Climate Change Affects Wetland Resources in Bangladesh: A Case Study on Hakaluki Haor

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ABSTRACT

The wetlands of Bangladesh support a wide variety of floral and faunal diversity. Approximately half the area of the country can be considered as wetlands consisting of a wide variety of types ranging from haors, beels, lakes, rivers and coastal forests to deepwater paddy fields and ponds. The wetland resources of Bangladesh are of enormous economic importance. The present study has attempted to observe the present situation of existing condition of wetland resources. However these aquatic resources have been subjected to rapid degradation due to the increasing population pressure, habitat destruction as well as natural causes. Hakaluki haor is one of the major wetlands of Bangladesh. With a land area of 18,386 hectares, it supports a rich biodiversity and provides direct and indirect livelihood benefits to nearly 190,000 people. Because of the critical conditions of the haor ecology, the government of Bangladesh declared Hakaluki as an Ecologically Critical Area (ECA) in April 1999.So the Hakaluki haor area is very important site for study as wetlands conservation practice. As there are some problems in conservation process, it is very important to try and find out the main causes of wetlands degradation and keep wetlands free from such harmful impacts. The study was initiated to find out the problems and propose some suggestions to develop the wetlands conservation process. The resources users were empowered with a collective effort to build institutions and implement sustainable use practices resulting in wetland resilience of the resources.

Key words: *Wetlands, GIS, Climate Change*

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Introduction

General

Wetlands are invaluable components of the environment, ecology, resource potential and biodiversity in Bangladesh. They are an integral part of the local ecosystem based cultures. All these wetlands form a unique mosaic of habitats with extremely rich diversity of flora and fauna, much of it as yet biologically undiscovered. The wetlands also support the livelihood of millions of people from such diverse activities as fishing to collecting honey and materials for thatching and wood for fuel. Wetlands are defined as: "Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters".In addition, the Convention provides that: "Wetlands may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six meters at low tide lying within the wetlands"[1].

Objectives of the Study

1. To understand the livelihoods of the inhabitants of the wetlands, the existing biodiversity situations of the wetlands and its extent.

2. To assess the impact of development interventions on the Biodiversity and Environmental issues of Wetlands.

3. To identify the use of wetlands.

4. To assess the indigenous knowledge of local people with regard to wetland resources management and practices.

5. To identify issues for the wetland resources at local, regional and national levels for its sustainable development.

Scope of the Study

The purpose of this project is to provide the wetland ecosystem-information and knowledge products. This includes wetland resources, the

role of wetland ecosystem services: water pollution, livelihood, food change and status of wetlands in the country, database on wetland development, management and conservation approaches and the case studies on conservation and maintaining of the wetland and its ecosystem. Available existing published literature, various project reports and information have also been used in perpetration of this paper [1].

Hakaluki Haor presents a very different type of ecosystem as well as new sets of management issues. It represents a complex wetland system with more than 238 interconnecting beels in a shallow basin formed between the Patharia and Madhab Hills to the east and the Bhatera Hills to the west. The major sources of water are the Juri, sonai Bardhal and Kushiyara rivers, which traverse the wetland and drain through a single outlet, the Kushiyara River. Most of the local inhabitants are in some way dependent on the wetland for their livelihood. Hakaluki Haor supports one of the largest inland fisheries in Bangladesh.

Importance of Wetlands for Bangladesh

Wetland covers about 50% of the total land area of Bangladesh (about 7 to 8 million hectares). About 7% of the country is permanently under water, 21% is periodically deeply flooded to a height of more than 90 cm, and around 35% of the country experiences shallow inundation. The variety of wetland areas found in Bangladesh include the riverine areas, creeks, seasonally Inundated floodplains known as haors, baors, beels, fresh water lakes and estuarine systems [2].

The wetlands of Bangladesh are a reservoir of biodiversity and natural resources upon which communities depend for their livelihoods. Fisheries from wetlands provide about 80% of the dietary protein of the population. Foods, fuel, fiber, fodder, building materials are also harvested from wetlands. The wetlands also provide water for irrigation and domestic uses and act as overwintering habitat for a rich variety of resident and migratory waterfowls. The economic uses of the wetlands include that for growing flood tolerant rice paddies, fish rearing, collecting mollusks, planting vegetable gardens, and rearing ducks and other livestock. Fodder for cattle and dried weeds for fuel, are also collected from the wetlands. Healthy wetland ecosystems also act as a buffer for floods and serve to reduce the vulnerability of local communities to drought and floods.

Geomorphologic Importance

Each year about 2.4 billion tons of sediment is transported by the major rivers of Bangladesh having a profound effect on the geomorphology of the floodplains and the coastal region. Most of the silt, carried bt the three mighty rivers,Ganges,Brahmaputra and Meghna, is lost in the depth of the Bay of Bengal. Some of this tremendous amount of silt is deposited on the shore in Meghna estuary causing land accretion particularly in the southeast region of the country and forwarding the coastline towards the sea [2]. The environment and ecology of the coastal regions is characterized by the unique geophysical phenomena, such as, sea surges and waves, upland discharge and sedimentation, erosion and accretion and storms and cyclones.

Livelihoods on Wetland Resources

Wetlands are one of the most productive and resourceful areas, which provide food, non-food aquatic resources and retain the ecological balance for the local residents as well as for the nation. The wetland environment has united the inhabitants into a society, which has a definite shape, culture and livelihood pattern. Due to the availability of wide variety of harvestable products, the people of the wetlands are traditionally self-reliant and have subsistence-oriented economy and livelihood. Wetlands of Bangladesh are one of the major sources of livelihoods particularly for cultivating food crops, vegetables, fishing, and pasture lands [3].

Crops Cultivation

About 76 % of the country total population live in rural area and major parts of the rural area is under various types of wetlands including floodplains, haors, baors, and lakes in Bangladesh. About 50% rural people are directly dependent on agriculture for their livelihoods and many others indirectly depend on agriculture input and crops marketing activities in wetland areas. In recent years due to consistent decline in inland capture fisheries, agriculture has emerged as the overwhelmingly dominant sector of the economy in the areas [3]. High level of agricultural dependence may be the preponderance of landless rural households who have no access to other productive employments in the wetlands. The vast flooded areas of wetland are covered by crops which can tolerate water logging and inundation. Before the introduction of mechanized dry-season irrigation in the sixties,

deepwater rice or broadcast aman rice used to be the major crop in the wetlands during the rains.

Wetland as Source of Food and Medicinal Plants

The vast majority of the poor in the wetlands are dependent on water resources for their subsistence. The rootstocks of ghechu (*Aponogetom* spp.), tatro or kachu, Indian lotus and waterlilies are rich in starch. The seeds of makhna (*Euryale ferox*) are also relished. Two wild species of rice, dhane (*Oryza coarctata*) of brackish water and jhora dhan (*Oryza rufipogom*) of fresh waterbodies, are used as substitute for cultivated rice. Paniphal (*Trapa bispinosa* and *T. maximowickzii*) are plentifully available in large waterbodies and provide nutritious starchy kernels. A number of other aquatic herbs are consumed as leafy greens [3]. Ghechu is cultivated after the harvest of boro in low-lying areas of Kishoreganj and Itna where the tubers reach a size of about 1.5 cm in diameter and are harvested in October and November as the floods recede. The ghechu tubers yield milky white flour having nutritive value like potatoes. As the tubers are not damaged in flood waters, ghechu forms one of the most important famine foods. Many people collect these resources for earning livelihoods and for household consumption.

Role of Fishery Resources to Maintain Rural Livelihood System

Structure of the rural livelihood system, depends on the inland open water fisheries to sustain rural livelihood system, status of protein intake and problem on health of rural population, and economic importance (trading, marketing and business) of the floodplain fish.

Fishing is the second largest livelihood activities. The majority of rural population depends on fishing there. The available information indicate that this sector employs about 2 million people who remain fully engaged in fishing, handling, packaging, transporting, distribution and marketing of fish. An estimate showed that about 10 million people are engaged as part-time fishermen to supplement their income or to live on fishing in some part of the year. About ten per cent of the population depends on fisheries for their livelihoods in Bangladesh [4].

As Habitat of Migratory Birds

About 207 species of birds live or visit Bangladesh. Among the birds 30% are waterfowls, 26% waders, 20% bush and her bland birds and the rest are grassland, air hawking prey. Of these fresh water birds 129 species (62.3 %) are resident and the other is migratory. Winter Guest birds from Himalayas and far away places like Siberia move to relatively warm swampy lands in Bangladesh to escape the freezing cold, and feed on snails and tiny fishes, which are abundant during this part of the year in the rice crops in haors, baors.

Forests

The Sundarbans freshwater swamp forests are a tropical moist broadleaf forest in Bangladesh. It represents the brackish swamp forests that lie behind the Sundarbans Mangroves where the salinity is more pronounced. The freshwater ecoregion is an area where the water is only slightly brackish and becomes quite fresh during the rainy season, when the freshwater plumes from the Ganges and Brahmaputra rivers push the intruding salt water out and also bring a deposit of silt. It covers an area of 14,600 square kilometers (5,600 square miles) of the vast Ganges-Brahmaputra Delta, extending from India's West Bengal state into western Bangladesh.

Socio-Economic Aspects of Wetlands

Human Habitation

Prior to the 12th century there is almost no information available on the human habitation here. The information up to the 17th century is sketchy. During the British period, this area was not stringently surveyed, and not a lot of information is available. It is believed that the early settlers of the area were Hindus and other ethnic groups including Garo, Hajong, Khasi and Koch people coming down from the hills to the north. They were drawn to the area because of its productivity. With the expansion of Muslim power in the south and the west further Hindu migration continued in the 13th and 14th century.

Navigation and Communication

Wetlands areas rely heavily on water transport and in monsoon months navigation is an important source of employment for their residents. Both professional boatmen and many non-traditional boatmen join in providing boat service. Of late, the introduction of mechanized boats has reduced the plying of country boats.Siltation, construction of roads and infrastructure development in the form of embankments contributed towards a negative impact on navigation as previous waterways have been blocked seriously impeding freight transport.

Biomass Production

For most of the local residents, wetlands are the only source of biomass for fuel, timber,compost,food and medicines. Wetlands yield a number of important products in the form of biomass ranging from fuelwood, timber and bark to fodder and organic manure. In dry season, a large number of grasses, sedges and pods of various legumes are collected for cattle feed. The biomass of submerged aquatics' is collected by local people after receding of floods and dumped on fallow land. As the muddy soil remains soft, the farmers simply remove the debris of aquatic weeds and plant boro rice. This plough less land preparation is a major technical specialty of the haor.The ash of water hyacinth contains 30% potash and 13% lime and is useful as an excellent compost fertilizer. Water hyacinth is also utilized as a good cattle feed [4].

Coral Reef

The only known coral reef of Bangladesh near Narikel Jinjira (St. Martin's island) was rich in diversity of corals and the associated macro algae even three decades ago. Several living small coral colonies are found in small sheltered pools very near the low tide level around the island. They also occur in the surrounding shallow sea, mostly growing on the beach rocks and calcareous sandstone concretions. The dead coral colonies also occur in pool-like depressions within the high and low tide levels. Some of them are located at an elevation of nearly 3.50m above the low tide level.

Ecotourism

Tourism in a wetland could be a means of generating revenue and employment besides attract visitors to the values of wetlands. On the other hand, it causes pollution and noise causing disturbance and harm to the fauna. Haors are unique wetlands and have started attracting tourists, although in limited numbers. The best time to visit the haors is at the end of the monsoons, say around August-September, when they are full with water. Thereafter, the water in the haors starts receding but still provides an awe-inspiring sight. In winter, the haors and beels receive thousands of migratory birds. It is the ideal season for bird-watchers, but then the haors are reduced in size and lose much of their watery grandeur.

Economy

These haors and beels support major subsistence and commercial fisheries, while the seasonally flooded lake margins support major rice-growing activities, and the abundant aquatic vegetation provides rich grazing for domestic livestock and an alternative source of fuel and fertilizers for the local people. The main crop grown in the haor basin is boro rice or dry season rice. Early monsoon flash floods often cause extensive damage to the boro crop. Protection in the form of full flood dykes or submersible dykes is being provided in some of the developed areas Haors and baors, along with the rivers, canals and the floodplain, are a major source of fish production. But, due to siltation, and harvesting of excessive amounts of fish to meet the demand of growing populations production of fish from this source is gradually dwindling. In recent years, the wetlands have also been used for rearing domestic ducks.

Flood Control

Yields in wetlands for non-irigated crops vary from year to year depending on the amount of pre-monsoon and post-monsoon rainfall and the consequent incidence of untimely or high floods and the speed of recession of flood water. On non-irrigated land, rice yield generally declines with increasing depth of flooding. Flood control projects in Bangladesh have been basically of embankments, river closures, excavation of drainage canals and drainage control structures. The flood control facilities have expanded steadily since the 1960s to about 3.37 million ha through the construction of 7555 km

of embankment. The flood control intensity and production of aman and aus rice.

Wetland Resources in Bangladesh

Wetland is the low lying ecosystem where the groundwater table is always at or near the surface. It includes areas of marsh, fen, bog, floodplain, and shallow coastal areas. Wetland is divided into estuarine and freshwater systems, which may be further subdivided by soil type and plant life. Based on biological and physical characteristics, 39 categories of wetlands were globally identified; of which 30 are natural and nine man-made. However, wetlands of Bangladesh can be classified on the basis of their hydrological and ecological functions and land type concept as stated in the Table 1.

Table 1: Classification of wetlands

1.	Saltwater wetlands	a) Marine	permanent shallow waters at low tide, e.g. bay coral reefs, e.g. St Martin's reef
		b) Estuarine	intertidal mud, sand or salt flats with limited vegetation, e.g. newly-accreted land intertidal marshes intertidal forest wetlands including mangroves, e.g. Sundarbans
		c) Lagoonal	brackish to saline lagoons with narrow connection with sea
2.	Freshwater wetlands	a) Riverine wetlands	permanent rivers and streams including some char land, temporary seasonal rivers and streams
		b) Lacustrine wetlands	There are thousands of lakes of varying sizes in Bangladesh, the greatest concentrations being in the main delta region covering the districts of Rajshahi, Pabna, Khulna, Jessore, Faridpur, Comilla and Noakhali.
		c) Palustrine wetlands	permanent freshwater marshes and swamps with emergent vegetation E.g. hijal forests of lowland.

Table 1: contd.

3.	Man-made wetlands		aquaculture ponds (brackish and freshwater) irrigated land, dam and irrigation channels, e.g. Kaptai Lake

From an agricultural point of view, soil scientists in Bangladesh adopt a different approach to define wetlands. On the basis of depth and duration of inundation/flooding, the country has been divided into six broad land types: highland, medium highland, medium lowland, lowland, very lowland, and bottomland. Among these land classes, medium lowland (which remains flooded up to a depth of 180 cm during MONSOON) through bottomland (which remains wet throughout the year) are considered as areas of wetlands [2].

Bangladesh possesses enormous area of wetlands including rivers and streams, freshwater lakes and marshes, Haors, Baors, Beels, water storage Reservoirs, fish ponds, flooded cultivated fields and estuarine systems with extensive mangrove swamps. Wetlands of coastal and marine origin are less important in Bangladesh. The haors, baors, beels and JHEELS are of fluvial origin and are commonly identified as freshwater wetlands. These freshwater wetlands occupy four landscape units - floodplains, freshwater marshes, lakes and swamp forests. The manmade wetlands include lakes, dighis, and ponds and borrow pits. Floodplains are made of river-born sediments and are subject to periodic inundation and occasional flooding. Freshwater marshes are more or less shallow water bodies lying at the back-slope of floodplains. In most cases, these are old or abandoned river courses, having tall reeds and grasses mixed with thickets of floating vegetation. Lakes are deeper perennial waterbodies. Swamp forests develop along the margins of beels, marshes and lakes.

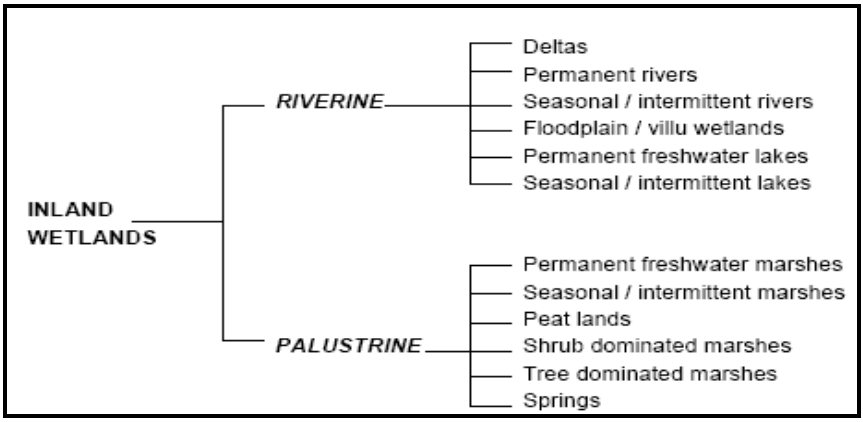

Figure 1: Types of inland wetlands

Existing Conditions of Wetlands in Bangladesh

Degradation of Wetlands and Damage Fishery Resources

Since independence there has been an accelerated expansion of physical infrastructure in the floodplains and haor areas. In recent years, decentralization of administration at the Upazila (sub-district) level also led to a rapid expansion of roads and feeder roads even in the rural areas of the haor basins [3]. These infrastructures were often done without proper planning or due regard to natural water flows. These poorly planned roads and drainage structures created water logging and had serious impact on the water regimes in the flood plains.

The degradation of wetlands in Bangladesh is mainly due to:

1. Increase of population and expansion of human habitats; expansion of agriculture and subsequent conversion of wetlands through drainage into rice fields;

2. Flood control and irrigation project for enhancement of agricultural productivity;

3. National, local and rural infrastructures like ill-planed roads; narrow culvert etc.

4. Over-felling of wetland trees;

5. Over-grazing by livestock;

6. Over-fishing and associated disturbances;

7. Siltation due to degradation of watershed areas which are often transboundary in nature;

8. Indiscriminate control/ regulation / use of water flows of main river systems in upper riparian;

9. Pollution of water due to industrial, urban, agrichemical and other types of pollutants including pollution from transboundary sources.

Resources Use Pattern Have Been Changing

Traditionally the wetland areas of the northeast were very sparsely populated. The rapid growth of population in the century has accelerated the process of settlement in these hitherto marginal and agriculturally unproductive lands. A significant area of wetland was covered by various types of forest including some unique and almost extinct freshwater mangrove species. Cultivable waste and fallow lands surrounded the wetland area villages, as population pressure on land was not as serve as it is now. Occupational pattern and resource harvesting in wetland areas are also one of gradual change and transformation. At the early stage of settlement, fishing and cultivation of deepwater broad cast aman were the main activities of the wetland people. Gradually over time, this transformation into extraction of other aquatic resources and looking for other livelihoods earning opportunities, as competition for available resources stiffened [6]. Landuse pattern in the haor basin depends on the land elevation. Since the basis is saucer shaped, its peripheral highland is used for homestead and adjacent to the homestead a patch of land and the sloping terraces are kept for vegetable gardening and post-harvest activity. Next hierarchy of land starts for agricultural use which is relatively higher in elevation, followed by

the medium and low land. The lowest depression is the beel or permanent water bodies. Beels are the habitat for the fish of the haor and the source of supplemental irrigation during dry season.

Pollution of Wetlands

The pollution problems mostly originate from the untimely application of fertilizers and from domestic wastes. All the rivers flowing through Bangladesh originate outside the country and these carry heavy loads of silt, sediments and other debris, including domestic, agrochemical and industrial wastes, from far-away places. Together with these, local wastes are added, thus making the water saturated and at times oversaturated with organic and inorganic pollutants. The wetlands of the whole country are the dumping grounds for these sediments and pollutants and flushing out of materials to the sea is quite slow. The result is serious deterioration of the aquatic resources. Most of the industries and factories are situated on the banks of the rivers or very close to a river system and the effluents and wastes are mostly thrown directly in the river water without any treatment to make the effluent 'safe' from the biological standpoint. As a result, the depletion of the biotic components near the sources is observed [6].

Whatever industries we already have are enough to render the entire wetlands of Bangladesh including the river systems 'biologically dead' if the conditions now prevailing are allowed to continue further. Many of our industries are creating hazardous conditions in their locality with continual disposal of toxic and harmful materials.The industrial effluent containing acids, heavy metals, ammonia, toxic substances, etc., are directly thrown untreated into the water and together with these are added the agrochemical substances (insecticides, pesticides, fertilizers etc.) and the huge quantity of domestic wastes making the situation worse, influences by the pressure of the human population for food, shelter, fuel and clothing. Sanitation problem alone has created enormous health disaster in addition to the damage of the biological environment of useful organisms.

Land Use Conflict

A balance of interdependence of land, water and people is essential to achieve an integrated development. The poor and landless coastal people

have tried to settle on newly-accreted lands and chars. This continuous invasion, at times by the investigation of influence people, causes retardation of the natural mangrove formation in the coastal areas and major land use conflicts. The land use pattern has to be directed towards integrated farming, rice-based fish culture, horticulture on dykes, floating nurseries where possible, and integration of ducks and poultry with aquaculture. For a balanced development there is a need to anticipate conflicts with other resource uses and resolve them in environment-friendly manner.

Endangered Species

Following are some major reasons behind biodiversity depletion in Bangladesh.

1. **High population density, extreme poverty and unemployment:** Bangladesh is one of the World's densely populated countries with a population of more than 150 million. Besides, more than 85% of the population of the country are living in rural areas and somehow depends upon various natural resources which often lead over exploitation of plant and animal products for their survival and income. Rural fuel consumption pattern is another important issue related to natural resource depletion in the country.

2. **Habitat loss, degradation and fragmentation:** Biodiversity is strongly associated with intact ecosystems and natural landscapes, however transformation of land use patterns, expansion of agricultural lands, change in cropping patterns, urbanization, expansion of road networks, unplanned embankments and other manmade factors have caused immense damage of habitats in all ecosystems. The following are some underlying factors related to this issue;

    (a) Encroachment
    (b) Shifting cultivation
    (c) Urbanization
    (d) Land use change and agricultural expansions
    (e) Commercial shrimp cultivation in coastal mangrove areas

3. **Illegal poaching:** There is a big (illegal!) international market for wild animals (and their part, e.g., teeth, bones, far, ivory etc.) for their aesthetic and medicinal value. Peoples involved with this underworld syndicates sometimes illegally hunting/trafficking wild animals to earn some easy cash. Besides, unregulated logging, illicit felling, indiscriminate harvest of medicinal plants, unplanned fishing, using bag nets, bottom trawling fishing, fishing in the breeding season and other factors are causing the depletion of biodiversity.

4. **Environmental pollution and degradation:** One of the biggest threats to biodiversity in Bangladesh is pollution of air, soil and water. Water is the greatest victim of contributed by toxic agro-chemicals (i.e., chemical fertilizers, insecticides), industrial effluents that are causing depletion aquatic resources and riparian natural resources [5].

Women at Haor Site

The majority of people in the haor site are orthodox Muslims and so, the society is conservative and male dominated. Women are not equally treated are men are not prepared to accept or listen to any of their logical argument. They are virtually treated as second class citizens, expected to be subservient to the men. They must cover their face with head-cloth and never speak aloud. Though schools are there offering opportunities for education, yet the literacy rate of women is regrettably low, and the prevailing social environment does not encourage them to go to school, let alone higher education for girls. Only 23% of women are literate in the haor areas (IUCN, 2000).Women are aware of their needs and problems and they sometimes have ideas about resolving them too, but they cannot act upon those because they perceive the solutions as unattainable. Child marriage, dowry and harassment of women are still widely practiced in the area. As women have limited access to legal protection, they feel hardly encouraged to attempt availing of any kind of legal protection.

Sanitation in Haor Area

Sanitation situation is worse in the haor region. It has been observed that about 67% people use unhygienic latrine and several other types of defecation practices are present in most of the haor areas. The defecation practice is also changed seasonally and a gender reflection also being visioned in the practices. It has been observed that the maintenance of the toilets is not a priority issue for the owners. Regarding toilet cleaning, there is no clear responsibility within family, but it must be presumed that in most of the cases it is the task of the women.

It is evident from the survey findings that there are only 29 % households, which have hygienic latrine; whereas in urban areas it is 60%, more than double compared to rural areas (National Baseline Survey, 2003). The remaining 67% households have unhygienic latrines (which are predominantly hanging latrines) and the rest 4% households usually go for open defecation. Among those who are using toilets about 77% had their own toilets and about 9% of them were using community toilets. Using community toilets is an important finding for haor area as both suitable toilet technology and space for constructing toilets are problematic [7].

Submersible (Partial Flood Control) Embankments

Submersible embankments reduce floodplain discharges and increase in-channel discharges, especially during the pre-monsoon period. They tend to concentrate floodplain discharges and overbank spills into fewer locations and more specific spill points, often at locations where embankments are eroded and channel erosion/deposition problems are occurring.

Further, while water level and discharge effects may be negligible for individual submersible embankment projects, several such projects occurring together within a drainage system can produce significant cumulative effects on water levels and flows. In the past in the Northeast Region, this potential for cumulative impacts was not appreciated and numerous submersible embankment projects were built throughout the Central Basin without planning for systemic drainage and other requirements. As it has turned out, their potential for cumulative impact has been not been fully realized as a result of frequent embankment breeches, wave damage, public cuts, and incomplete structures and embankments.

Methodology

Site Selection

Hakaluki haor is a complex ecosystem, containing more than 238 interconnecting beels/Jalmahals.The most important beels are Chatla, Pinlarkona, Dulla, Sakua, Barajalla, Pioula, Balijhuri, Lamba, Tekonia, Haorkhal, Tural, Baghalkuri and Chinaura.The total area of the haor is approximately 18,000 ha, including the area which is completely inundated during monsoon. Of this total area, beels (permanent wetlands) cover an area of 4,635 ha. This 18,000 ha area represents area demarcated as ECA declared by the Government of Bangladesh for Hakaluki haor.

Location

Hakaluki haor lies between latitude 24° 35' N to 24° 45' N and longitude 92° 00' E to 92° 08' E. It is bounded by the Kushiara River as well as a part of the Sonai-Bardal River to the north, by the Fenchuganj-Kulaura Railway to the west as well as to the south, and by the Kulaura-Beanibazar Road to the east. Hakaluki haor falls under the two administrative districts (Maulvibazar and Sylhet) and five upazilas (Barlekha, Kulaura, Fenchuganj, Golapganj and Juri).

Data Collection

Survey 20 villagers and local people with a Survey Questionnaire and collect some data about livelihood, haor resources and environments, local transportations system and the biodiversity condition of Hakaluki haor area. A sample of Survey Questionnaire is given in Appendix A. Different type's data was collected from different areas. The collected data are categorized as:

1. **Basic data** (Name, Father's Name, Number of Family Members, Number of Earning Family Members, Educational Qualification, Religion, Village, Union, Upazila, District)

2. **Livelihood** (Main occupation, Source of income, Average monthly income, Own Land, Type of house, Type of latrines, Source of water, Source of light, Energy sources)

3. **Haor Resources and Environment** (The activities get hindered in haor, Restrictions during resource collection, Family members involved in fishing, Existing fisheries resource management practices, Existing fishing system, Economic activities that depend on haor resources, Haor development, Benefit of migratory birds, The reason of flooding in haor area, Protection the haor)

4. **Transportation System** (Vehicles use for transportation, Monthly expenditure on transportation)

Analysis of Data

Table 2: Frequency of observation based on daily activities

Activities	No. of Observation
Fishing	18
Hunting birds/animal	11
Firewood/collection	16
Cattle grazing	11
Plant collection	14
Tree cutting	12
Poultry grazing	15
Collecting cattle feed	12
Cow dung collection	5
Collecting food	3
Extract sand	0
Others	1

The observation data which was collected during the field visits was categorized according to specific activities as show in Table 2.

Results and Discussions

Agricultural Production

There are three major rice crops in Bangladesh: Aus, Aman and Boro. Of them, Boro is the main form of production in the haor area, while Aus and transplanted Aman are almost universally found on highland and medium highland floodplain ridge soils. Aus are widely transplanted in this wet region; elsewhere, sprouted seeds are shown on wet puddle soils. Most such land remains fallow in the rabi season. With irrigation, HYV Boro is followed by rain fed transplanted Aman.

On lower land, mixed Aus and Aman or deepwater Aman are the traditional practices on basin margins, with local Boro paddy or grass land (used for dry season cattle grazing) in basin sites. With LLP irrigation, the area under Boro paddy, mainly early maturing local varieties, has greatly expanded in the past 30 years, thus considerably reducing the area formerly under grassland and reed swamp. Rabi crops such as vegetable, spices, sweet potato, potato, pulses and mustard are mainly grown on loamy-bank soils [8].

Goods, Services and Economic Values

The haor system provides a wide range of economic and non-economic benefits to the local people as well as to the people of Bangladesh and the world at large. These include benefits in terms of fish production, rice production, cattle and buffalo rearing, duck rearing, collection of reeds and grasses, and collection of aquatic and other plants. The haor system also protects the lower floodplains from flash floods occurring in the months of April-May, recharges the water tables, maintains the supply of fish in other lower riparian water bodies, provides habitat for migratory and local waterfowl, and generates important carbon sequestration services.

Natural Resources

Fisheries

Haors and Floodplains in Bangladesh are important sources of fisheries resources for the country. Kalibaus, Boal, Rui, Ghagot, Pabda and Chapila are the main fish species of the Haor.

From the Kushiyara there are frequent upstream movements of fish towards the beels and tributaries of Hakaluki. Beels in Hakaluki haor are important for fisheries. They provide the winter shelter for the mother fisheries, and in early monsoon these mother fisheries produce millions of fries for the entire downstream fishing communities. Consequently, protection of these fisheries not only benefits local people, but also all the people in the lower floodplains.

At the same time it important to note that each of these beels also provide a natural habitat for different species of fishes. However, many of the beels have lost their capacity to provide shelter as mother fisheries, and hence are subjected to severe degradation due to a) sand deposits from upstream rivers and canals, b) using complete dewatering technique for fishing activities and c) absence of aquatic plants to provide feed and shelter for parent fish [9].

Most of these beels are leased out by the Government of Bangladesh for fishing activities for at least a period of three years, with provision for renewals. Each beel has a surrounding land area known as kanda where reeds and swamp forests used to exist in the past. Over time, human pressure, encroachment and also land allocations by the government to the landless has reduced the reed and the swamp forest area which provided shelter and feed for fish during the monsoon.There are claims that under the current practice of land leasing, Hakaluki haor is in danger of losing nearly 32 fish species out of 107 because of over fishing by the lessee. This is a serious threat to fish stocks in the haor.

Waterfowl

Hakaluki haor is a very important resting place for migratory waterfowls flying in from the north.The most interesting species is the Barheaded Goose, which is now very rare in fresh water wetlands. Other important species include Adjutant Stork, Bear's Pochard, Falcated Teal,

Broadbill Sandpiper, Spotted Redshank, Nordmann's Greenshank, Temmiinck's Stint, Steppe Eagle and Osprey. In a survey conducted under FAP 6 in 1994, 64,000 waterfowl were counted in Haorkhal and 15,000 waterfowl were counted in Chatla beel. Illegal poaching has been a threat to the waterfowl population.

Vegetation

Ecological characteristics, particularly vegetation patterns, differ sharply between the permanent and seasonal water bodies in Hakaluki haor. Within the permanent water bodies, vegetation is less dense in the monsoon than in winter, since the vegetation becomes submerged and does not thrive without light. However, the aquatic vegetation that exists begins germinating with the onslaught of the monsoon floods. Aquatic vegetation occurs mainly in the shallower parts of the Haor. Other than the shorelines (kanda), most of the open water areas are weed-free [10].

Problems in Hakaluki Haor

1. Serious reduction of fish habitat, fish population and diversity;

2. Extinction and reduction of wildlife including birds and reptiles;

3. Extinction of many indigenous varieties of rice with the propagation of high yielding varieties;

4. Loss of many indigenous aquatic plants, weeds and shrubs;

5. Loss of natural soil nutrients;

6. Loss of natural water reservoirs and their resultant benefits; and

7. Degeneration of wetland-based ecosystems, occupations, socio-economic institutions and cultures.

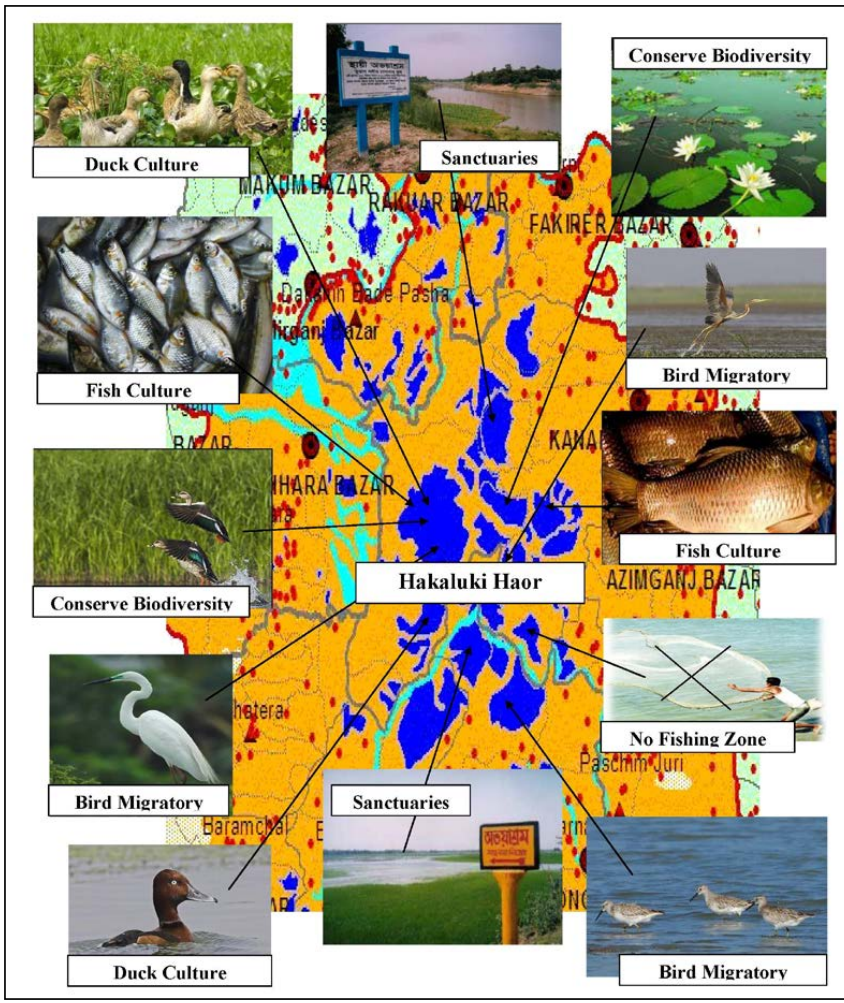

Figure 2: Some zones are divided according to reserve places for preserving species in hakaluki haor

Suggestions for Development of Wetland Conservation

1. Re-Excavation of Beels and Canals
2. A Permanent Wetland Sanctuary
3. Plantation in Haor area
4. Awareness building
5. Household Energy from poultry waste
6. Women Empowered
7. Making Local Governance work for wetlands
8. National Resources (NR) planning at local level

The region's wetlands contribute to the livelihood of a high percentage of the local community through floodplain agriculture, open water capture fisheries, swamp forest plant products, domestic water supply, and provides a means of transportation and communication.There are various systems used in the region to guide the exploitation of the resources. Jalmohals are leased out under the guiding principles of nitimala. This approach is based on a peoples-participatory approach to fisheries resource management. Mosque-based hijal forest management involves local participation in management of community forests and reflects the concept of sustainable resource utilization. People's participation involves community action and, particularly in the context of the wetlands, needs to ensure that the poorest of the poor have an effective role -- in choosing social actions, in implementing decisions, and in deriving equitable benefits from the programmes. Specific areas in which there is an urgent requirement for public participation needs to be engendered are:

1. Lowland floodplain /haor forest management.
2. Sustainable utilization and protection of wetland weeds and wildlife.
3. Integrated management of wetland ecosystems.

People, in and around these wetlands, have evolved indigenous management systems. The involvement of local people in wetland management is of prime importance since they are an active part of the ecosystem.

Conclusions and Recommendations

Conclusions

Following conclusions have been drawn from this study:

1. There is a continued strong local demand for wetland resources and their market values remain relatively high. The increasing harvesting pressure on fisheries has already pushed the systems beyond sustainable levels resulting in the decline of overall production.

2. There are many beels and canals which are not enough deep to fisheries, so it very important to deep the beels and canals that in dry seasons there are much water which can use by villagers for irrigation purpose.

3. Limited opportunities for alternative sustainable livelihoods, lack of alternative sources of fuel wood and fodder, poor enforcement of fisheries and wildlife protection act as key causes of biodiversity loss at the Hakaluki Haor site.

4. The other important causes of wetlands degradation in Hakaluki Haor area are inadequate information on status and functioning of critical ecosystems and no effective management authority at field-level.

5. It should also be noted that the Hakaluki Haor has already been degraded from overuse, loss of water body connections, water diversion, and pollution, conservation to boro rice and sedimentation form mismanagement of the surrounding watershed. This means that the condition of wetland would be much endanger for biodiversity conservation.

6. There is not enough co-relation between the Government and Non-government institutions which work in Haor area. So it's very important to take steps for developing their present situation.

Recommendations

In view of the fact that local communities are yet to achieve sustainability as regards their livelihood as well as the environments they live in currently, the following recommendations are forwarded for further implementation considerations by all concerned local people:

1. A small part of wetlands should be protected to restore fisheries. A good target sanctuary area is about 5% of the dry season water area and permanently set a site from use to regenerate wetland productivity and biodiversity (fish, birds, plants).

2. Excavation to deepen beels, canals and baors that makes fish shelters there, and where short closed seasons are followed in the wider wetland to allow fish to spawn and repopulate.

3. Government should ensure cooperation between NGOs working in the same locality to maximize coverage of poor resource users linked with resource management.

4. The people living in the haor areas suffer a lot for want of roads. So the flood management work by putting embankments should be such that it can be usable throughout the year for communication, but does not disturb the wildlife.

5. In the name of agriculture and food production, draining out of wetlands should be stopped. The wetlands all over the country should be protected and preserved.

6. The life of the people in wetlands and its eco-system should be included in school textbooks for awareness of the children about this resource.

7. Rivers, canals, ponds, lakes, haors, beels, baors, and all other water bodies and resources should be kept free from pollution;

8. All sorts of leasing of wetlands or jalmahals should be stopped.

References

[1] M.Salar.Khan, Enamul Huq, Saleemul Huq, Helal Ahmed, 1994. *Wetlands Of Bangladesh,* Bangladesh Centre for Advanced Studies (BCAS 1994) in association with Nature Conservation Movement.

[2] Waliuzzaman, M., Haque, R., Ahmed, R. and Nishat, A., 2003. *Monitoring and Evaluation Guidelines for Community Based Wetland Resource Management,* IUCN Bangladesh (2003).

[3] Shuriya Farzana, Ainun Nishat, Mir Waliuzzaman and Rashiduzzaman Ahmed, 2004. *Community Based Haor and Floodplain Resource Management: The Gender Perspectives,* IUCN Bangladesh.

[4] Rashiduzzaman Ahmed, Md. Rakibul Haque and M. Saiful Islam Khan, 2004. *Introduction to Community Based Haor and Floodplain Resource Management,* IUCN Bangladesh.

[5] Junaid K. Chowdhury, 2005. *Plant Resources of Haors and Floodplains: An Overview,* IUCN Bangladesh.

[6] Thompson,P. and S.N.Chowdhury, 2004. *Experiences in wetlands co-management-the MACH project,* A Technical Paper, pthompson@winrockbd.org, snc@winrockbd.org, pp. 18-19.

[7] Junaid K. Chowdhury, 2005. P*lant Resources of Haors and Floodplains: An Overview,* IUCN Bangladesh.

[8] Ali L. M. and Thompson P, 2006. *Wetland Protection and Enhancement through Sanctuaries in Bangladesh,* MACH Technical Paper 4, Winrock International/BCAS/CNRS/CARITAS B, Dhaka, Bangladesh.

[9] Thomson, P. and Colvito, L., 2007. *Economic value of Bangladesh Wetlands,* MACH Technical paper 6. Winrock International, Dhaka.

[10] MM Rahman, A Begum, Ainun Nishat, Z Hossain, MK Roy, A Karim, 2010. Water development activities and their impacts on

wetlands, *Journal of Human Ecology, Freshwater Wetlands in Bangladesh: Issues and Approaches for Management*, IUCN- The World Conservation Union, pp. 23-32

[11] Ashitava Halder, M. Anisul Islam, 2012. *Co-management of the wetlands and it may contribute to the livelihoods of the poor people*, Center for Natural Resource Studies, A Technical Paper, a_haldarbd@yahoo.com; anis@cnrs.org.bd;

[12] AKM Khusrul Amin, MA Haque, M Alamgir, 2013. Analysis of the Wetland Degradation around the Vicinity of Dhaka City in Bangladesh, *Asian Journal of Water,* Volume 10, Number 2 / 2013, pp. 19-26.