrates, reptiles, amphibians and plants.
- ❖ Preservation of floral and faunal genetic diversity
 - Ecosystem plays an essential role in maintaining wildlife populations, providing key habitat for a diverse fauna and flora.
- ❖ Wetlands store surface water, which then infiltrates into the ground, providing recharge to aquifers. This ground water recharge, in turn, is slowly released back to adjacent surface water bodies, such as streams, providing water during low flow periods (base flow).
- ❖ Floodwater storage, Groundwater recharge

- Wetlands store water during flooding events and then slowly release the water as flooding subsides. This can significantly reduce peak flood flows and resulting flood damage downstream.
- ❖ Many species are dependent upon wetlands for all or a portion of their life cycle. Wetlands provide habitat for fish, birds, mammals, reptiles, amphibians, and invertebrates.
- ❖ Wetlands support vegetation that acts as a flood buffer and reduces stream bank erosion during flooding events.
- ❖ Wetlands improve water quality by filtering polluted runoff from cities and agricultural lands. They trap sediments, utilize excess nutrients present in runoff, and breakdown many waterborne contaminants. Constructed wetlands are used to treat contaminated waters from mines, sewer systems, and urban storm water runoff.
- ❖ Sustainable utilization of resources and ecosystems
 - Many local and provincial /territorial economies rely directly on ecosystem resources such as fish and wildlife, plant products and wood. Renewable resources associated with wetlands are central to the traditional subsistence lifestyle of a nation's aboriginal and indigenous people. Wetlands also support substantial tourism and recreational opportunities, such as water cruise, hunting, fishing, bird watching, boat racing and nature photography.
- ❖ Research, Education and Economic Benefits
 - Important ecosystem is often visited for recreational purposes such as hiking, bird watching, wildlife photography, and hunting. These activities can translate into cash money spent at local businesses, adding to the economy. The students need to see numerous plants and animals to have a firsthand idea of the country's ecosystem, which is needed to groom them as future conscious citizens of the country. The cost incurred for such educational activities is relatively minor, compared to the knowledge gained.

The ecosystems of Bangladesh are vitally important for the nation. It has the highest concentration of wetland dependent people in the world. The wetland is the source of income and nutrition for the millions of rural people. Intensive use of agriculture, fishing and collection of other aquatic resources help the rural people and creates employments. Economic value of wetlands can be quantified in economic (monetary) terms. The goods and services provided by the environmental resources or systems, whether or not market prices are available to assist. There is no market for goods or services; a value has to be found through surrogate (replacement) method to establish society's willingness to pay for the goods or its services. A major problem in assessing the value of ecosystems arises when the services provided, such as climate change regulation or biodiversity conservation and benefit the global community. This type of value has not been considered in the application and cases presented here since these are only found in other countries.

IUCN Bangladesh has conducted few preliminary studies on the economic values of ecosystem and its services. A national forum was also established for Green Economy and Ecological Economy. An initial assessment of wetlands values was carried out by IUCN-Bangladesh as case studies focusing the TanguarHaor. But it is still waiting to have a comprehensive values evaluation of the wetlands of Bangladesh. However, MACH project has been assessing the economic values of the sites at Hail Haor. Apart from their ecological role, wetland plants contribute greatly to the economy, science and livelihood of the people of Bangladesh. Wetland plants offer a variety of products and services which are of considerable benefit, Figure 15.

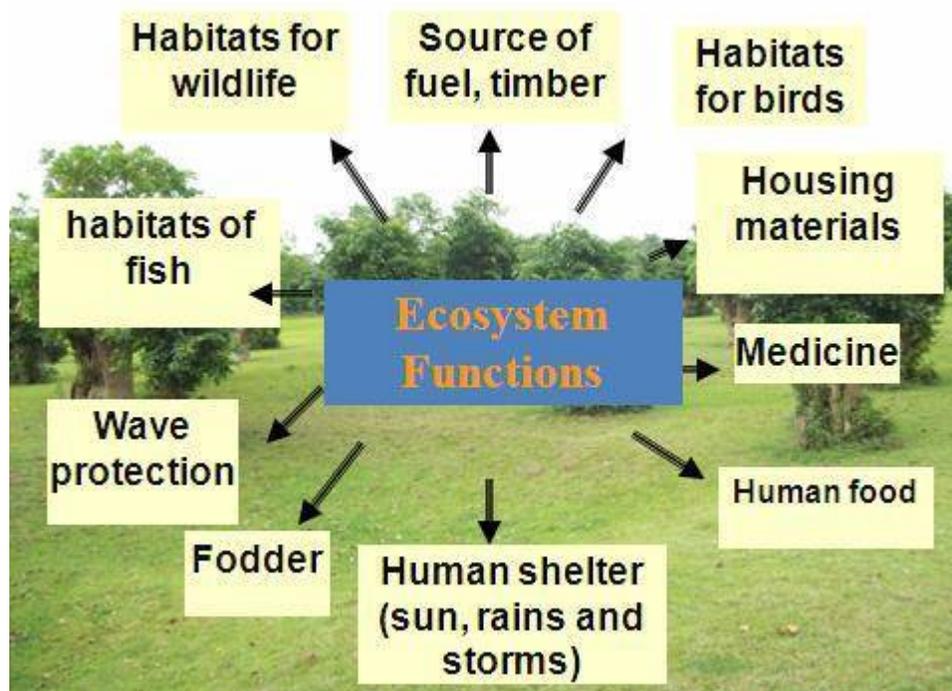


Figure 15 Ecosystem services

Ecosystems are associated with diverse direct and indirect uses. Bangladesh is traversed by numerous rivers and creeks as it comprises most of the delta of two great rivers- the Ganges and the Brahmaputra. About two-thirds of Bangladesh may be classified as wetlands according to the Ramsar Convention definition. About 6 to 7% of Bangladesh is always under water, and in the monsoon 21% is deeply (> 90 cm) flooded, and around 35% experiences shallow inundation (FAO, 1988). Unfortunately, these habitats are in decline due to over-use of resources, increased rates of sedimentation, and the conversion of more and more wetlands to agriculture and urban development to meet the demands of a rapidly growing population. As a nation, Bangladesh has the highest concentration of wetland dependent people in the world. Diverse species of plants, insects, amphibians, reptiles, birds, fish, and mammals depend on wetlands for food, habitat, or temporary shelter. Wetlands have archaeological, historical, cultural, recreational, and scientific values. Societies have been traditionally formed along the waterbodies, and artefacts found in wetlands provide information about these societies. The monetary value derived from the observation and photography of wetland-dependent birds, is also very high. Scientists value the processes of wetlands individually, particularly, the role of wetlands in the global cycles of carbon, nitrogen, and water. Many scientists consider the removal of carbon dioxide from the atmosphere into plant matter and its burial as peat (sequestration) the most valuable function of wetlands. Carbon sequestration is thought to be an important process in reducing the greenhouse effect and the threat of global warming.

3.7. Existing Policy and Regulation

Bangladesh has promulgated several important laws, rules and developed national policies focusing the environment, in general, and the natural resources management, in particular, in recent years. All these policies have considered several cross-cutting issues and through a variety of national and international policy instruments. The government has clearly committed itself to environmentally sound management of biodiversity assets, and to achieve and maintain the environmental quality acceptable to extractive users and sustainable ecosystem functions. Policies and institutions affecting wetlands, like wetland resources themselves, cut across inter-sectoral boundaries, bound up in a complex web of sectoral resources management policies, legislation and organization. Ministry of Environment and Forest as the focal organization of Ramsar Convention for Bangladesh had taken initiative to prepare a national wetlands policy.

The following 14 key messages are globally endorsed as the turn key to formulate the wetlands policy and strategy (Ramsar Conventions) and these strategies could be implemented under this Delta Plan.

- ❖ A cross-sectoral focus is urgently needed from policy- and decision-makers that emphasizes securing wetland ecosystems and their services in the context of achieving sustainable development and improving human well-being.
- ❖ Management of wetlands and water resources is most successfully addressed through integrated management at the river (or lake or aquifer) basin scale that is linked to coastal zone management for coastal and near-shore wetlands and that takes into account water allocations for the ecosystems.
- ❖ Wetlands deliver a wide range of critical and important services (e.g. fish and fiber, water supply, water purification, coastal protection, recreational opportunities, and increasingly, tourism) vital for human well-being. Maintaining the natural functioning of wetlands will enable them to continue to deliver these services.
- ❖ The principal supply of renewable fresh water for humans comes from an array of wetland types, including lakes, rivers, swamps and groundwater aquifers. Up to 3 billion people are dependent on groundwater as a source of drinking water, but such abstractions increasingly exceed their recharge from surface wetlands.
- ❖ The services delivered by wetlands have been arguably valued at US\$14 trillion annually. Economic valuation now provides a powerful tool for placing wetlands on the agenda of conservation and development decision-makers.
- ❖ Wetlands encompass a significant proportion of the area of the planet; the global estimate is 1280 million hectares (equivalent to approximately 9% of land surface) and is recognized as an under-estimate.
- ❖ The degradation and loss of wetlands is more rapid than that for other ecosystems. Similarly, the status of both freshwater and, to a lesser extent, coastal species is deteriorating faster than that of species in other ecosystems. Wetland-dependent biodiversity in many parts of the world is in continuing and accelerating decline.
- ❖ Wetland loss and degradation has primarily been driven by land conversion and infrastructure development, water abstraction, eutrophication and pollution and over-exploitation. Losses tend to be more rapid where populations are increasing most and where demands for increased economic development are highest. Global climate changes is expected to further exacerbate the loss and degradation of wetland biodiversity including species that cannot relocate and migratory species that rely on a number of wetlands at different stages of their life cycle.
- ❖ The continuing loss and degradation of wetlands are leading to reduction in the delivery of wetland ecosystem services, yet at the same time demand for these same services is projected to increase.

- ❖ Current use of two wetland ecosystem services – freshwater and capture fisheries dependent on natural reproduction - in some regions is now in excess of levels that can be sustained even at current demands, much less future ones.
- ❖ The projected continued loss and degradation of wetlands will result in further reduction in human well-being, especially for poorer people in less developed countries where technological solutions are not as readily available.
- ❖ Progress towards achievement of the Millennium Development Goals depends on maintaining or enhancing wetland ecosystem services.
- ❖ The priority when making choices about wetland management decisions is to ensure that the ecosystem services of the wetland are maintained (and where appropriate, restored). This can be achieved by application of the wise use principle and guidelines of the Ramsar Convention.

National wetlands policy is an important national need of the country which might consider the above mentioned 14 key messages.

Ramsar Convention, 1992

The Convention on Wetlands of International Importance, (Ramsar Convention) is the intergovernmental treaty that provides the framework for the conservation and wise use of wetlands and their resources. It was adopted by the international community in 1972. The country has ratified the 1992 RAMSAR Convention (Convention on Wetlands of International Importance, especially as Waterfowl Habitat) on wetlands of international importance and waterfowl habitat, and as a party has taken steps to stem the encroachment and loss of wetlands.

The Ramsar Convention is the only global environmental treaty that deals with a particular ecosystem, the Convention uses a broad definition of the types of wetlands covered in its mission, including lakes and rivers, swamps and marshes, wet grasslands and peat-lands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans. The Convention's mission is "the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. The pioneering 'Wise Use Guidelines' emphasized the importance for contracting parties to:

- ❖ Adopt national wetland policies, involving a review of their existing legislation and institutional arrangements to deal with wetland matters (either as separate policy instruments or as part of national environmental action plans, national biodiversity strategies, or other national strategic planning).
- ❖ Develop programmes of wetland inventory, monitoring, research, training, education and public awareness.
- ❖ Take action at wetland sites, involving the development of integrated management plans covering every aspect of the wetlands and their relationships with their catchments.
- ❖ Provide expertise, either through Ramsar technical personnel and its network or through external consultants.
- ❖ Make available the further guidelines adopted by the conference of the parties on many aspects of wetland conservation and wise use.
- ❖ Fund projects through the Ramsar small grants fund, wetlands for the future and Swiss grant for Africa.
- ❖ Seek third-party funding for wise use projects.
- ❖ Prevent introduction of exotic species
- ❖ Legislate protection of threatened species

- ❖ Develop national strategies, plans and programme to conserve and use sustainably biological diversity

UN Framework Convention on Climate Change (UNFCCC)

Bangladesh is one of the signatories of the United Nations Framework Convention on Climate Change (UNFCCC or Agenda 21, 1992) and the Kyoto Protocol (1997). The LDCF was established to support a work programme to assist Least Developed Country Parties (LDCs) carry out, inter alia, the preparation and implementation of national adaptation programmes of action (NAPAs). The Global Environment Facility (GEF), as the entity that operates the financial mechanism, has been entrusted to operate this fund and in Bangladesh UNDP operating the GEF fund in favour of GEF. The LDCF was established under the United Nations Framework Convention on Climate Change (UNFCCC) and is managed by the GEF. The fund addresses the special needs of the 48 Least Developed Countries (LDCs), which are especially vulnerable to the adverse impacts of climate change. This includes preparing and implementing National Adaptation Programmes of Action (NAPAs) to identify urgent and immediate needs of LDCs to adapt to climate change. The Convention supports the concept of "sustainable development", calls for developing and sharing environmentally sound technologies and emphasizes the need to educate people about climate change.

Wetland systems are vulnerable to changes in quantity and quality of their water supply, and it is expected that climate change will have a pronounced effect on wetlands through alterations in hydrological regimes with great global variability. Wetland habitat responses to climate change and the implications for restoration will be realized differently on a regional and mega-watershed level, making it important to recognize that specific restoration and management plans will require examination by habitat. Floodplains, mangroves, sea grasses, salt marshes, arctic wetlands, peat lands, freshwater marshes and forests are very diverse habitats, with different stressors and hence different management and restoration techniques are needed. The Sundarban (Bangladesh and India), Mekong river delta (Vietnam), and southern Ontario (Canada) are examples of major wetland complexes where the effects of climate change are evolving in different ways. Thus, successful long term restoration and management of these systems will hinge on how we choose to respond to the effects of climate change.

Convention on Biological Diversity (CBD), 1992

The objectives of the Convention on Biological Diversity (CBD) is to conserve biodiversity and promote sustainable use of its components, establish protected areas, integrate biodiversity in national plans and policies, protect traditional cultural activities, and a fair and equitable sharing of the benefits arising out of the use of genetic resources. Since signing the CBD, biodiversity issues have received some attention in a variety of sector policy and strategy documents since that time. Bangladesh has also been a participant in earlier global conservation initiatives before "biodiversity" became the watchword of the day. Bangladesh Government, as a signatory to the Convention has committed, in general terms, to undertake national and international measures aimed at achieving three explicit objectives: the conservation of biological diversity; the sustainable use of its components, and the equitable sharing of benefits arising out of the utilization of genetic resources. The Convention on Biological Diversity (CBD) is a legally binding treaty that seeks to preserve the diversity of life forms through conservation and sustainable use. In doing so, it contributes to the overall objective of sustainable development. It is the first and only global agreement to address all aspects of biological diversity – genetic resources, species and ecosystem.

United Nations Millennium Development Goals

Eight millennium development goals (MDGs) were set in millennium summit of United Nations in September 2000, committing the nations to fulfil series of targets with a deadline of 2015. Environmental concerns were specified under the goal 7 "Ensure Environmental Sustainability". The goal 7 explicitly includes two particular targets that are related to biodiversity and wetland conservation and management, as follows (<http://www.un.org/millenniumgoals/environ.shtml>).

- ❖ Target 7.A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources
- ❖ Target 7.B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss

In case of Bangladesh, the progress of Target 7.A was evaluated in 2005, however the achievements of Target 7.B was not evaluated (GoB and UN, 2005). Globally, the target for reducing biodiversity loss was not achieved by 2010.

Migratory Waterbird Conservation Strategy

The country has ratified the 1994 Bonn Convention named the Convention on Migratory Species aims to conserve terrestrial, aquatic and avian migratory species throughout their range. This convention specializing in the conservation of migratory species, their habitats and migration routes, CMS complements and co-operates with a number of other international organizations, NGOs and partners in the media as well as in the corporate sector. The development models tailored according to the conservation needs throughout the migratory range of wild animals.

In recognition of the threats to migratory waterbirds and the need for action to conserve them and their habitats, the Asia-Pacific Migratory Waterbird Conservation Strategy: 1996-2000 was developed. The Strategy has been very successful in promoting international cooperation and an awareness of the need to work together to promote conservation. A number of international and national activities have been undertaken, primarily, through the implementation of three regional migratory waterbird conservation action plans (shorebirds, cranes and Anatidae) including the establishment of three networks of sites of international importance for these groups of waterbirds and a range of activities, as has been reported in previous issues of Wetlands.

The Asia-Pacific Migratory Waterbird Conservation Strategy: 2001-2005 aims to continue and expand on the successes of the previous Strategy by providing the international framework for the conservation of migratory waterbirds and their habitats in the Asia-Pacific region into the 21st century. Bangladesh is home to a very rich number of migratory birds and Government could consider the strategy and aims for conservation.

The Strategy outlines eight key elements to promote the conservation of migratory waterbirds and their habitats:

- ❖ Action plans for species-groups and globally threatened species.
- ❖ Effectively managed networks of sites that are internationally important for migratory water birds.
- ❖ Raised awareness of water birds and their link to wetland values and functions throughout the region and at all levels.
- ❖ Increased capacity of government agencies and non-government organizations to implement conservation actions for migratory water birds.
- ❖ An enhanced knowledge base and increased information exchange for the sound management of migratory water birds and their habitats.
- ❖ Harmonized national and state policies and legislation as a foundation for the conservation of migratory water birds and their habitats.
- ❖ Enhanced organizational relationships at all levels to increase cooperation and deliver greater conservation benefits.
- ❖ Adequate planning and resources to implement the Strategy.
- ❖ Achieved implementation of Action Plans for three species-groups in the East Asian-Australasian Flyway, selected globally threatened species, and the Central Asian-Indian Flyway;

- ❖ Established effective networks of sites in the flyways to conserve migratory water birds and their important habitats;
- ❖ Built and strengthened capacity of governments and NGOs to sustainably manage water birds and wetlands primarily by providing training to managers of important sites;
- ❖ Promoted conservation education, public and community awareness at the international, national and local level through the development of products and programmes;
- ❖ Enhanced programmes to monitor water bird diversity and abundance at important sites; through improving our knowledge base of wetlands by contributing to regional inventories;
- ❖ Improved our understanding of migration patterns and conservation needs of water birds;
- ❖ Promoted the implementation of improved national policy and legislation to ensure management of water birds and their habitats;
- ❖ Improved links between local communities at important sites;
- ❖ Promoted the sharing of knowledge and skills through various forums (meetings, publications, newsletters, web sites, etc.); and
- ❖ Mobilized at least USD 5 million to achieve these activities.

National Environment Policy

The main policy objectives and priorities are to maintain the ecosystem balance and overall development through protection and improvement of the environment; identifying and regulating pollution and environmentally degrading activities; ensuring environmentally sound development; ensuring sustainable and environmentally sound use of all natural resources, and actively remain associated with all international environmental initiatives. The policy attempts reducing the rate of environmental degradation, improving the natural and man-made environment, conserving habitats and biodiversity including forest, agriculture and fisheries and promoting sustainable development, and improving quality indicators of human life. The Department of Environment (DoE) is assigned with the responsibility to implement the policies concerning protection of ecologically critical areas (ECAs). Forest Department (FD) is responsible for managing Protected Areas and Wildlife, whereas many forest areas are actually beyond the legal jurisdiction of Ministry of Environment and Forests (MoEF). Furthermore, most of the concerned Ministries and Departments including the MoEF lack institutional capacities in terms of human, technological and financial resources needed for proper implementation of the policies. It is, therefore, imperative to make coordinated and integrated efforts to prioritize the areas of relevant legal and policy reform for facilitating wise and sustainable use of our biological resources.

To address the environmental problems, Bangladesh developed the Bangladesh National Environmental Management Action Plan (NEMAP, 1995). The Action Plan is a product of a participatory process led by NGOs with participation by grassroots people.

National Wetlands Policy:

Ministry of Environment and Forest as the focal organization of Ramsar Convention for Bangladesh, had taken initiative to prepare a national wetlands policy. A draft was prepared and discussed at various forums in association with IUCN Bangladesh. As a member country of wetlands convention, it is mandatory to develop national wetlands policy. Organizations engaged in wetlands conservation and learned bodies of the country have urged government to have the national policy and strategies for wetlands conservation. The policy is not yet finalized.

National Forestry Policy (1994-2015):

The policy initiated a 20-year forestry master plan to preserve and develop the nation's forest resources which is supported by Forests Act, 1927 and Wildlife (Preservation and Security) Act, 2012. The plan provides a framework for optimizing the forestry sector's ability to stabilize environmental conditions and assist economic and social development. Government of Bangladesh attempts to bring about 20% of the country's land under the afforestation programs by the year 2015 by accelerating the pace of the program through the coordinated efforts of the government, NGOs and active participation of the people in order to achieve self reliance in forest products and maintenance of ecosystem balance. Policy objectives are to contribute to sustainable environmental development and poverty alleviation through people's participation in forest protection and management, and support for forestry development from a broader sector of society.

Bangladesh Forestry Master Plan (1994):

For twenty years, the Forestry Master Plan provides detailed guidelines and recommendations for developing a protected area system in Bangladesh. It includes a forestry biodiversity conservation plan. The legislation providing for the establishment and management of protected areas in Bangladesh (The Wildlife Conservation Act, 1974), puts aside areas of "outstanding scenic and natural beauty with the primary objective of protection and preservation of scenery." The most recent development towards forestry and forest biodiversity conservation is declaration and inauguration of Eco Parks by the Govt.

National Land Use Policy 2001:

Ministry of Land under the government of Bangladesh formulated National Land Use Policy 2001, which highlights the importance and modalities of land zoning for integrated planning and management of land resources of the country. Many other policies, strategies, and plans of the government have also recommended for land zoning since long. The national land use policy also mentioned the need of formulating a zoning law and village improvement act for materializing the identified land zoning area. The Land Use Policy (2001) identifies issues of water body loss and degradation and emphasizes the need to harmonize national agricultural and fisheries policies in order to avoid conflict and simultaneously increase agricultural and fisheries production. The policy also recognizes the perilous situation of deforestation and land degradation in terrestrial ecosystems.

National Agriculture Policy 1999:

The milestone activities comply with the overall objective of the National Agriculture Policy 1999 that tend to make the nation self-sufficient in food through increasing production of all crops and ensure food security for all. The specific objectives of the National Agriculture Policy are to ensure a profitable and sustainable agricultural production system by preserving and developing land productivity and increasing income of the farmers; reduce dependence on any single crop to minimize the risk of food insecurity; increase production and supplies of more nutritious food crops and thereby ensuring food security and improving nutritional status; preserve existing biodiversity of different crops; take necessary steps to ensure environmental protection as well as eco-friendly sustainable agriculture, and establish agriculture as a diversified and sustainable income generating sector through strengthening agro-forestry programmes. Although, overall agriculture encompasses the development of crops, livestock, fishery, environment and forestry, separate policies on fisheries, livestock, as well as environment and forestry have already been formulated by the respective ministries.

National Water Policy, 1999

The National Water Policy is a unique policy that provides guidance for preservation of wetland. The Policy was promulgated in 1999, and it provides policy direction for overall water sector of Bangladesh. Water resources

management in Bangladesh faces immense challenge for resolving many diverse problems and issues. There is a growing need for providing total water quality management, and maintenance of the eco-system. The Water Policy addressed that apart from their scenic beauty, the natural wetlands of the country, Haor, baor and beels are of great economical and environmental value.

National Jalmahal Management Policy, 2009

The Government has adopted the Jalmahal Management Policy in 2009 for conservation; increased production and biodiversity conservation of fisheries resources, as well as khas waterbodies in favour of real fishermen and earns revenue. The basis of the Policy is "*Jal Jar, Jola Tar*" (he who owns the water, owns the waterbody). The Policy defines 'Jalmahal as the a water body where water remains in some times or throughout the year and is known as Haor, baor, beel, jheel, pond, ditch, lake, dighi, khal, river, sea etc.' Such Jalmahals can be closed or open. Jalmohals designated as fish sanctuaries will be transferred to the Directorate of Fisheries according to the policy. For increased production and to conserve biodiversity, some areas or the whole jalmahal will need to be converted into fish sanctuaries.

Bangladesh Climate Change Strategy and Action Plan, 2009

The Bangladesh Climate Change Strategy and Action Plan 2009 is an updated and revised version of the one prepared original Plan in 2008 with professional, administrative and logistics inputs from many people, which included the Ministry of Environment and Forest in the lead role, and Environment Specialists and others. Climate Change is no longer considered something to happen in future, it is happening now. Bangladesh Government is fully committed to take all measures so that climate change is managed in a way that people are fully protected from its adverse impacts. The tasks however are many and complex. The nation is vulnerable to climate change and consequently adaptation should be the priority. The Climate Change Action Plan is built on 6 pillars, as follows:

1. Food security, social protection and health
2. Compressive disaster management
3. Infrastructure
4. Research and knowledge
5. Mitigation and low carbon development
6. Capacity building and institutional

National Adaptation Program of Action: 2005

National adaptation programmes of action (NAPAs) provide a process for Least Developed Countries (LDCs) to identify priority activities that respond to their urgent and immediate needs to adapt to climate change – those for which further delay would increase vulnerability and/or costs at a later stage. It is well recognized both in the scientific and negotiating community that Bangladesh would be one of the most adversely affected country to climate change. Low economic strength, inadequate infrastructure, low level of social development, lack of institutional capacity, and a higher dependency on the natural resource base make the country more vulnerable to climate stimuli (including both variability as well as extreme events). The strategic goals and objectives of future coping mechanisms are to reduce adverse effects of climate change including variability and extreme events and promote sustainable development. Future coping strategies and mechanisms are suggested based on existing process and practices keeping main essence of adaptation science which is a process to adjust with adverse situation of climate change.

National Biodiversity Strategy and Action Plan (NBSAP), 2004

Bangladesh developed its national strategy and programs or plans for conservation and sustainable use of biodiversity resources. Ministry of Environment and Forests (MOEF) with the collaboration of IUCN Bangladesh Regional Office and funding support from UNDP/GEF has prepared in 2004 the *National Biodiversity Strategy and Action Plan (NBSAP)*. This initiative was taken to comply with the requirement for such a plan for each country

signatory to the CBD. NBSAP of Bangladesh provides a framework for conservation, sustainable use, ecosystem services and sharing the benefits of biodiversity of the country. Biodiversity (flora and fauna) conservation is closely inter-related with social and economic development. In Bangladesh, threats to biodiversity arise from loss of habitats largely due to deforestation and inappropriate water and agricultural management, over-harvesting of resources, efforts to increase agricultural productivity, and natural disasters. Thus, the NBSAP also provides a framework for securing the necessary environmental conditions to reduce poverty, ensure sustainable development and ecosystem services and respond to the implementation of elements of the country's Poverty Reduction Strategy Paper (PRSP) and Bangladesh Sixth Five Year Plan (2011-15). The overall goal of the NBSAP is to conserve Bangladesh's biological diversity and maintain ecosystem services in a sustainable manner in order to ensure socio-economic development of the nation and ensuring livelihood security of the people for present and future generations. These strategy statements are co-related with the proposed project outcomes and outputs.

The National Biodiversity Strategy and Action Plan (NBSAP) of Bangladesh provide a framework for conservation, sustainable use and sharing the benefits of biodiversity of the country. A major focus of the NBSAP is the need for cross-sectoral linkages, reflecting the fact that in Bangladesh, more so than most other countries, biodiversity conservation is closely inter-woven with social and economic development. Sixteen strategies have been developed to shape and direct the actions towards achieving the goals and objectives of the NBSAP (MoEF, 2004). These are:

Strategy 1: Recognize the value and importance of biodiversity for the Bangladeshi people and document properly its components, distribution and value.

Strategy 2: Conserve ecosystems, species and genetic pool of the country to ensure that the present and future wellbeing of the country and its people are secure

Strategy 3: Restore ecosystems and rehabilitate endangered species

Strategy 4: Adopt national measures and standards to deal with invasive alien species and genetically modified organisms

Strategy 5: Promote equitable sharing of biodiversity conservation costs and benefits among different sectors of the society

Strategy 6: Contribute to raising awareness and building capacity of biodiversity conservation among the different sectors of the society

Strategy 7: Promote use of traditional knowledge for conservation, use and protection of the local communities' intellectual property rights

Strategy 8: Establish institutions for inter-sectoral implementing mechanism for the Bangladesh National Biodiversity Strategy and Action Plan.

Strategy 9: Enhance Protected Area management, recognizing the benefits of collaboration with local communities in their management (co-management).

Strategy 10: Ensure wise use of wetland resources.

Strategy 11: Establish participatory mechanisms to receive and utilize the inputs from private sector, civil society, academia and local communities about the different processes leading to biodiversity conservation, use and sharing of benefits.

Strategy 12: Review and develop biodiversity related legislation(s) and establish a specific branch in the Judiciary to deal with biodiversity and environmental issues

Strategy 13: Establish an open and transparent monitoring and reporting system status and trends of implementing the principles of CBD

Strategy 14: Develop a financial strategy that is innovative and sustainable.

Strategy 15: Address issues of synergies with other Multilateral Environmental Agreements (MEAs) and processes that deal with climate change, disaster management, livelihoods, food security and sustainable development

Strategy 16: Integrate biodiversity conservation into the national development making, planning and processes

Bangladesh National Conservation Strategy (NCS)

The National Conservation Strategy (NCS) is an important step towards achieving the objective and integrating the policies on environment. The updated Strategy builds on the Poverty Reduction Strategy Paper (PRSP), World Summit on Sustainable Development and Millennium Development Goals (MDGs). The strategy is divided into 17 chapters on the basis of sectoral profiles. The sectors span over all the important areas that require inter -sectoral and intra-sectoral consideration: Human Resources, Land Resources, Water Resources, Forest Resources, Biodiversity, Fisheries Resources, Crop Agriculture, Industry, Rural Development, Energy and Minerals, Urbanization, Health and Sanitation, Transport and Communication, Disaster and Disaster Management, Environmental Education and Awareness, Gender Issues, and Environment and International Obligations. Under the National Conservation Strategy Implementation Project, pilot interventions were taken for Tanguar Haor Wetland Biodiversity Conservation and Conservation of Coral Resources of Narikel Jinjira(St. Martin's Island).

National Sustainable Development Strategy (NSDS)

The National Sustainable Development Strategy (NSDS) has been prepared to meet the formidable environmental challenges that Bangladesh faces in the way to development. However, in the section of Urban Environment, no guideline strategy for urban plantation, urban watershed preservation and urban ecosystem management have been presented. In the section of Environment, Natural Resource and Disaster Management, recommendations have been provided to ensure environmental protection for humans, ecosystems and resources with due emphasis on conservation, augmentation and efficient utilization of the natural resources. The key recommendation and strategy mention in NSDS in context of ecological perspective is to

- Enhancing forest biodiversity and wildlife conservation through expanding protected area, restoring ecosystems and rehabilitating endangered species
- Protection and expansion of forests and forest resources, retaining the integrity of hill ecosystems that sustain plant and animal biodiversity
- Ensuring wise use of natural resources with special emphasis on maintaining the integrity of wetland ecosystems
- Protecting the forest and wetland resources through adopting co management approach with community participation, further development of coastal green belt and promoting people's ownership of social forestry.
- Estuary and coastal ecosystem management, coastal land zoning, integrated management of coastal water infrastructures
- Ensure environmental protection for humans, ecosystems and resources which will support conservation, augmentation and efficient utilization of natural resources.
- Restoration of depleted ecosystems including wetlands.
- 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 critical and sensitive areas.

- 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.
- Adopt co-management approach for conservation of wetland biodiversity and sustainable use of its resources.
- Master Plan for Haor Area is to be followed for management of ecological resources of the haor area.
- Gradually shift to organic mode of agricultural production and other ecofriendly activities in terrestrial and aquatic systems.

Sixth-five Year Plan (SFYP)

Three relevant aspects of the SFYP are discussed in this section; Environmental Protection, Climate Change and Disaster Management. Bangladesh was an early convert to this understanding. Economic progress, accompanied with rapid urbanization and industrialization, had also left its toll on Bangladesh's ecosystem. This was evident from natural calamities, loss of bio-diversity, deforestation, destruction of wetlands and inland fisheries, arsenic contamination in the ground water in the southern part of the country, soil nutrient depletion and inland salinity intrusion in the South West region, creeping desertification in the Northern region etc. Bangladesh is also one of the most natural disaster prone areas that suffer from ravages of floods, cyclones, storm surges and drought. In urban areas, air pollution, sound pollution and waste load from industries, hospitals, and municipalities are matters of great concern. The plan emphasizes on reaching out to the poor and the vulnerable population and environment, improved livelihoods, ecosystem conservation management, climate change and disaster risk management. In the SFYP, there is a commitment on the part of the government to the implementation of international conventions and protocols related to the environment, biodiversity, Climate Change as well as other national policies and plans approved by the GOB.

The DoE is formulating and implementing policies and programs that strike a realistic balance between the existing livelihood requirement of the people and sound environmental resource management that can ensure sustainability. A major part of its activities include environmental impact assessment carried out through the Environment Conservation Rules promulgated under the Environment Conservation Act 1997. These programs will be continued and would be strengthened during the SFYP. Programs undertaken by the DoE include raising awareness on environment, environmental management and its monitoring, implementation of the international conventions and protocols signed by the government and programs to implement existing environmental laws of the country. DoE is engaged in implementing a number of programs to improve as well as to protect the environment towards green economy which will reflect clean development mechanism as well. A brief listing of these programs is:

- ❖ Control of Air Pollution
- ❖ Control of Industrial Pollution
- ❖ Control of Noise Pollution
- ❖ Conservation of Ecosystem
- ❖ Partnership Program for Environment Protection
- ❖ Conservation of Biological Diversities
- ❖ Protection of the Ozone Layer
- ❖ Measures toward Management of Wastes
- ❖ National Bio-Safety Framework

- ❖ Saving the River
- ❖ Generating electricity from waste
- ❖ Declaring Ecologically Critical Areas
- ❖ Reduction in the Production and Use of Black Polythene

Relevant Laws and Regulations

The Environment Conservation Act 1995 is a parent law for ensuring conservation and sustainable use of the biological resources of the country and protection of its environment. Many of its loopholes were remedied in the subsequent amendments, Notifications and Circulars. The law is designed to conserve the environment, improve environmental standards and control and mitigate environmental pollution. It has overridden other inconsistent laws, established a Department of Environment empowered to intervene in almost all areas of environmental concerns, provided operational definition of important phrases like conservation, environment, ecosystem, pollution etc. and prescribed punishment for various environmental offences.

Section-5 of the Environment Conservation Act, 1995 provides for in-situ conservation by empowering the Government to declare areas as Ecologically Critical Areas and to take measures to protect the ecology of those areas provided that it is satisfied that the ecosystem of that area has reached or is likely to reach a 'critical state'. In these ECAs, a ban is imposed on certain activities, including the felling or extracting of trees and forest products; hunting and poaching of wild animals; catching or collection of snails, corals, turtles and other creatures, any activity that may threaten the habitat of flora and fauna; activities likely to destroy or alter the natural characteristics of soil and water; controls over the establishment of industries that may pollute soil, water, air and/or create noise pollution and other activities that may be harmful for the fish and other aquatic life. Under the Rules 1997, industries have to carry out an EIA, install environmental treatment plants, conform to environmental quality standards, report accidents or unforeseen discharges of pollutants, and take remedial measures. The Department of Environment issues Environmental Clearance Certificates which indicate that an industrial unit is conforming to the Rules.

The Wildlife Preservation (Amendment) Act 1974 which has been revised and named as Wildlife (Preservation and Safety) Act 2012 provides new dimension for the protection of wildlife as well as their habitat for conserving and sustaining ecosystem functions as well as biodiversity. The Act defines various protected areas in the form of game reserves, national parks, eco-park and wildlife sanctuaries and aims to preserve wildlife in those protected areas. The wildlife sanctuary regime also requires undisturbed breeding ground for the protection of wildlife as well as all natural resources in the sanctuary. The Act classified the wild animals as game and protected animals and listed them in the annexed schedules. While the game animals can be killed or hunted with a permit, protected animals are fully protected except for saving life, crops or livestock. However, by an executive order dated 18 June 1998, the Prime Minister's Office prohibited hunting of all types of wild animals for the following five years. This provision has not yet been renewed.

The Forest Act 1927 (amended in 2000) empowers the Government to declare any area of forest as Reserved or Protected and by doing so it may take measures for in-situ conservation of biological diversity. The government may also establish its control over portions of private forest by declaring them as controlled or vested forests, and conversely, assign the village community to the management of portions of reserved forest. Besides, afforestation and reforestation programme is running by Government of Bangladesh for the well being of ecosystem.

Bangladesh Wildlife (conservation and security) Act, 2012

It is an Act to provide for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh. The provision for the conservation and safety of biodiversity, forest and wildlife by the state has been inserted in article 18A of the

Constitution of the People's Republic of Bangladesh, and it is expedient and necessary to provide for the conservation and safety of biodiversity, forest and wildlife of the country by repealing the existing law relating to conservation and management of wildlife of Bangladesh.

National Water Act 2013

The Water Act 2013 is based on the National Water Policy, and designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources in Bangladesh. Punishment related to water quality degradation caused by industrial discharge and other sources of pollution is not adequately addressed in the Act. Water pollution issues are deferred to the provisions of the Environmental Protection Act of 1995 without much clarification. The Act remains nebulous without a clear commitment by the government to ensure the quality of water for various beneficial uses as outlined in the Environmental Protection Act. The Act does not address the need for establishing effluent treatment plants or the maximum contaminant levels that will be allowed for discharge to receiving bodies of water by industries and other potential sources of pollution. The Act provides the legal framework for development, management, extraction, distribution, usage, protection, and conservation of water resources. However, the Act falls short in making a commitment by the government to ensure the quality of water for various beneficial uses.

National and Sectoral Policy Statements

Memorandum for the Bangladesh Aid Group 1992-93. This document summarizes the 'New Development Perspective' of the government's vision for the future development of the country, and is consistent with participatory democracy' (FAP-6, 1993). Overall goals are identified; nine strategies specified to meet the goals are mentioned below:

- ❖ Integration of national conservation strategy to prevent the degradation of the environment and improve its capacity of sustainable development with multi-level economic planning.
- ❖ Control and prevention of environmental pollution and degradation related to soil, water and air.
- ❖ Promotion of environment friendly activities in the field of development.
- ❖ Preservation, protection and development of natural resources bases.
- ❖ Strengthening the capabilities of public and private sectors to manage environment concern as a basic requisite for sustainable development.
- ❖ Creation of people's awareness for participation in environment protection activities.
- ❖ Conserve and develop wetlands and protect migratory birds.

Policy Statement on Forest, ecosystem and biodiversity:

- ❖ Conserve, expand and develop forest to sustain the ecological balance and meet the socio economic needs and realities.
- ❖ Include tree plantation programmes in all relevant development schemes.
- ❖ Stop shrinkage and depletion of forest land, tree coverage and forest resources.
- ❖ Develop and encourage use of substitutes of forest products.
- ❖ Conserve wildlife and biodiversity, strengthen related research, and help in dissemination exchange of knowledge in concerned areas.
- ❖ Conserve ecosystem and develop wetlands and protect migratory birds.

3.8. Policy Directives for Ecosystem Conservation

Government of Bangladesh has formulated a numbers of national policies, strategies and action programmes targeting ecosystem protection, biodiversity conservation, natural resources management, climate change adaptation and mitigation for a long term sustainable development. A unique wetland policy provides a clear opportunity to recognize wetlands as ecosystems requiring different approaches to their management and conservation, and not being masked under other sectoral management objectives. Ministry of Environment and Forests as the focal organization of Ramsar Convention for Bangladesh had taken initiative to prepare a national wetlands policy. Wetlands are seldom explicitly covered at a national level in other existing natural resource management policies such as for water, forest, land, biodiversity or other sectors.

All those policies mentioned above are reviewed in this document and duly synchronized in the strategy proposed. The policies have also adhered proper importance on the delta, specially the ecosystem resources values and their environmental services. National policies pertaining to environment and sustainable development have categorically emphasized the ecological and economical significance of the wetlands of the northeast region. These include both renewable and non-renewable natural resources. Mangrove, freshwater swamps and marshes are especially very rich in aquatic plants with enormous diversity. Biomass productivity of submerged plants is very high and has a great development potential of green manure and green energy.

In Sundarbans two major sectors such as fisheries and forest have been contributing huge revenue to exchequer in the national economy. Some of the rare plants and wildlife are found in Sundarbans, which are of global conservation significance. People's livelihoods are mostly dependent on the biological resources of Sundarbans. The Sundarbans' Island ecosystem and the Delta's riverine ecosystem are also major wintering ground of migratory waterfowls in the region and situated at the cross-roads of East-Asia-Australasia and Central Asian Flyways. Several hundred species of wild flora and fauna are found in the Haor areas in abundance. Main biodiversity components for immediate management consideration under wetlands policy are:

- ❖ Resources management should be on the basis of ecological zoning
- ❖ Protection of mother fishery specially the duars and migration path of fish
- ❖ Restoration of costal, mangrove and swamp forest through natural regeneration and afforestation.
- ❖ Protection of grassland and reed lands.
- ❖ Train and enhance people's knowledge of resources uses on the basis of "Ramsar Wise Use"
- ❖ Maintain rotator resource use zone and conservation area.
- ❖ Excavation of silted beels and water management
- ❖ Keeping free-flow of water between beels and rivers
- ❖ Monitoring of water quality and minimizing water pollution from ships, industries and land-based sources
- ❖ Protection of key/flagship species of biodiversity
- ❖ Special measures for conservation of migratory waterfowl and waders
- ❖ Establish Sundarban monitoring Center of Global Excellence for Management Research, Education and for Nature Tourism
- ❖ Establish riverine sanctuary at representative ecosystems and biodiversity conservation

3.9. Past Initiatives for Ecosystem Management

3.9.1. Government Agencies

Conservation of Biological Diversities

The Government of Bangladesh in 1999 has declared 8 areas of Cox's Bazaar and Teknaf Peninsula, St. Martin's Island, Sonadia Island, Hakaluki Haor, Tanguar Haor and Marjat Baor, the Gulshan-Baridhara Lake and 10 km land ward periphery of Sundarbans as Ecologically Critical Areas (ECAs). Later in 2009, 4 rivers around Dhaka city (Buriganga, Shitalakha, Balu and Turag) were declared as ECA's making the total number to 12. The GEF/UNDP assisted project titled Coastal and Wetland Biodiversity Management Project at Cox's Bazaar and Hakaluki Haor (CWBMP)' is now rename to Community Based Adaptation to Ecologically Critical Areas (CBAECA), which is being implemented by the Department of Environment. The project has undertaken various programs towards conservation of the biological diversities of 4 ECA's namely Cox's Bazaar- Teknaf Peninsula, Sonadia Island, St. Martin's Island and Hakaluki Haor. The aim is to ensure conservation, management and sustainable use of the biological and other resources of the ECA's through establishing institutional arrangement.

Under the above program, several ECA coordination committees have been constituted at district, Upazila and Union levels and also 72 Village Conservation Groups (VCF) have been formed. Sea turtle conservation and hatchery, and fish sanctuaries have been established along with many other conservation measures undertaken in the ECA's. Five NGOs are engaged in awareness raising and community mobilization programs towards conservation and regeneration of biodiversity. The Government has issued a notice to impose a ban on illegal hill cutting in March 2002 by considering the importance of hills for a balanced ecosystem and environment. Tendency for illegal cutting of hills has reduced noticeably as a result of gradual increase of awareness about the negative impact of hill cutting.

A notice declaring ecologically critical areas was issued on April 19, 1999. These areas include ten kilometres around the Sundarbans Reserve Forests, Cox's Bazaar and Teknaf sea shore, Saint Martin's Island, Sonadia, Hakaluki Haor, Tanguour Haor, Marjat Haor and Gulshan Lake. Activities banned in these areas include felling or collecting trees from these areas; hunting, catching or killing wildlife; industrial development; fishing and other activities that might affect fish and other aquatic life, and any activity that could destroy or change the natural characteristics of soil or water.

Jurisdiction over wetlands in most nations is spread among federal, provincial (state), territorial and municipal governments, and among different government departments and agencies. None of this myriad of departments and agencies at any level is likely to be responsible for all aspects of wetland management, conservation and sustainable use. Although limited efforts have been made, coordination and communication within and among governments remains inadequate. The need is not for one agency to look after the wetlands, the need is to stress better coordination, communications, and consistent enforced policy that is followed by all government agencies. A National Wetland Policy can be the mechanism to enhance and promote effective coordination and communication among such agencies.

In Bangladesh, government agencies, with the opportunity to provide leadership to ecosystem conservation programmes, are often poorly supported with few resources in terms of staffing and funding. Their political position /level of authority in the government hierarchy may also be of a lower rank with less influence, reporting through one or more ministries. The linkages needed to be effective, such as coordinating programme opportunities that are good for wetlands to national water, agricultural and development priorities, are often difficult for the government to consider.

The flowing government agencies, including semi-autonomous bodies, have been involved with ecosystem and biodiversity management, research and projects work:

- ❖ Ministry of Water Resources (MoWR)
- ❖ Ministry of land (MOL)
- ❖ Department of Fisheries (DoF)
- ❖ National Herbarium and National Botanic Garden
- ❖ Bangladesh Water Development Board (BWDB)
- ❖ Water Resources Planning Organization (WARPO)
- ❖ Department of Public Health Engineering (DPHE)
- ❖ Municipal Corporation (MC)
- ❖ Bangladesh Chemical Industries Corporation (BCIC)
- ❖ Local Government Engineering Department (LGED)
- ❖ Shahjalal University of Science and Technology (SUST), Sylhet
- ❖ Khulna University
- ❖ Chittagong University
- ❖ Jahangirnagar University
- ❖ Rajshahi University
- ❖ Dhaka University
- ❖ Department of Environment (DoE)
- ❖ Forest Department (FD)
- ❖ Bangladesh Haor and Wetland Development Board (BHWDB)
- ❖ BFRI (Bangladesh Forest Research Institute)

3.9.2. Non-government Organization and Agencies

Several international and national NGO's have played key roles in the creation of international and regional agreements, wetland resources and flora, which have been immeasurable values in assisting Asian countries, including Bangladesh, to address national biodiversity concerns. These organizations have done their research and awareness work in Haor and wetland areas. Each of the organizations is engaged in implementation projects and will likely to continue to serve in this capacity for the government departments. The following international and national organizations are still working for ecosystem, wetland and biodiversity management in Bangladesh:

International Organization

- International Union for the Conservation of Nature (IUCN)
- Wetlands International
- CONCERN Worldwide
- Winrock International
- World Vision
- Agriconsulting S.p.A
- UNDP
- UNEP
- FAO
- GIZ
- SDC
- Helvetas Swiss Intercooperation

- Islamic Relief
- Save the Children

National Organizations

- Center for Natural Resources Studies (CNRS)
- Nature Conservation Management (NACOM)
- Bangladesh Centre for Advanced Studies (BCAS)
- CARITAS Bangladesh
- Integrated Water Resources Management Unit (IWRMU)
- CEGIS
- Voluntary Association for Rural Development (VARD)
- BRAC (formerly Bangladesh Rural Advancement Committee)
- Proshika
- Arannayak Foundation (AF)
- Sodev Consult
- Poush
- Sushilon
- Uttaran
- Center For Sustainable Development (CFSD)
- Taungua
- TMSS
- RDRS
- Marine Life Alliance
- CODEC
- CARINAM

3.9.3. Different Institutional and Project Initiatives

Several national and international organizations have taken initiatives for conservation ecosystem, biodiversity and forest management. Projects and Programmes of relevance to the ecosystem, wetland and biodiversity in Bangladesh are described in Annex A-3. A total of 53 projects have been found. Among them, implementation of 20 projects is ongoing.

4. Strategy Development

4.1. Problem and gap issues

Ecosystem in Bangladesh plays an important role in the ecology, environment, economy and livelihood of the country. But ecosystem habitats, and wetlands biodiversity in Bangladesh, have long been facing serious degradation and loss, due to many natural and anthropogenic factors. Besides natural causes, factors like overexploitation of resources, lack of property rights, human encroachment, conflicts over natural resource management, pollution, and conversion to other uses, as well as the absence of effective enforcement of laws, are some of the most important factors for the decline in the quality of the ecosystem and abundance of biodiversity of the country. These natural resources need to be protected and conserved to maintain the ecological balance, protect environment, and improve/ sustain the livelihood of poor people.

In spite of the richness of the biodiversity and natural resources abundance in the delta basin, degradation in general terms, has been observed. Unwise uses of natural resources are causing threats to the resource base in terms of its

sustainability and growth. Following are few problems underlined by studies conducted by CEGIS, NERP, IUCN and CNRS.

- Government and political commitment

In Bangladesh, the political commitment by the Government is a major issue, which, in any case, should be environmental friendly. The Government has some target to fill up the public demands to the development of any sort of environmental hazard-related project. The examples are the proposed Rampal Power Plant and Deep Sea Port in Sonadia Island, scheduled to commence soon. Both projects would have negative impacts on Sundarban Mangrove Forest and also on the ecologically critical area like Sonadia Island. In context of biodiversity conservation Govt should be more participatory to mitigate environmental loss. The relevant Policy and Act should be updated and strictly operated for each real vent sector. For implementing industrial project near the ecologically significance area or the Ramsar site or protected area, Govt should follow the rules and Acts and should have the option for alternative site selection. As the scenario looks at present, a huge gap exists between the Govt and the environmentalists, which should be reduced so that an integrated conservation of the ecosystem can be applied.

- Lack of a complete inventory of species

For making any development plan the first and foremost activity is to have the resource inventory in hand. So, it is an urgent and immediate task to prepare a comprehensive inventory.

- Environmental Impact Assessment Monitoring

According to the Bangladesh Government instruction and funding organization criteria, every development project should have EIA Clearance. For this purpose, many environmental organizations undertake EIA study. But after receiving the EIA Clearance from DoE, there is no proper monitoring to follow up the programme.

- Habitat degradation

Although it is generally mentioned by various interest groups that the ecosystems are degrading, and is resulting in massive loss of natural habitats; in reality, there is no quantified data to evaluate the status and rate of ecosystem loss.

- Filling up of water bodies for agricultural purpose

There is an increasing trend to reclaim wetlands for various purposes such as housing, industry and agricultural practices.

- Over exploitation of wetland resources

Over-exploitation of fisheries resources from rivers, mangrove area and swamp forest, has tremendously increased in Bangladesh. Unplanned fishing, fishing in breeding season, over fishing, hunting water bird, duck rearing and other factors are causing depletion of biodiversity.

- Environmental pollution

Water is being polluted from discharge of untreated solid and liquid waste from various sources such as:

- Coal, goods and passenger carrying boats
- Discharge of crude oil from mechanized boats
- Dumping of household waste
- Waste disposal from fertilizer factory and cement factory
- Residual pollution of chemical fertilizer and pesticides

Table 12 shows the problem, gap and the status evaluation of the ecosystems.

Table 12: Problem, gap and status evaluation of ecosystem

Problem/Issue	Nature	Present State	Gaps	Comments
Vision	Policy	National ecosystem and wetlands policy does not exist	National ecosystem and wetlands policy to be prepared	IUCN has drafted one wetlands Policy for the Gov. Drafting national policies are Govt's responsibility
Ecosystem and Wetlands Management Organization	Institution	DoE, FD, Haor and Wetlands Development Board	Proper operation, capacity building, and functioning, inter-disciplinary interaction of the board is not up to the mark	Cross-sectoral integration and Haor Master plan implementation
Species extinction	Genetic erosion	Causes are not known	Study required and International expert(s) involvement necessary	DoE, FD, DU should be involved
Threatened species	Ecological crisis	Preliminary list available	Species Recovery and Protection programme for threatened species with highest priority	Research and updating is under process by IUCN BD
Mangrove and Swamp forest	Habitat loss	More than 75% of swamp and reeds forest are damaged	Restoration, regeneration and rehabilitation should be started	DoE, FD, can implement
Bird Hunting	Bio resources	Trends of harvest shifted from local consumption to commercial poaching	Hunting permits should be allowed to certain species having normal population/to a certain time /quota/location	Act according to the rules of Bangladesh Wildlife Preservation Acts
Mother fishery	Genome base	Over-harvest by dewatering the beels & harvesting during breeding season	Fish sanctuary and their implementation	Replication of success cases
Mollusks and Crustacian	Invertebrates resources	No data available	Needs detail study	High development value for pearl/duck feeds
Turtles	Fauna	Fishermen are harvesting	No data available on its harvest quantity	Population recovery/farming
Mammals	Fauna	Hunting and forest destruction wiped out all big games	Captive breeding and re-introduction of Swamp and Hog deer	In future Rhinoceros/Wild buffalo/Blue bull may be re-introduced in Companyganj reedlands
Alien Species	Flora	Ipomoea and Water hyacinth and some terrestrial species such as eucalyptus, akashmoni, rubber etc.	No planned uprooting events	Manual uprooting events should be initiated urgently Immediate survey should be

Problem/Issue	Nature	Present State	Gaps	Comments
		are aggravating some wetlands.		conducted and actions taken.
Mangrove forest	Salinity Intrusion /Sediment	Decreasing mangrove vegetation /fauna	Fresh water injection	Ensure upstream flow
Ecosystem Habitat	Grass land, village bush, char land etc,	Degradation due to conversion into agriculture land	Eco-friendly land use	Preserve land for ecosystem conservation
Aquatic ecosystem	Industry	Continuous pollution	Proper rule and law not followed	Relocation of industry
Industrial project	Thermal power plant	Threat to Sundarbans without proper monitoring	Environmentalists and industrialists to mitigate the problems	Relocation of power plant

4.2. Potential Development

There is a scope to involve national and international organizations for the interest of ecosystem development as they are global concern as much as they are local concern. A number of national and international organizations are working in the Sundarbans, other forest areas, river areas, and Haor areas for several years. The responsible authority can engage them to conduct the activities, as well as seek possibilities of donor(s) involvement for the activities. The ecosystem has the values in national and international level. A large number of wetlands of significant national and regional values exist and many sites have significant local values as the local communities get the benefits (ecosystem services) from it in different ways.

Following potential development should be considered for healthy ecosystem, biodiversity and wetland management

- Establish Sundarbans Forest and Biodiversity Research Center for research, conservation, education and for nature tourism
- Manage resources on the basis of ecological zoning
- Conduct assessment of economic value of Charland ecosystem
- Undertake protection project for mother fishery
- Initiate restoration of mangrove, charland, swamp forest through natural regeneration and afforestation
- Initiate afforestation and reforestation with indigenous species
- Implement programs for protection of grassland and reedlands
- Train people to enhance their capacity on uses of resources on the basis of "Ramsar Wise Use"
- Undertake excavation of silted beels and water management
- Maintain free-flow of water between beels and rivers
- Minimize water pollution from ships and land-based sources
- Plan and implement projects / Formulate Protection Act for Key/Flagship species
- Undertake special measures for conservation of migratory waterfowl
- Establish sanctuaries at representative ecosystems
- Plan strategies for conservation of threatened wildlife species
- Climate change impact assessment, community based adaptation and mitigation
- Integrate ecosystem based education and adaptation at all levels of curriculum
- Plan and implement scheduled research and monitoring activities
- Involve national and international organizations for wetland benefits
- Mainstream ecosystem based adaptation (EbA), biodiversity and wetland conservation objectives in Government plan, policies and strategies

- Forest and biodiversity in Chittagong Hill Tracts (CHT), Greater Sylhet Hills, Madhupur, Comilla and Dinajpur area

Table 13: Overall development potential, risks and abatement

Segments	Potential	Risks	Abatement	Remarks
Tourism	-Eco/Nature Tourism -Community based tourism	-Pollution, -Over crowd, -Noise and disturbance, Accidents	- Contingency plan - Keep within carrying capacity - Strict regulation - Safety measures -Education on responsible tourism	Tourism related policies, rules, Eco-tourism guidelines to be followed
Wildlife farming	-Turtle -Waterfowl -Snakes -Marsh Crocodiles -Deer -Crab	Wild versus captive	Strict compliance of Bangladesh Wildlife Acts and CITES regulations	International standard/ISO, should be followed
Handicrafts	-Earthen pottery -Tiles -Cricket bat from Indian Willow tree(<i>Salix tetrasperma</i>) wood -Mats (Shital Pati) from Reeds -Jute materials	Over harvest	Production/culture	Eco-living and green living rules to be practiced
Ecosystem festival	-Boat race -Swimming -Fishing -Wetlands folk culture	Over crowding	Minimizing harm to nature	Local culture and heritage should be highlighted

4.3. Driving forces and issues for ecosystem conservation

Ecosystem is dynamic and complex in the context of biological diversity and its production and services. This delicate ecosystem is impacted by various anthropogenic and natural pressures driven by local and regional forces. Through analyzing the overall ecosystem, Driver-Pressure-State-Impact-Response (DPSIR) framework has been developed focusing on the ecosystem and biodiversity conservation issues in the Delta region.

A description of the Driver-Pressure-State-Impact-Response (DPSIR) framework is given in Figure 16.

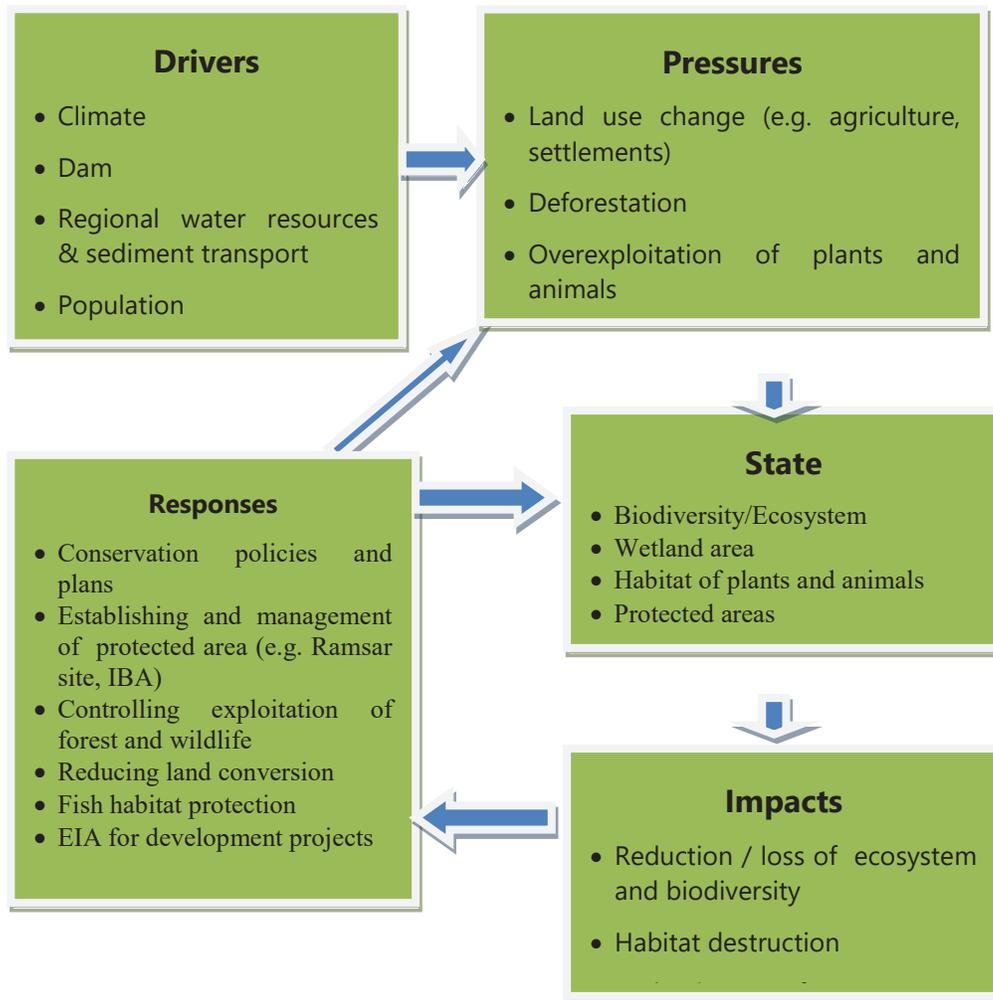


Figure 16 DPSIR Framework for ecosystem and wetlands issues risk

Driving Force:

- ❖ **Climate change:** It is a driving force for the regional water resources and agro-climatic condition of the wetlands of the Delta Region beside the pressures of human exploitation. The hydrological characteristics govern not only the biodiversity and wetland ecosystem but also the socio-economy and livelihoods of people in the area. Seasonal floods, cyclones, flash floods and droughts trigger to develop a water resources development project, which affects the wetlands ecosystem, biodiversity stock, and fish migration. Over longer periods, a century and more, climate change is likely to be an important factor for changing the whole ecosystem.
- ❖ Government of Bangladesh has promulgated several important laws/policies, strategies for the protection and conservation of renewable natural resources and ecosystems. All the policies have put special attention towards conservation and wise use of wetlands and its vast biological resources. The country has become parties to global/international wetlands and biodiversity conventions. Government has also prepared National Biodiversity Strategy and Action Plans where the wetlands conservation is identified as a priority sector for sustainable development.

- ❖ **Farraka Barrage:** Due to the construction of the Farraka Barrage, the riverine ecosystem along the Gorai and upstream of the Ganges River along the Rajshahi, Pabna, and Kushtia districts, has changed substantially. Salinity intrusion is an immediate future threat for Sundarbans and Gorai River ecosystem.
- ❖ **Destruction of ecosystem and wetland habitat:** Some habitat and species are gradually declining in the Delta area.
- ❖ **Over exploitation:** Some species are harvested intensively and resulting in unsustainable condition
- ❖ **Water pollutions:** Due to several human causes the water is polluting in different ways e.g. industrial effluents, agricultural insecticides, pesticides, developments works, and coal carrying boats, oil spills, etc.
- ❖ **Illegal hunting:** Illegal hunting is reducing the useable habitat significantly in the area.
- ❖ **Traditional management systems:** The traditional management systems are being challenged by powerful local persons who control these systems. The distribution of the natural resources is also not done properly.
- ❖ **Illegal felling of lowland forest:** Illegal removal of trees in these areas is taking place. There is a lack of protection measures for natural regeneration of swamp forest.

4.4. Facts and future challenge for ecosystem conservation

On ecosystem habitat:

1. Loss of habitat through reclamation of wetlands
2. Tree cutting from natural forest
3. Unplanned urbanization
4. Destruction of wetland
5. Climate change
6. Over population
7. Coal based thermal power plant and industries near Sundarbans
8. Dying river
9. Oil spills and navigation
1. Industrial pollution and lack of proper mitigation and environmental monitoring for industry and project
10. Unplanned infrastructure development
11. Proper application of law?
12. Proper implementation of wildlife conservation and security act
13. Inadequate knowledge of ecosystem structure and function
14. Lack of skilled human resources in managing wetlands biological diversity
15. Lack of knowledge and awareness
16. Lack of integration for environmental planning
17. Uncontrolled tourism

On hydrological regime

2. Reduction or diversion of water flow
3. Transboundary river issues
4. Barrage Construction
5. Dying River
6. Oil spills and navigation

On species diversity and wildlife:

1. Invasive plants
2. Introduction of exotic species
3. Increase in disturbance by humans
4. Introduction of Alien Species (IAS)
5. Monoculture (acacia, rubber, tea, teak, eucalyptus plantation)

4.5. Recommendation for ecosystem conservation

- Formation of wetland and ecosystem protection cell and Networking
- Autonomy and strengthening of planning agency with decentralized structure
- Enforcement of existing rules and acts
- Implementation of international protocols
- Community based conservation programme and ecosystem based adaptation
- Environmental education through people's participation
- Environmental education programme from primary to university level.
- Effective monitoring system for accountability and transparency
- Prevention of land speculation through land management policy
- Awareness generation among all (mass awareness)
- Public-Private-Community Partnership (PPCP) concept should be there for environmental upgradation
- Introduction of Environmental Auditing System by environmental experts
- Community based house to house waste collection.
- Organic waste recycling.
- Formulation of clinical and hospital waste disposal system law

4.6. Ecosystem Conservation and Management Strategy

Apart from the national interest to conserve ecosystem, biodiversity and sustainable management, the Government of Bangladesh is obliged to conserve national biodiversity and perform wise use of wetland resources as the country is signatory to a number international agreements/protocols related to ecosystem and biodiversity conservation and

management i.e. Convention on Biological Diversity; Ramsar Convention, Convention on the Conservation of Migratory Species of Wild Animals 1994, United Nations Framework Convention on Climate Change (UNFCCC), etc.

As the Government is obliged to protect the ecosystem, biodiversity and wise use of wetland, therefore it is requisite to initiate strategic options on ecosystem, biodiversity conservation and sustainable management. To protect the ecosystem and biodiversity the following strategies could be applied.

- ❖ Strategy-1: Zoning of the region on the basis of Ecological attributes distribution of biological Resources and the land use patterns. Establish new land use zone considering the historical biophysical changes and present scenario. Special attention is demanding for wise use of wetlands resources and conservation aquatic resources genomes. Swamp and reeds natural regeneration and protection aresignificant issue.Against the backdrop, firstly we have to halt the ongoing over exploitation trends of the swamps by any means. Secondly to determine the sustainable resource harvesting quota. And finally, plantation of indigenous species of aquatic and wetlands plants.
- ❖ Strategy 2: Management Plan development and implementation of the identified ecosystem of global significance.
- ❖ Strategy 3: Immediate protection of important mother fisheries and their migration route between rivers and beels.
- ❖ Strategy 4: Threatened species of wild flora and fauna recovery programme.
- ❖ Strategy 5: Establish wetland protected areas network nationally and globally.
- ❖ Strategy 6: Assessment of degradation of wetlands ecological values and functions at regional level.
- ❖ Strategy 7: Establish Sundarbans Research Center for research, education, conservation, awareness, networking, recreation, monitoring and evaluation.
- ❖ Strategy 8 : Strengthen Local Institutions for wetland and biodiversity management
- ❖ Strategy 9: Biodiversity enhancement and sustainable Management
- ❖ Strategy 11: Identify ecologically important area (ECA) within the region to protect the biodiversity and mitigate conflicts over resource exploitation and providing legal arrangement should be arranged.
- ❖ Strategy 12: Establish a national monitoring programme: Monitoring of important ecosystem, wetlands is required to recognize wetlands' changing ecology, i.e. changes of flora and fauna, hydrology or chemistry, in response to climate change, pollution and other long-term impacts. Habitat/land use studies on a national or regional scale should be permit evaluation of the success of direct conservation initiatives and allow to identify wetland loss still occurring or not and the reason behind it.
- ❖ Strategy 13: Develop a structured approach to implementing coordinated national wetland programmes that will foster effective wetland projects, such as through Bangladesh Haor and Wetlands Development Board ensure proper maintenance and management of protected wetlands after designation, acquisition and/or retention.
- ❖ Strategy 14: Promote Effective Wetland Science; establishment of national priorities for wetland scientific research with regular review is necessary as of comprehensive national inventory as the vital basis for many activities necessary for achieving the wise use of wetlands, including policy development, identification and designation of Ramsar sites, documentation of wetland losses, and identification of wetlands with potential for restoration.

- ❖ Strategy 15: Wetland Data Management; comprehensive national inventory is the vital basis for many activities necessary for achieving the wise use of wetlands, including policy development, identification and designation of cortically endangered sites, documentation of wetland losses, and identification of wetlands with potential for restoration.
- ❖ Strategy 16: Coordinate and rationalesse government programmes to minimize their adverse effects on wetlands and to encourage wetland conservation; create programme incentives that will encourage the landowner and conservation agencies to maintain wetlands.

These strategies can be implemented through the following programs:

1. Strengthening legal and policy provisions for ecosystem and biodiversity management
 - ❖ Revising policies and rules related to ecosystem and biodiversity conservation, especially for protection of endangered and threatened species
 - ❖ Setting standard for soil and water quality
2. Habitat preservation program for wildlife, fisheries and migratory birds
 - ❖ Maintaining existing protected areas and establishing new protected area for preserving habitat of wild plants and animals including migratory species on the basis of life cycle analysis of the species
 - ❖ Control and monitoring plant and animal population for food chain management within protected habitat
 - ❖ Monitoring and maintenance of water and soil quantity through water flow regulation in the protected areas
3. Research and education program on ecosystem biodiversity conservation and management
 - ❖ Baseline study on biodiversity status Delta region
 - ❖ Research on valuation of ecosystem services of every ecosystem
 - ❖ Characterization of "Eco-hydraulics"/ "Eco-hydrograph" for ecosystem
 - ❖ Developing ecosystem health/ quality monitoring methods (e.g. bio-indicator for water/ soil quality)
 - ❖ Developing course/ research curriculum on ecosystem and biodiversity management in university level education
 - ❖ Research on evolution and life cycle of key species as well as endangered and threatened species
 - ❖ Research on sustainable production of goods and services of ecosystem
 - ❖ Research on the impact of climate change on ecosystem, wetland and biodiversity
 - ❖ Research on the impact of pollution on wetland habitat and biodiversity
 - ❖ Establishment of gene bank of all plant and animal species
 - ❖ Sustainable management of commercially important biodiversity and ecosystem
 - ❖ Promote eco-tourism as alternative income from ecosystem
 - ❖ Promote plantation program
 - ❖ Promote sustainable pearl farming
 - ❖ Promote farming of medicinal plants
 - ❖ Pollution control and prevention from agriculture, industry, infrastructure development and urban settlement

- ❖ Controlling use of chemical fertilizer and pesticides in agriculture
- ❖ Restrictions over solid waste and wastewater disposal from industries, mechanized boats and urban settlement to wetland area

4.7. Overview of the Plan

The Delta Plan will be implemented through sustainable ecosystem management, optimal utilization of natural resources for next 100 years. Policies, strategies and plans relevant to the ecosystem have been extensively reviewed to identify the goal and target priorities, and to establish linkage with the Delta Plan. The Plan is being formulated in an integrated manner, envisioning mainly, ecosystem and environmental sustainability, establishment of Sundarbans Research Center, wetland and biodiversity conservation and management, afforestation, eco friendly structure development, sustainable wetland resource use and integrated ecosystem service for poverty alleviation.

The investment portfolios have been emphasized in the following aspects including wide response with strategy.

- Sundarbans Research Center
- Eco- zoning
- Conservation of threatened flora and fauna
- Restoration of wetland
- Habitat Conservation
- Pollution control and prevention from agriculture and industry
- Sustainable management of ecosystem, wetland biodiversity through community based approach
- Sustainable management of commercially important and threatened species
- Research and education program on ecosystem, biodiversity conservation and management
- Habitat preservation for wildlife, (including Dolphin) and migratory birds
- Strengthening legal and policy provisions
- Ecosystem based adaptation (EbA), Conservation Research & Education
- Natural History Museum
- Nature Tourism
- Global ecosystem and wetlands networking
- Reeds land conservation
- Afforestation of swamp forest species

A total of 12 programme/projects have been identified and presented in the investment portfolio of this report (Chapter 5). The proposed projects under the Delta Plan were summarized on issues based investment portfolio.

5. Development of Project Portfolio

Having discussed many aspects of Ecological Settings in the preceding chapters, it is significant that the importance of ecosystem, wetlands and their conservation should be demonstrated to all relevant organizations and individuals so that integrated and converging actions are taken by them. Ecosystem conservation through Ecosystem based Adaptation (EbA) is vital to achieve the objectives of biodiversity conservation described in various international conventions and treaties, more so for Bangladesh as it is also a signatory. A project portfolio has been developed to give a ready idea of how to help to protect the ecosystem wetland and its biodiversity in the country.

5.1. Project Summary

Project Code: ES-01

Project Title: Eco-management zoning of Charland Ecosystem for Biodiversity Protection

Rationale: Many charlands of Bangladesh, rich in biodiversity, are located along the major rivers. But due to absence of any sustainable development policy, and programs and actions, the resources of these charlands are disappearing fast. Hence, it is an urgent need to: i) do zoning of the region on the basis of ecological attributes, distribution of biological resources and the land use patterns; ii) establish new land use zoning considering the historical changes and present scenario; and iii) maintain natural regeneration of areas having significance of swamp and reeds. The project will, first initiate actions to halt the ongoing over exploitation trends of the reedlands and swamp forest; second, to determine the sustainable resource harvest quota of charland resources, third, plantation of indigenous species of aquatic and wetlands plants to restore the natural features of the degraded charland areas; and finally, identification of the charland areas for ecosystem and biodiversity protection.

Objective: Determination of natural ecological features for development of management plan for Charland

Lead Agencies: Ministry of Environment and Forest, Ministry of Water Resources, Ministry of Fisheries

Location: Charland of Padma and Jamuna Rivers

Time Frame: 10-15 years

Supporting Agencies: FD/DoE/BWDB/LGED/DoF/CEGIS

Project Code: ES-02

Project Title: Restoration of Ecologically Important Coastal Islands

Rationale: Natural characteristics of many coastal regions are being damaged for various reasons. People are harvesting ecosystem resources in a very detrimental way. They are also collecting aquatic fauna in huge quantity. Various types of fish are being captured by draining waters. Mollusks are collected for duck meal and for making lime. Hunting and trapping of water birds are commonly seen in the winter season. Water pollution from the oil spilling/leakage from the mechanized boats and cargos are noticed frequently. Sand mining is going on unabated. All these uses are not always wise as well as environment- friendly; rather these are unsustainable utilization of ecosystem resources.

Objective: Protection and restoration of ecologically important Coastal Islands (Saint Martin's Island, Sonadia Island, Urir Char etc.) for threatened ecological communities and permit wise use of biological resources

Lead Agencies: Ministry of Environment and Forest, Ministry of Water Resources, Ministry of Fisheries

Location: Saint Martin's Island, Sonadia Island, Urir Char and Char Kukri Mukri

Time Frame: 20 – 30 years

Supporting Agencies: FD/DoE/BWDB/LGED/CEGIS

Project Code: ES-03

Project Title: Development of Riverine Bird Sanctuary

Rationale: The Ganges-Brahmaputra-Meghna basins are important habitats of riverine birds. Some of the resident and migratory birds use riverine ecosystems for feeding and breeding. The project is to identify the potential and important habitat of riverine birds and finally, to establish a sanctuary.

Objective: Establish new Protected Area (PA) having appropriate representation of riverine birds

Lead Agencies: Ministry of Environment and Forest /Wildlife and Nature Conservation Circle

Location: i) A section of the Gorai River, ii) a section of the Jamuna river, both upstream and downstream of Jamuna bridge, iii) Munshiganj part of the Padma River, and iv) Meghna and Tentulia River reach surrounding Bhola

Time Frame: 5- 10 years

Supporting Agencies: FD/DoE/Bangladesh Bird Club/Other NGOs

Project Code: ES-04

Project Title: Establishment of Sundarban Forest and Biodiversity Research and Monitoring Center

Rationale: Major ecosystem of Bangladesh is wetlands, forest and the livelihoods of people and the economy of the country are mostly dependent on wetlands and forest ecosystem services and values. Despite the immense significance of wetlands and forest, the country is still lacking an appropriate organization to aspire the ecological and economic attributes of the forest and wetlands. Furthermore, the Sundarbans have high cultural, religious and heritage values. Bangladesh is a party to Ramsar Convention.

In recent years Government of Bangladesh has promulgated several important laws and developed national policies focusing the environment, in general, and the natural resources management, in particular. Thus, this proposed Center will be the active arm of FD and take part for Sundarban research and conservations.

Objective: Sundarbans forest ecosystem research, monitoring and conservation of Tigers and other flora and fauna

Lead Agencies: Ministry of Environment and Forest /Department of Environment, Ministry of Fisheries

Location: Sundarban Forest (Khulna/Satkhira range)

Time Frame: 15 years

Supporting Agencies: FD/ DoE/DoF/CEGIS/Other NGO/ Forest Research Institute (FRI)

Project Code: ES-05

Project Title: Development of Dolphin Sanctuary

Rationale: The GBM basins are important habitat of two species of Dolphins. But due to environmental degradation the habitat of dolphin are in worse condition. This program is set to identify the potential habitat of dolphins and finally establish the Sanctuary.

Objective: Establish new Protected Area (PA) having appropriate representation of dolphins

Lead Agencies: Ministry of Environment and Forest /Department of Environment, Ministry of Fisheries

Location: Portion of the following rivers: Padma, Surma, Passur, Baleshwar and Jamuna, where dolphins breed and live; also found in Maheshkhali Channel

Time Frame: 3-5 years

Supporting Agencies: FD/DoF/DoE/CEGIS/Other NGOs

Project Code: ES-06

Project Title: Ecosystem Habitat preservation program for plants, wildlife, fisheries and migratory birds

Rationale: Protected areas like Hakaluki Haor and Tanguar Haor were established with the aim of conservation of biodiversity and maintaining habitats and services from Haor wetlands. This kind of initiative needs to be replicated to

optimal number of habitats and strengthened with additional efforts on management of population of species and monitoring of habitat quality based on life cycle analysis of different species. Especially for the migratory species (birds and fish or other animals), delineation of a protected area should be based on life cycle of the species. Also regular monitoring of habitat quality with indicators (e.g. soil, water quality or bio indicators) is needed to guide the management to evaluate degradation or improvement of ecosystem quality.

Objective: Preservation of biodiversity by providing suitable environment for plants and animal species

Lead Agencies: Ministry of Environment and Forest /Department of Environment /Forest Department, Ministry of Fisheries

Location: Matian Haor, Shanir Haor, Paglar Haor, Sonamorol Haor, Kuakata sea beach and other locations depending on priority

Time Frame: 10-20 years

Supporting Agencies: FD/DoF/DoE/LGED/CEGIS/Other NGOs

Project Code: ES-07

Project Title: Research and education program on ecosystem, wetlands biodiversity conservation and management

Rationale: Some research and community awareness programs were carried out by different organizations for conservation and management of ecosystem and biodiversity. Extensive research program is required for the whole Delta basin to explore opportunities of efficient wetland resource utilization and management. Universities can develop special higher degree research programs on biodiversity conservation that will support research programs or vice versa.

Objective: Explore and establish scientific basis for conservation strategy of ecosystem and biodiversity

Lead Agencies: Ministry of Environment and Forest /Ministry of Water Resources

Location: Chalan Beel, Marjat Baor, Hakaluki and Tanguar Haors

Time Frame: 10-15 years

Supporting Agencies: FD/BWDB/DoE/CEGIS/Other NGOs/Forest Research Institute (FRI)

Project Code: ES-08

Project Title: Management of commercially important Wetland Ecosystem

Rationale: Fish, fuel wood and thatching materials, medicinal plants are the major commercial products of wetlands. Due to overexploitation of these resources, some important species are being threatened in the Delta Basin. On the other hand, promotion of some economically valuable species, may suppress the growth of other ecologically important species. Thus, sustainable management of commercially important species is crucial.

Objective: Initiation and promotion for management of commercially important wetlands biodiversity.

Lead Agencies: Ministry of Environment and Forest, Ministry of Fisheries

Location: Hilsha breeding areas, Tanguar Haor, Hail Haor, Hakaluki Haor, Ratargul Swamp forest, Ranchi Swamp forest

Time Frame: 10-15 years

Supporting Agencies: FD/DoE/DWDB/DoF/CEGIS/Other NGO

Project Code: ES-09

Project Title: Pollution control in River Ecosystem

Rationale: Industrial waste, chemical fertilizers and pesticides for agriculture practices are the factors, which may contribute to water and soil pollution. Mechanized boats spill oil in the rivers. Also, there is risk of water pollution by transportation of coal using the river. Industries like cement factory, fertilizer factory, and pulp and paper mills dispose wastewater and solid wastes into the rivers. Moreover, the solid waste and sewage from the settlements also create pollution locally. These issues should be managed properly for the present and the future environmental protection of wetlands.

Objective: Identify sources of pollution and take prevention measures from different sources

Lead Agencies: Ministry of Environment and Forest, Ministry of Fisheries

Location: Buriganga, Turag, Balu, Karnaphuli, Rupsha and Passur Rivers

Time Frame: 10-40 years

Supporting Agencies: FD/DoE/DoF/CEGIS/Other NGO

Project Code: ES-10

Project Title: Survey and Conservation of Globally Critically Endangered Spoon-billed Sandpipers (SBS) in the coastal areas of Bangladesh

Rationale: The population of Spoon-billed Sandpipers is equivalent to 240-400 mature individuals and 360-600 individuals in total. Habitat loss has had a large impact on this species. As with many coastal regions, tidal mudflats are being reclaimed for industry or aquaculture. Pollution, climate change and human disturbance are the factors that have also altered the habitat of this species. Hunting of shorebirds also contributes to the decline of the Sandpipers. Recent population surveys indicate an extremely rapid decline in this species, with reduced productivity, leading to fears that the population is ageing rapidly

Objective: Habitat conservation and population census

Lead Agencies: Ministry of Environment and Forest

Location: Sonadia Island and coastal areas

Time Frame: 5-10 years

Supporting Agencies: CEGIS/FD/DoE/ Bangladesh Bird Club/NGOs

Project Code: ES-11

Project Title: Survey and Conservation of Globally Endangered Masked Finfoot in Sundarbans

Rationale: The species appears to have declined dramatically and is now visible in comparatively few sites, surviving at low densities everywhere. The present population may number as low as 1,000 individuals. The main threat is the destruction and increased levels of disturbances the Sundarbans is subjected to. Habitats have been further degraded by oil spills, the removal of backside vegetation and changes in hydrology resulting from dam construction, and siltation. Hunting and collection of eggs and chicks have been recorded and although their contribution to the population declines. Khan (2002) reported that one local individual had collected eight eggs from Bangladesh Sundarbans. Conservation and awareness campaigns and encouragement for enforcement of law are required to reduce poaching all over the range. More research on the biology and ecology of these attractive, but threatened birds is urgently needed.

Objective: Habitat conservation and population census

Lead Agencies: Ministry of Environment and Forest

Location: Sundarban Mangrove Forest

Time Frame: 5-10 years

Supporting Agencies: CEGIS/FD/DoE/ Bangladesh Bird Club/Other NGOs

Project Code: ES-12

Project Title: Red List Assessment of Plants of Bangladesh

Rationale: Bangladesh is a green country. It has more than 5000 plant species. Among them, some species are at-risk of facing extinction. Proper assessment of the plant species at-risk of extinction in Bangladesh has not been done.

Objective: To know the extinction risk status of flora of Bangladesh. The vision-objective may be written as follows: Knowledge gained on extinction risk status of flora of Bangladesh. Plant species at-risk of extinction identified, and information communicated and published.

Lead Agencies: Ministry of Environment and Forest

Location: Its is mainly a desktop research work; field investigation is needed in different forests of Bangladesh

Time Frame: 3-5 years

Supporting Agencies: CEGIS/FD/National Herbarium/IUCN, Forest Research Institute (FRI), Arannayak Foundation.

6. Implementation Arrangement

Different plans and projects regarding ecological setting could be implemented by involving related organizations. MoEF with the Forest Department and DoE as the apex body could implement a project like "Sundarban forest ecosystem and biodiversity research and monitoring center". It could act as the central focus of all activities for Sundarban and Tiger conservation.

The Delta Plan will be a long term plan, prepared for a period of 100 years, with the provision of updating and incorporating rationale change in demand. The first fifteen years may be considered as short term and the rest as medium and long term for development project implementation. A national committee should be formed with relevant representation of various stakeholders. Meanwhile, a high level committee under the chairmanship of FD and DoE under MoEF should address the implementation arrangement for each project. In addition, the responsible authority should need to increase their expert manpower and capacity buildings regarding the future conservation plan of Sundarbans.

6.1. Implementation of the Plan

Implementation of the Sectoral Plan of Ecological Settings will have three phases, which begins conceptually in the financial year 2015-2016. The three phases of the Plan are defined as follows:

- Short term: 1-15 years
- Medium Term: 15-50 years
- Long Term: 50-100 years

Longer term impacts will be felt in the case of infrastructure with lifetimes that go beyond that period. The operation and maintenance implications of ecosystem, wetland and biodiversity will continue in the future. Monitoring of the

implementation of the plan will be a continuous process for which the FD will be the responsibility center. There will also be annual reviews and five-yearly reformulations running along with the Five Year Planning process.

6.2. Institutional Arrangements

The Investment Portfolio assigns primary responsibility of each programme/project to a specific agency. The Investment Portfolio of Ecological Settings will be executed by MoEF, DoE, Wildlife and Nature Conservation Circle, FD, Forest Research Institute (FRI), BWDB, LGED and BWHDB. Each of these agencies will be responsible for identifying and designing the specific projects. They will also have to be conversant and consistent with the policies, rules and guidelines set out by the government from time to time. Against this backdrop, the Plan allows the line agencies to prepare their own plans and initiate them through the normal administrative channels. The Investment Portfolio also sets out which agencies are expected to play a secondary or support role within a particular programme/project. Many of these roles are strategic in terms of sustainability or institutional advantage. CEGIS, IUCN, CNRS, NACOM, BBC, Wild Team, CARINAM, Marine Life Alliance, Poush, CFSD, Arannayak Foundation will be the secondary or supporting agencies, for feasibility study, GIS Mapping, baseline study etc.

6.3. Monitoring and Coordination

The Sectoral Plan will be implemented by different agencies under the overall monitoring, coordination and advice of the FD, DOE under the Ministry of Environment and Forests (MoEF). The FD has been mandated to coordinate the activities for the integrated development. The FD will be responsible for monitoring the project activities. Monitoring may involve site visits, consultations with the stakeholders etc. An MIS on monitoring and activity evaluation is to be developed and followed by the FD as the quality management mechanism for the project



Figure 17 Monitoring and Coordination at various levels

7. References

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8. Annex

Annex A1: International Bird Area (IBA) Criteria

Globally threatened species

The site qualifies as an IBA if it is known, estimated or thought to hold a population of a species categorized by the IUCN Red List as Critically Endangered, Endangered or Vulnerable. In general, the regular presence of a Critical or Endangered species, irrespective of population size, at a site may be sufficient for a site to qualify as an IBA. For Vulnerable species, the presence of more than threshold numbers at a site is necessary to trigger selection. Thresholds are set regionally, often on a species by species basis. The site may also qualify under this category if it holds more than threshold numbers of other species of global conservation concern in the Near Threatened, Data Deficient and, formerly, in the no-longer recognized Conservation Dependent categories. Again, thresholds are set regionally.

Restricted-range species

The site forms one of a set selected to ensure that, as far as possible, all restricted-range species of an EBA or SA are present in significant numbers in at least one site and, preferably, more. The term 'significant component' is intended to avoid selecting sites solely on the presence of one or more restricted range species that are common and adaptable within the EBA and, therefore, occur at other chosen sites. Sites may, however, be chosen for one or a few species that would be otherwise under-represented, because of particular habitat requirements.

Biome-restricted species

The site forms one of a set selected to ensure, as far as possible, adequate representation of all species restricted to a given biome, both across the biome as a whole and, as necessary, for its entire species in each range state. The 'significant component' term in the category definition is intended to avoid selecting sites solely on the presence of one or a few biome-restricted species that are common, widespread and adaptable within the biome, and therefore, occur at other chosen sites. Additional sites may, however, be chosen for the presence of one or a few species which would be otherwise under-represented for reasons of particular habitat requirements.

Congregations

This applies to 'water bird' species as defined by Delaney and Scott (2002) 'Waterbird Population Estimates' Third Edition, Wetlands International, Wageningen, The Netherlands, and is modelled on criterion 6 of the Ramsar Convention for identifying wetlands of international importance. Depending upon how species are distributed, the 1% thresholds for the bio-geographic populations may be taken directly from Delaney & Scott. They may be generated by combining flyway populations within a bio-geographic region or, for those for which no quantitative thresholds are given, they are determined regionally or inter-regionally, as appropriate, using the best available information.

This includes those seabird species not covered by Delaney and Scott (2002). Quantitative data are taken from a variety of published and unpublished sources.

This is modelled on criterion 5 of the Ramsar Convention for identifying wetlands of international importance. Where quantitative data are good enough to permit the application of A4i and A4ii, the use of this criterion is discouraged.

The site is known or thought to exceed thresholds set for migratory species at bottleneck sites. Thresholds are set regionally or inter-regionally, as appropriate.

The selection of Important Bird Areas (IBAs) is achieved through the application of quantitative ornithological criteria, grounded in up-to-date knowledge of the sizes and trends of bird populations. The criteria ensure that the sites

selected as IBAs have true significance for the international conservation of bird populations, and provide a common currency that all IBAs adhere to, thus creating consistency among, and enabling comparability between, sites at national, continental and global levels.

Ecologically Critical Area refers to ecologically defined areas or ecosystems affected adversely by the changes brought through human activities. The Bangladesh Environment Conservation Act (BECA), 1995 has provision for Ecologically Critical Area (ECA) declarations by the Director General of the Department of Environment in certain cases where ecosystem is considered to be threatened to reach a critical state. If the government is satisfied that due to degradation of environment, the ecosystem of any area has reached or is threatened to reach a critical state, the government may by notification in the official gazette declare such areas as Ecologically Critical Areas. The government shall specify, through the notification provided in sub-clause (1) or by separate notification, which of the operations or processes cannot be initiated or continued in the Ecologically Critical Area (Bangladesh Environment Conservation Act/BECA), 1995. In April 1999, the Director General of the Department of Environment (DOE) officially declared nearly 40,000 ha, within seven separate wetland areas, as ECAs. These sites are Hakaluki Haor, Sonadia Island, St Martin's Island, and Teknaf Peninsula (Cox's bazar Sea Beach) but not their buffer zones. Tangua Haor, Marjat baor (oxbow lake) at Jhenaidaha and outside of Sundarbans Reserved Forest at 10 sq. km extent all of which were deemed to meet the 'urgency criterion' required by BECA, i.e., they were "threatened to reach a critical state". The ECA area encompassed by the site contains biodiversity of global significance. Over 800 species of wildlife have been identified from the ECA areas, more than 20 of which are globally threatened.

Annex A2: Ramsar Criteria

Adopted by the 7th (1999) and 9th (2005) Meetings of the Conference of the Contracting Parties, superseding earlier Criteria adopted by the 4th and 6th Meetings of the COP (1990 and 1996), to guide implementation of Article 2.1 on designation of Ramsar sites.

Group A of the Criteria. Sites containing representative, rare or unique wetland types

Criterion 1: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeography region.

Group B of the Criteria. Sites of international importance for conserving biological diversity
Criteria based on species and ecological communities

Criterion 2: A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities.

Criterion 3: A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeography region.

Criterion 4: A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

Specific criteria based on waterbirds

Criterion 5: A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds.

Criterion 6: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.

Specific criteria based on fish

Criterion 7: A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity.

Criterion 8: A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

Specific criteria based on other taxa

Criterion 9: A wetland should be considered internationally important if it regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

List of Notable Publications By General Economics Division (GED) Bangladesh Planning Commission since 2009

1. Policy Study on Financing Growth and Poverty Reduction: Policy Challenges and Options in Bangladesh (May 2009)
2. Policy Study on Responding to the Millennium Development Challenge Through Private Sectors Involvement in Bangladesh (May 2009)
3. Policy Study on The Probable Impacts of Climate Change on Poverty and Economic Growth and the Options of Coping with Adverse Effect of Climate Change in Bangladesh (May 2009)
4. Steps Towards Change: National Strategy for Accelerated Poverty Reduction II (Revised) FY 2009-11 (December 2009)
5. Millennium Development Goals: Bangladesh Progress Report 2009 (2009)
6. Millennium Development Goals: Needs Assessment and Costing 2009-2015 Bangladesh (July 2009)
7. এমডিজি কর্ম-পরিকল্পনা (৫১টি উপজেলা) (জানুয়ারি-জুন-২০১০)
8. MDG Action Plan (51 Upazillas) (January 2011)
9. MDG Financing Strategy for Bangladesh (April 2011)
10. SAARC Development Goals: Bangladesh Progress Report 2011 (August 2011)
11. Background Papers of the Sixth Five Year Plan (Volume 1-4) (September 2011)
12. 6th Five Year Plan (FY 2011-FY 2015) (December 2011)
13. Millennium Development Goals: Bangladesh Progress Report-2011 (February 2012)
14. Perspective Plan of Bangladesh 2010-2021: Making Vision 2021 a Reality (April 2012)
15. Public Expenditure for Climate Change: Bangladesh Climate Public Expenditure and Institutional Review (October 2012)
16. Development of Results Framework for Private Sectors Development in Bangladesh (2012)
17. ষষ্ঠ পঞ্চবার্ষিক পরিকল্পনা (২০১১-১৫) [মূল ইংরেজি থেকে বাংলায় অনূদিত] (অক্টোবর ২০১২)
18. Climate Fiscal Framework (October 2012)
19. Public Expenditure for Climate Change: Bangladesh CPEIR 2012
20. First Implementation Review of the Sixth Five year Plan -2012 (January 2013)
21. বাংলাদেশের প্রথম প্রেক্ষিত পরিকল্পনা (২০১০-২০২১) রূপকল্প ২০২১ বাস্তবে রূপায়ণ (ফেব্রুয়ারি ২০১৩)
22. National Sustainable Development Strategy (2010-2021) (May 2013)
23. জাতীয় টেকসই উন্নয়ন কৌশলপত্র (২০১০-২০২১) [মূল ইংরেজি থেকে বাংলায় অনূদিত] (মে ২০১৩)
24. Millennium Development Goals: Bangladesh Progress Report 2012 (June 2013)
25. Post 2015 Development Agenda: Bangladesh Proposal to UN (June 2013)
26. National Policy Dialogue on Population Dynamics, Demographic Dividend, Ageing Population & Capacity Building of GED [UNFPA Supported GED Project Output 1] (December 2013)
27. Capacity Building Strategy for Climate Mainstreaming: A Strategy for Public Sector Planning Professionals (2013)
28. Revealing Changes: An Impact Assessment of Training on Poverty-Environment Climate-Disaster Nexus (January 2014)
29. Towards Resilient Development: Scope for Mainstreaming Poverty, Environment, Climate Change and Disaster in Development Projects (January 2014)
30. An Indicator Framework for Inclusive and Resilient Development (January 2014)
31. Manual of Instructions for Preparation of Development Project Proposal/Proforma Part-1 & Part 2 (March 2014)
32. SAARC Development Goals: Bangladesh Progress Report-2013 (June 2014)
33. The Mid Term-Implementation Review of the Sixth Five Year Plan 2014 (July 2014)
34. Millennium Development Goals: Bangladesh Progress Report 2013 (August 2014)
35. Population Management Issues: Monograph-2 (March 2015)

36. GED Policy Papers and Manuals (Volume 1-4) (June 2015)
37. National Social Security Strategy (NSSS) of Bangladesh (July 2015)
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