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Wetland Conservation in Context of Climate Induced Changes: Bangladesh Perspective

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Abstract:

Geographic location and Geo-morphological conditions of Bangladesh have made the country one of the most weather vulnerable ones to wetlands in context of climate induced changes. Bangladesh is a land of wetland which occupies around 50% of the country. Wetlands play a crucial role in maintaining the ecological balance of ecosystems and cultural figures as well, but wetland habitats of Bangladesh is under constant threats due to climate induced changes and anthropogenic activities. Climate change, however, is causing acceleration in the rise of sea level, which would seemingly put wetlands at risk of excessive calamities. Drought, excessive temperature, mountain snowfields and glaciers melting, riverbank erosion, salinity intrusion, flash-flood, storm surges, higher water temperature, magnitude of precipitation change, coastal cyclones. Seasonal anomalies and extremes are main threats to the wetland ecosystem. As a result biodiversity is reducing, many species of flora and fauna are threatened, wetlands-based ecosystem is degenerating, and the living conditions of local people are deteriorating as livelihoods, socioeconomic institutions, and extensive cultural values as well. Technology, legislation, educational knowledge, action plan strategy, conservation practices are required to manage wetlands. Therefore, Bangladesh now needs a comprehensive approaches, strategy and integrated system combining political, economic, social, technological and institutional supports to address sustainable wetland conservation and the newly added crisis, climate change.

Keywords: Wetland, Climate Change, Threats, Conservation, Comprehensive approaches.

1. Introduction:

Bangladesh lies between latitudes 20°34'N and 26°38'N and longitudes 88°0l'E and 92°41'E. It is bounded by India in the west and north, by India and Burma in the east, and by the Bay of Bengal in the south. Geographically, Bangladesh is an interesting country lying at the junction of the Indian and Malayan sub-regions of the Indomalayan realm. The country has a very long history of human settlement, agriculture and water body.

Wetlands include a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as salt-marshes, mangroves, and sea-grass beds, but also coral reefs and other marine areas no deeper than six meters at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs. The total area of wetlands in Bangladesh has been variously estimated at between seven and eight million hectares, i.e. about 50% of the total land surface. This includes at least 480,000 ha of permanent rivers and streams, 610,000 ha of estuaries and mangrove swamps, between 120,000 and 290,000 ha of haors, baors and beels, over 90,000 ha of large water storage reservoirs, 150,000-180,000 ha of small tanks and fish ponds, 90,000-115,000 ha of shrimp ponds, and some 5,770,000 ha of land which is seasonally inundated to a depth of 30 cm or more (Akonda 1989; Nishat 1993).

Bangladesh wetlands have a wide range of ecological, socio-cultural, economic and commercial importance and

values through their natural processes and functions which are known to provide a large range of benefits including provision of food, fiber, fuel, biochemical, flood control, ground water replenishment, shoreline stabilization and storm protection, sediment and nutrient retention, climate change mitigation, water purification, support to biodiversity, recreation and cultural values. These goods and services support livelihoods of large communities, particularly the poorest of the poor who depend on wetland resources for sustenance. History and practice has shown that wherever wetlands have been degraded, poverty has also increased leading to further wetland degradation.

Wetland organisms' vicinity including biogeochemical processes, phytoplankton, aquatic macrophytes, macro-invertebrates, fish, and birds have shown decreasing condition due to climate extremes and calamities like sea level rise, warming temperature, abnormal floods, storm surges, cyclone etc (Smithsonian). A rise in temperature of 1-5 degrees (C), mainly due to increased CO_2 and other greenhouse gases (GHG[1]), will cause thermal expansion of ocean waters and melting of alpine and high latitude glaciers, in turn causing sea level rise. Bangladesh is recognized as one of the countries' most weather vulnerable to climate change. Climate induced hazards such as flood, cyclone, drought, excessive temperature mountain snowfields and glaciers melting, riverbank erosion, salinity intrusion, flashflood, storm surges, higher water temperatures, precipitation anomalies, coastal cyclones, seasonal anomalies and extremes are damaging assets, homes, properties and infrastructure. Communities and people predominantly dependent on natural resource for livelihood support are finding it difficult to cope with the uncertainties and magnitude of the impacts. Conservation approaches recognizing that climate change may substantially affect the ecological character of wetlands and their sustainable use, and aware of the potentially important role of wetlands in adapting to and in mitigating climate change.

2. Methodology:

The objective of the study was to review current climatic changes and adaptation status of wetland in Bangladesh, both autonomous and planned; and to identify the needs of the relevant responsible bodies to facilitate the community on adaptation and existing wetland conservation, management practices. A number of tools were used in the study including,

A. Review of literature,

B. Community consultation,

C. Process documentation of the adaptation practice,

D. Compilation and review of the projects implemented by Eminence Bangladesh, and

E. Key informant interview.

To document the adaptation practices the following areas, wetlands and locally experienced climate extremes were considered.

Table 1: Wetlands, areas and climate extremes

Wetlands	Area (in Km^2)	Major Climatic Extremes
Open water body		
Rivers	7,497	Mountain snowfields and glaciers melting, sea level rise, subsidence, flood, riverbank erosion, drought, salinity intrusion, flashflood, storm surges, higher water temperatures, precipitation anomalies, coastal cyclones.
Estuaries and mangrove swamps	6,102	
Beels and haors	1,142	
Inundable floodplains	54,866	
Kaptai Lake	688	
Closed water body		
Ponds	1,469	Rainfall scarcity, flood and

[1] Water vapour, CO_2, CH_4, N_2O, HFC, PFC, SF_6

Baors (Oxbow Lakes)	55	inundation, storm surges, cyclone, soil erosion, salinity intrusion etc.
Brackish-water farms	1,080	

(Source: Ahmed *et al.* 2004)

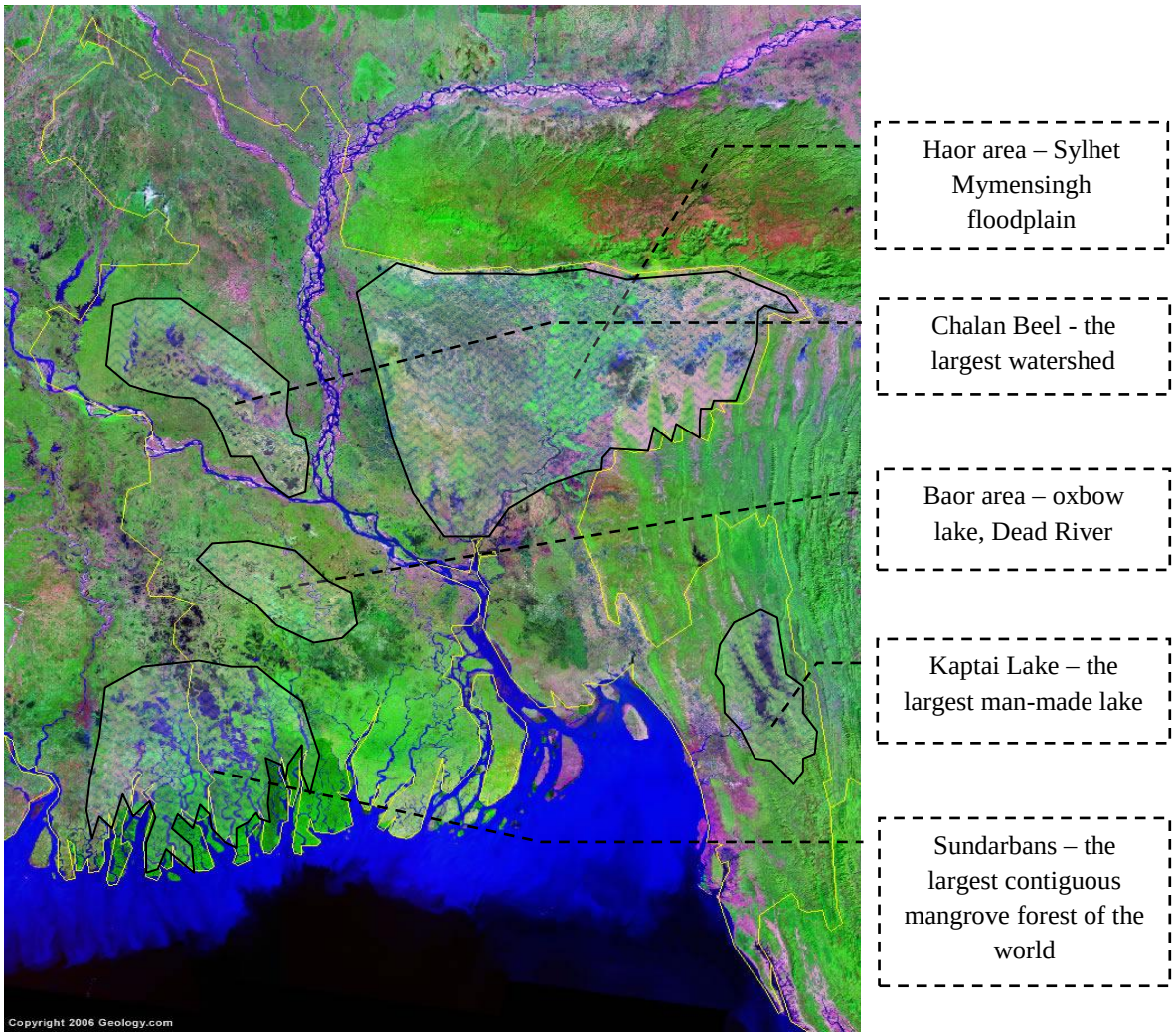

Figure 1: Major wetland bodies that occupies Bangladesh

Study reviewed all relevant materials on status and level of knowledge and practices on climate risk, management and adaptation in Bangladesh, and more specifically focus on good practices on sustainable wetland conservation practices, climate risk management and adaptation at sectoral level.

3. Results:

3.1 Socio Economic Valuation of Wetland:

Wetland has a necessary valuation through socio-economic aspects in combination with various elements of human wellbeing and ecosystem services. The range of the benefits people derive from wetlands is termed as their ecosystem services. These can be functionally classified into four broad categories including provisioning, regulating, cultural and supporting services (Suh & Woo 2010).

Table 2: Socio-economic values of wetland

Services	Examples
1. Provisioning	
Food	Production of fish, wild game, fruits and grains.
Fresh water	Storage and retention of water for domestic, industrial and agricultural uses.
Fiber and fuel	Production of logs, fuel woods, peat, fodder.
Biochemical	Extraction of medicines and other materials from biota.
Genetic materials	Genes for resistance to plant pathogens, ornamental species etc.
2. Regulating	
Climate regulation	Source of sink for greenhouse gases (footnote); influence local and regional temperature, precipitation, humidity, and other climatic processes.
Water regulation (hydrological flows)	Ground water recharge/ discharge.
Water purification and waste treatment	Retention, recovery and removal of excess nutrients and other pollutants.
Erosion regulation	Retention of soil and sediments.
Natural hazards regulation	Flood control, storm protection.
Pollination	Habitat for pollination.
3. Supporting	
Soil formation	Sediment retention and accommodation of organic matter.
Nutrient cycle	Storage, recycling-reduce-reuse, processing and acquisition of nutrients.

3.2 Cultural Valuation of Wetlands:

Wetlands, as suppliers of water and numerous other goods and values nowadays termed 'ecosystem services' that have been similarly esteemed through human history. A rich, diverse and in many cases; still vibrant cultural heritage has developed in and around wetlands in many regions of the world along with Bangladesh as well. Ensuring that this heritage is recognized and properly valued in today's fast-changing world is one of the greatest challenges for the conservation and sustainable use of wetlands. Cultural services are non material benefits people obtain from wetland ecosystems through spiritual enrichment, cognitive development, reflection, recreation and aesthetic experiences including cultural diversity, spiritual and religious values, knowledge systems, education values, inspiration, aesthetic values and social relations, sense of place, cultural heritage values and ecotourism. Some summarized highlighted valuations which directly related to human survival are; water wheel and underground water system, transportation of goods and peoples[2], terraced rice paddies, hunting, fishing gears[3] and salt pan, various techniques of food processing and manufacturing goods, ancient and historical structures, wetland

[2] Reed boat at Titicaca- Peru, reed houses at Iraq- Korea
[3] Hooks, nets, ancient traps, cage

based culture (recreation[4], eco-tourism, education, sacred places, music, dance and literature i.e. myths and legends, festivals, water and mud therapy and valuation on customs, rules and plays i.e. traditional management system, fishing cooperative regulations, traditional production systems, management, conservation and resource use plan.

3.3 Changes in Climatic Parameters and Impacts:

The country enjoys a humid, warm, tropical climate and its climate is influenced primarily by monsoon and partly by pre-monsoon and post-monsoon circulations. The south-west monsoon originates over the Indian Ocean and carries warm, moist, and unstable air. The monsoon has its onset during the first week of June and withdraws in the first week of October; however, the onset and withdrawal dates vary from year to year. The main rainy period begins with the onset of the moisture-laden south-west trades which are drawn to the Indian sub-continent by the intense heat and consequent low pressure over Punjab (in Pakistan and India) and the upper Ganges Valley and the filling up of the equatorial lows by air masses from these hot areas (IPCC 2011; Chakraborty 2011).

- Rising temperature will lower water quality in wetland through a fall in oxygen concentrations, release of phosphorus from sediments, increased thermal stability, and altered mixing patterns.
- Higher temperatures will negatively affect micro-organisms and benthic invertebrates and the distribution of many species of fish, and oxygen depletion. The thermal optima for many mid to high-latitude cold-water species are lower than 20°C.
- Species extinctions are expected when warm summer temperatures and anoxia (oxygen depletion) eliminate deep cold-water refuges.
- Invertebrates, waterfowl and tropical invasive species are likely to shift pole-ward with some potential extinction.
- Major changes will be likely to occur in the species composition, seasonality and production of planktonic communities (e.g., increases in toxic blue-green algal blooms) and their food web interactions resulting in changes in water quality.
- Enhanced UV-B radiation and increased summer precipitation will significantly increase dissolved organic carbon concentrations, altering major biogeochemical cycles.
- Water body may respond with a decline in fish yields and breeding cycles.
- The seasonal migration patterns and routes of many wetland species will need to change and some may be threatened with extinction.
- Small increases in the variability of precipitation regimes will significantly impact wetland plants and animals at different stages of their life cycles.
- In monsoonal regions, increased variability risks diminishing wetland biodiversity and prolonged dry periods promote terrestrialization of wetlands.
- In dry land wetlands, changes in precipitation regimes may cause biodiversity loss.
- Changes in climate and land use will place additional pressures on already-stressed ecosystems along many rivers in the world.
- An increase or decrease in freshwater flows will also affect coastal wetlands by altering salinity, sediment inputs and nutrient loadings.
- Expansion in range for many invasive aquatic weeds.
- Water levels are expected to increase in haors at high latitudes, where climate models indicate increased precipitation, while water levels at mid and low latitudes are projected to decline.
- Closed haors, baors, beels are most vulnerable to a change in climate because of their sensitivity to changes in the balance of inflows and evaporation. Changes in inflows to such haors, baors, beels can have very substantial effects and, under some climatic conditions, they may disappear entirely.

[4] Hunting, bird watching, fishing, hiking, boating, swimming, hot spring

3.4 Threats of Wetlands:

3.4.1 Sea Level Rise (SLR):

Melting of polar ice poles due to global warming and temperature causes extensive sea level rising to the water body. If the increase of sea level rise will be 1 meter, then country's 15% of land will be submerged under water with the intrusion of salinity. While marshes can withstand some environmental stress, more frequent storm surges and greater wave action superimposed on rising sea level which will exacerbate marshes erosion. Saltwater inundation and erosion from SLR will affect coastal wetlands and the wildlife they support. Elevated sea levels may enlarge tidal pools and channels. While marshes can withstand wave action to a certain degree, erosion may escalate with more frequent storm surges (e.g. nor'easters, tropical storms and cyclones) superimposed on a higher sea level. A 45 cm sea level rise would inundate 75% of the Sundarbans, and 67 cm sea level rise could inundate all of the system. Because of sea level rise around 120000 km^2 area of Bangladesh is vulnerable to flooding.

3.4.2 Temperature:

Changes in temperature have a serious impact on the crop physiology and biodiversity of wetlands. In 2007 the temperature in winter goes down in the haor basin. May be it was bellow 18ºC that cause no cereal in the rice and bellow 32^0C causes no prawn. Rising temperature will lower water quality in wetland through a fall in oxygen concentrations, release of phosphorus from sediments, increased thermal stability, and altered mixing patterns. High temperature could damage the BOD-P^H-COD[5] in water body. Due to high temperature; changes occur in significant loss of plant diversity, changes in marsh hydrology with the development of Phragmites, and a reduction in insect, bird, and other animal species (IPCC 2011).

3.4.3 Climatic Hazards (Flood, Cyclone, Precipitation):

Climatic haphazard and weather calamities play a severe damage of wetland ecosystem and biodiversity. Small beels are being drained annually to increase catches, and this is increasing the rate of sedimentation. Severe soil erosion in the water catchment areas of all the great rivers has resulted in greatly increased rates of siltation, and this has now become a serious problem at many of the wetlands. At the same time, flash floods have become a common phenomenon and these now cause considerable damage to rice paddies at the beginning of every monsoon season. Reed beds severely disappeared or become very rare, probably due to a combination of over-utilization (of useful species) and changes in water quality (leading to poorer light penetration). Run-off during exceptionally heavy rainfall occurring in neighboring upland areas is responsible for flash floods. Such floods occur as waters from the hilly upstream rush to the plains with high velocity, mauling standing crops and destroying physical infrastructure. Flash floods cause extensive damages to crops and property, particularly in the haor areas. Around 4000 km^2 area of south-east and 1400 km^2 area of north-east Bangladesh are subject to flash flood. For crops, it is their timing which is usually most important. Early floods (in April-May) generally cause severe damages. Hydrologic Alterations due to frequent natural calamities cause deposition of fill material for development, drainage for development, farming, and mosquito control, dredging and stream channelization for navigation, development, and flood control, diking and damming to form ponds and lakes, diversion of flow to or from wetlands.

Amphibians, reptiles and mammals have all reportedly decreased significantly in numbers, mainly due to habitat destruction, but also due to storm surges, cyclones (Sidr, Aila, Nargis etc), Crop loss was found to be rather high during the local months of Choitra (March-April), Baishakh (April-May) and Jaistha (May-June) due to lack of adequate rainfall, drought conditions, or because of hailstorms. Major crop damage was expected in Bhadra (August-September) and Aashwin (September-October) due to excessive rainfall and cyclonic storms. A lower level of crop loss in Srabon (July-August) could be expected due to rainfall induced water logging, since transplanting aman paddy becomes difficult in inundated low lying lands, which has a great potential to reduce yield for late transplanting of the seedlings. The frequent cyclone is causing loss of vegetation and erosion in Sundarbans which are the coastal mangroves that straddle the coasts of western Bangladesh and neighboring India.

3.4.4 Drought:

In terms of magnitude drought exhibit a pronounced spatial distribution in Bangladesh. The western parts of the

[5] Biochemical oxygen demand, presence of hydrogen, chemical oxygen demand

country receive less rainfall averaging some 1400 mm as against the national average of about 2150 mm. As a consequence, susceptibility and severity of drought in the western districts are much higher than elsewhere. Characteristics of moisture retention capacity, infiltration are damaged due to high prevalence of drought which was observed in the western districts of Rajshahi, Bogra, Pabna, Dinajpur, Rangpur and Kustia. Drought occurred during the late rainy season and caused a net reduction of rice production. The recorded dryness in the winter for many of the eastern wetlands of Bangladesh is much higher than the previous record and also caused lack of upstream water flow in winter.

3.4.5 Salinity Intrusion:

Ingress of salinity is a major problem in coastal Bangladesh. Diminished flow in the dry season allows salinity to penetrate far inland through this estuarine river system. Salinity limits opportunities for supplemental irrigation of rice crops in freshwater areas and damages the same crops by flooding during very high tides. The upland progression of saline water during the dry season eliminated surface water potentials for significant land areas in the southwest, south-central and southeast regions. The increased salinity has affected the natural regeneration of mangroves, and in some areas there is now no regeneration at all. The density of Spotted Deer in Sundarban appears to be lower in western areas, where salinity is highest, than in the east where it is lowest. Salinity was reported from many of the closed water wetlands of southern Bangladesh, including the beel basin of Gopalganj and Masura districts.

3.4.6 River Bank Erosion:

Most of the rivers of Bangladesh flow through unconsolidated sediments of the Ganges-Brahmaputra-Meghna floodplain and delta. The riverbanks are susceptible to erosion by river current and wave action. River erosion includes channel shifting, the creation of new channels during floods, bank slumping due to undercutting, and local scour from turbulence caused by obstruction. The Brahmaputra, the Ganges, the Meghna, the Teesta, and the Surma-Kushiyara rivers flow within well defined meander belts on extensive floodplains where erosion is heavy. Sudden changes are common during floods that cause rapid bank erosion. In lower deltaic areas, river bank erosion is caused by tidal currents and storm surges from the sea. The Bangladesh Water Development Board (BWDB) estimated that about 1,200 kilometers of riverbank has been actively eroded and more than 500 kilometers has been facing severe problems related to erosion. Satellite-image studies of the Ganges-Brahmaputra-Middle-Meghna rivers show that an area of 106,300 hectares has been lost due to erosion between 1982 and 1992, while the accretion amounted to only 19,300 hectares. The net erosion rate was therefore estimated at 8,700 hectares per annum. In 2010, Rangamati, khagracchari, bandarban region annual estimation of soil erosion were 100-120 tonnes (Chakraborty *et al*. 2011).

3.4.7 Anthropogenic Activities:

Dominant human activities on wetlands are land use conflict between communities. Most of the pond and shallow channels of have already been converted into agricultural land. Fishing and agricultural activities cause a considerable amount of disturbance to waterfowl populations, and over-fishing may be a problem. Persecution as pests (e.g. wild boar, otters), and perhaps accidental poisoning (e.g. frogs, by use of pesticides) are another threats indeed. Oil spillage and over exploitation on the timber resources, aquatic fauna and sea-birds, uncontrolled exploitation of coral reefs, limestone deposits, collection of the eggs of marine turtles for human consumption are the major concerns. Pollution inputs by runoff from urban, agricultural, silvicultural, and mining areas, air pollution from cars, factories, and power plants, old landfills and dumps that leak toxic substances and marinas, where boats increase turbidity and release pollutants. Vegetation damages of wetlands by grazing domestic animals, introduction of nonnative plants that compete with natives, removal of vegetation for peat mining etc.

3.5 Critically Endangered and Threatened Species:

Swamp forests vegetation like *Barringtonia acutangula* (Hijal) and *Pongamia pinnata* (Koroch) trees that were once common at the haor, have now become very rare due to water disturbance and flood anomalies. Reed beds dominated by *Phragmites karka* have been severely disappeared or become very rare, probably due to a combination of over-utilization (of useful species) and changes in water quality (leading to poorer light penetration). As a result of excessive temperature and pollution, populations of *Labeo rohita* and *Labeo gonius* have decreased, and *Catla* (Catla) is now rare. Vulnerable reptiles include *Pannthera tigris* (Royal Bengal Tiger), *Gavialis gangeticus*

(Gharial), *Crocodylus porosus* (Estuarine Crocodile) and endangered *Cairina scutulata* (White-winged Wood-Duck). A gradual replacement of *Heritiera tomes* with *Excoecaria agallocha* is a likely long-term effect. The small populations of *Python molurus,* (Rock Python), *Rana hexadactyla* (Green Frog) remains under pressure due to lack of aquatic disturbance like excessive temperature, salinity, acidity and deteriorate condition of water.

3.6 Legislations for Wetland Management:

Although the existing laws in Bangladesh are not specific to the needs and problems of lake management and conservation, but there are some sectoral laws having bearing on lake issues. These are:

- ✓ National Water Policy, 1999
- ✓ The Haor Development Board Ordinance, 1997
- ✓ Bangladesh Environmental Conservation Act, 1995
- ✓ East Bengal Protection and Conservation of Fish Act, 1950
- ✓ Bangladesh Wildlife (Preservation) (Amendment) Act, 1974
- ✓ The East Bengal State Acquisition and Tenancy Act, 1950
- ✓ The Land Reform Board Act, 1989
- ✓ National Rural Development Policy, 2001

Beside the national Laws, Bangladesh is signatory of CBD, Ramsar, CITES, CMS, etc.

3.7 Wetland Conservation Practices:

Wetland adaptive and restoration attempts, practices and measures are (Kusler & Kentula 1990):

- ⇒ Small dams: It can be used to reestablish or create wetland hydrology. Small earthen dams can be built at very low costs using standard farming equipments.
- ⇒ Backfilling canals: It can be lead to at least partial restoration of wetlands impacted by canal construction.
- ⇒ Control of impact of feral fish: Uses natural processes to restore wetland biodiversity; quick local responses in wetland health are visible to community and funding bodies.
- ⇒ Crevasse splays: Inexpensive method of restoring wetland in subsiding deltas.
- ⇒ Dredged material: It provides an alternate method of disposing and existing environmental benefits.
- ⇒ Excavation: Allows creation of wetlands at a number of locations.
- ⇒ Fresh water diversion: Reintroduce fresh water and to some degree sediment supplies to deltaic wetlands isolated from rivers by levees. Freshwater biological communities displaced by saltwater intrusion can quickly recover.
- ⇒ Increase of effective flooding across floodplains: Uses natural processes to restore wetland biodiversity, simple action possible at many locations, quick local responses in wetland health is visible to community and funding bodies.
- ⇒ Maintenance of water cover to prevent sulfuric acid runoff in acid sulfate soils: Uses natural processes to restore water regime and water chemistry; quick local response in wetland health is visible to community and funding bodies.
- ⇒ Planting: It quickly establishes vegetation structure under some circumstances.
- ⇒ Reintroduction of the drying cycle in drowned temporary wetlands: Uses natural processes to restore wetland biodiversity; quick local responses in wetland health are visible to community and funding bodies.
- ⇒ Groundwater removal: Pumping groundwater that is sometimes called “cone of depression” around wetland, alleviating impacts from contaminated groundwater.
- ⇒ Removing culverts: It can result in immediate re-establishment of tidal flushing with subsequent rapid changes in vegetation and faunal communities. In some cases, improved flushing can reduce mosquito populations.
- ⇒ Terracing: It may lead to recover of vegetated emergent marsh habitat or establishment of submerged aquatic

vegetation within terrace cells.

⇒ Weed control: It can allow re-establishment of native plant communities.

⇒ Aerial Photograph Interpretation and Historic Mapping.

4. Discussion:

4.1 Major Accomplishment Approaches for Wetlands:

⇒ Oxbow Lakes Small-Scale Fishermen Project: period was 1988-1996 and major challenges were to increase the productivity of Oxbow lakes and their adjacent waterways, to boost the income of functionally landless people.

⇒ Netrakona Integrated Agricultural Production and Water Management Project: agricultural development support, research demonstration and training, polder rehabilitation and management, supporting the rehabilitation of five flood control polder schemes, rural infrastructure development, vegetables production increased by 186%.

⇒ Small-Scale Water Resources Development Sector Project: project period was 1995-2000 and major challenges were to bring a sustainable increase in agricultural production, increase income of smallholders, 280 water management cooperative societies had been set up, members were trained, fish production increased to 653 tonnes to 2375 tonnes between 1996-2002.

⇒ Aquaculture Development Project: project period was 1998-2003 and key approaches were working to improve the living standards of fishing communities and women's groups, to boost fisheries and aquaculture production and incomes of people living in poverty.

⇒ Community-Based Resource Management Project: project period was 2000-2010 and key roles were to improve participants' access to essential services and resources, to diversify their livelihood options, to empower women in a district that is remote, neglected and characterized by destructive flooding patterns, supports the transfer of water and land management rights, provides access to savings and credit services at the village level, empowers women by addressing strategic gender needs.

⇒ Sustainable Environmental Management Programme (SEMP): prevent and reverse present trend of environmental degradation, promote sustainable development, reduce poverty, capacity strengthening at community, local and national levels.

⇒ Fourth Fisheries Project (FFP): project period was 200-2006 and major roles were to support sustainable growth in an equitable benefit distribution fashion, community based inland open-water fisheries management, development and management of coastal shrimp aquaculture, supply of equipment, transportation, and, studies for freshwater aquaculture extension and training; support to management, and assessment of ecosystems' sustainability, and, that of exotic species; institutional support, to include training, civil works, and/or equipment as needed.

⇒ Community Based Fisheries Management (CBFM)- I &II: project period was 2001-2007 and prime objectives were to ease the growing fishing pressure and stop fishing during the breeding season, usually for a three-month period – April to June each year, to establish fish sanctuaries where no fishing is allowed.

⇒ Costal and Wetland Biodiversity Management Project (CWBMP): had been implanted since 2006 in the Ecological Critical Areas (ECAs), viz., Sonadia island, St. Martin’s island and Teknaf peninsula and in Hakaluki haor, main objectives were to ensure the conservation and sustainable use of globally significant coastal biodiversity at the Cox's bazar sites through their management as ECAs, to ensure the conservation and sustainable use of globally significant wetland biodiversity at Hakaluki haor site through its management as an ECA, to support efforts by DoE to institutionalize the concept of ECA management using the experience gained through the above demonstration sites.

⇒ Management of Aquatic Ecosystem through Community Husbandry (MACH): project period was 1998-2008 and it included all floodplain resources (fish, plants, wildlife), support entire resource users (poorer fishers, farmers, landless labourers, women, local elites & govt. officials), two groups at each region of the sites, federation for Resource Users Groups (RUGs) and Resource Management Organization (RMOs), with separate NGO for each type of group, adequate IGAs to reduce fishing pressure, human resources development, adaptive

management and policy initiatives.

⇒ Integrated Floodplain Management (IFM): significant use of RNRSS and other natural resources research outputs for the benefit (direct/ in-direct) of poor men and women in diverse contexts, test, demonstrate and assess adaptive learning networks for co-production of knowledge, identify lessons and processes involving CBOs, generate comparisons between floodplain environments which are expected to improve understanding of generic lessons and issues of context specific organizational development and performance.

4.2 Approaches for Wetland Conservation:

4.2.1 Inland Freshwater Wetland Conservation:

- Recognizing that climate change may substantially affect the ecological character of wetlands and their sustainable use, and aware of the potentially important role of wetlands in adapting to and in mitigating climate change.
- However, river management systems, such as levees and flow diversions, have reduced river-pulsed floods and the delivery of sediment to delta wetlands, decreasing their ability to form soil and raise elevation (Baumann *et al.* 1984).
- Baira cultivation: baira is an environment friendly floating platform made of water hyacinth and used as seed bad and for growing vegetable and species practice widely in the floodplains of Bangladesh. 23 species of vegetable and 6 species of spices have been successfully produced and harvested.
- Dredging of river beds combats increased sedimentation, thereby improving navigability.
- High bank of pond and or using nets around the pond.
- Increasing vegetative coverage along river banks protects against erosion resulting from increased flow and flooding.
- Protection and regeneration of the swamp forest in the haor ecosystem.
- Establishment of fish sanctuary, priority will be given to the fish breeding grounds and harvesting on the breeding season, usually it is early monsoon in haor and mid monsoon in beel basin.
- Protection of reed lands and swamp forest.
- Legislation to prevent eutrophication[6]: established standards for agricultural, industrial, and household water sources.
- Ordinance for the conservation of Reed vegetation zones: reeds play an important role in purifying water as well as providing habitat for birds and fish.
- Ensuring participation of poor in planning phase: some of the recent initiatives used Participatory Action Plan Development (PAPD) as a consensus building tool among stakeholders. It helped the stakeholders to find a win-win solution of an ought to arise conflict prior to implementation (Sultana, *et al.* 2004).

4.2.2 Marine Coastal Wetland Conservation:

- The land owners wish to establish a Wildlife Sanctuary under the Bangladesh Wildlife (Preservation) (Amendment) Act, 1973, and to manage the sanctuary for the conservation of waterfowl and other natural resources.
- A group of Forest Reserve should be in a series of successively more comprehensive working plans. The emphasis of this management plan is on the management of the tiger and all other wildlife as an integral part of forest management that assures the sustainable production of forest resources to meet the needs of the local human population.
- Forest Inventory Project (FIP) for sustainable production of timber, fuel-wood and other forest products, with due consideration to wildlife conservation and the social amenity value of the area.

[6] Addition of artificial or natural substances, such as nitrates and phosphates, through fertilizers or sewage, to an aquatic system

- Buffer zones, in which disturbance is kept to a minimum through restriction of access, should be established in areas peripheral to the sanctuary boundaries (Suh & Woo 2010; WHC 2011).
- Construction of wet-park, which is used as an artificial wetland, marsh or swamp created as a new or restored habitat for native and migratory wildlife, for anthropogenic discharge such as wastewater, storm water runoff, or sewage treatment, for land reclamation after mining, refineries, or other ecological disturbances such as required mitigation for natural wetlands lost to a development.
- Doincha (*Sesbania sp*.) cultivation, also known as shola, is a member of *Leguminosae* family and plays a vital role if increasing soil fertility. In the nodules of the roots of this plant, nitrogen fixation occurs through bacterial action, thereby increasing the soil fertility.
- Waterfowl Management Plan (WMP), which are paying huge dividends for waterfowl and water birds.
- Protection and regeneration of mangrove on the coast by waste treatment, wetland mapping etc.

4.2.3 Some General Approaches:

- Keep the carbon stored in wetland where it is.
- Rehabilitate wetland restore biodiversity and sustainable livelihoods.
- Raise awareness of water-wetland-biodiversity linkages.
- Engage the full range of public and private sector stakeholders and promote multi-convention cooperation.
- Provide positive incentives for sustainable wetland management that promote their full potential in climate change adaptation and mitigation.
- Protection of (restored) resources involves taking away threats, and providing viable alternatives and conservation education to the local community.
- Multi-stakeholder national coordination committees may be required, chaired by a 'national level authority' with sufficiently empowered to influence over macro policy formulation, planning and implementation of risk reduction and adaptation initiatives within and among the Sectors.
- Basic framework should centre on existing government structures (institutions) through providing necessary technical assistance in order to build sufficient capacity through technology transfer to deal with Disaster Risk Reduction (DRR), and climate change and adaptation matters, and to reflect the later in all development activities.
- National issues statement and background paper accumulation, defining wetlands at a national level and defining stakeholders as well, initiating national consultations, implementing national and local wetland policy workshops, creating a wetland policy writing team, ensuring political support for the next steps, time scales.
- Developing a cabinet memorandum, government endorsement and approval, announcement, establishing wetland conservation objectives in government policies, enhancing coordination and communication among government agencies, creating more incentives to conserve wetlands, fostering better wetland management after acquisition or retention.
- Risks inherent in restoration and creation, and the possibility of success for restoring or creating particular wetland types and functions should be reflected in standards and criteria for projects and projects design.
- A legal agreement for the implementation of the co-management arrangement must be developed.

4.3 Institutions involvement in Wetland Management:

- Government sectors: Ministry of Environment and Forests, Ministry of Planning, Department of Environment, Ministry of Finance, Ministry of Health/DG-Health, Bangladesh Meteorological Department (BMD), Ministry of Food and Disaster Management, Ministry of Water Resources, (Bangladesh Water Development Board), Ministry of Agriculture, (BIRI, BARC, BARI), Ministry of Information, Ministry of Local Government, Rural Development and Cooperatives, and its associated organizations.
- Non Government sectors: Bangladesh Institute of Development Studies (BIDS), Bangladesh POUSH, Center for Natural Resource Studies (CNRS), Bangladesh Centre for Advanced Studies (BCAS), IUCN-Bangladesh,

Centre for Environment and Geographic Information Services (CEGIS).

- Academia: Dhaka University (DU), Jahangirnagar University (JU), Bangladesh University of Engineering and Technology (BUET), Independent University of Bangladesh (IUB) and Brac University, North South University (NSU).

5. References:

Akonda, A. W. (1989), "Wetlands of Bangladesh", in Scott, D.A. (ed), *A Directory of Asian Wetlands*, International Council for Bird Preservation: International Waterfowl and Wetlands Research Bureau.

Nishat, A. (1993), "Freshwater Wetlands in Bangladesh: Status and Issues", in Nishat, A., Hossain, Z., Roy, M. K. & Karim, A. (eds), *Freshwater Wetlands in Bangladesh-Issues and Approaches for Management*: IUCN, pp. 9-22.

Smithsonian, A. (2009), "Climate Change Found To Have Paradoxical Effects in Coastal Wetlands", ScienceDaily.

Ahmed, R. et al. (2004), "Introduction to Community based Haor and Floodplain Resource Management", IUCN Country Office-Bangladesh: Dhaka, pp. 10-20.

Suh, S. O. & Woo, S. H. (2010), "Wetland Management: Experiences from Asian Countries", Ramsar Regional Centre (RRC)- East Asia: Republic of Korea.

Intergovernmental Panel on Climate Change (IPCC), (2011), "Some useful links", [Online] Available: http://www.ipcc.ch/links/links.shtml (accessed 7th January, 2011).

Chakraborty, T. R. & Bhattacharjee, S. (2011), "Climate Change Adaptation in Bangladesh", Proc. Department of Geography: Bardhuan University, India.

Nicholas, R. et al. (2009), "An increasing CO_2 sink in the Arctic Ocean due to sea-ice loss".

Kusler, J. A. & Kentula, M. E. (1990), "Wetland Creation and Restoration: The Status of the Science", Island press: Washington, DC, pp. 594.

Baumann, R. H., Day, J. W. & Miller, C. A. (1984), "Mississippi deltaic plain wetland survival: sedimentation versus coastal submergence", Science 224:1093-1095.

World Heritage Committee (WHC), (2011), "UNESCO World Heritage Site List", [Online] Available: http://whc.unesco.org/ (accessed January 2011).

Sultana, P. & Thomson, P. (2004), "Methods of consensus building for community- based fisheries management in Bangladesh and the Mekong Delta", *Agricultural Systems*, 82, pp. 327-353.