Review Paper

Understanding the Changes of the Wetland Ecosystem and Its Impact on the Biodiversity of Tanguar Haor in Sunamganj

Abstract

In this paper, it is tried to reveal the changes on ecosystem and biodiversity of a unique wetland known as Tanguar Haor. The global importance of this wetland has made a declaration as the Second Ramsar Site of Bangladesh in 2000. On the other hand, it is also recognized as an Ecologically Critical Area due to gradually overexploitation and degradation consequences of its natural resources. It consists of diverse types of floral and faunal remains including fish species, wetland plant species, amphibians, reptiles, bird species and mammals. The fisheries, forest and land are the main resources of this critical wetland ecosystem. But unsustainable extraction and utilization of its natural resources are vital consequences to threatening the haor ecosystem. Over the time, the ecological balances and biodiversity have been changed due to the effects of flash flood, reduction of forest resource, extension of agricultural land, community control and exploitation, soil erosion, forest degradation, habitat degradation, water imbalance, unbalanced human interference, illegal poaching and government participation in resource management. This study focuses on evaluating the nature, ecological setting, ecosystem and biodiversity, rate of wetland changes, resource degradation and how these factors make an impact to people's livelihood and lifestyle in that area. Following a content analysis of past and recent literatures, reports, and empirical studies, the arguments illustrate the typical landscape changes over last 60 years of the biodiversity and critical ecosystem of Tanguar Haor area.

Keywords: Ecosystem, Biodiversity, Wetland/Haor, Tanguar Haor,

1. Introduction

Tanguar haor is a unique wetland ecosystem in Bangladesh that has been identified as an area of national and international importance and attention. The Government of Bangladesh has declared it as an Ecologically Critical Area in 1999 due to gradually overexploitation and degradation consequences of its natural resources. The global importance of this wetland has made a declaration as the second Ramsar Site of Bangladesh in 2000. It supports more than 140 species of fresh water fish and as many as 150 of an estimated total of 200 wetland plant species occurring in haor areas across the country. In addition, 11 amphibians, 34 reptiles, 206 bird species and 31 mammals are found in the area (Banglapedia 2012). This part consists of about 800 more than 100-year-old, pollarded Barringtoniaacutangula (hijal) and Pongamiapinnata (koroch) trees. The fisheries, forest and land are the main resources of Tanguar haor (Islam 2014). This haor basin consists of almost 10,000 ha area of land and also supports to more than 60,000 population for their livelihood (Albertsen 2012). It consists of diverse types of floral and faunal diversity especially reptiles, birds, fish species, amphibians etc. The setting with diversity plays an important role to remain the haor ecosystem (Choudhury 2016).

However, in some recent studies it is seen that some significant changes are occurring in the wetland ecosystem of Tanguar haor due to unsustainable extraction and utilization of its natural resources which is going to create an extensive threat to the ecosystem of the haor area, for example reed beds dominated by Phragmites karka have been severely reduced for collecting fuel and thatch, and the conversion of marginal wetlands for agriculture. Certain species of aquatic plants that were used to be common in the area, have now disappeared or become very rare, probably due to a combination of over utilization and changes in water quality (Mayor-gordove 2014). Also, the IUCN (2008) survey shows that 95% of the population depends on Tanguar haor for their livelihood/ survival and 81% receives household income from it.

In this article, it is tried to review, compare and present the changes in the wetland ecosystem of the Tanguar Haor at Sunamganj in Bangladesh over last (1955-2015) 60 years with an addition to the flash flood impact in Tanguar haor area in 2017. So, to understand the dynamic changes in Tanguar haor, various secondary sources and data from some empirical study reports, like published research reports of international journals, government reports, project reports of international organizations working at Tanguar haor, have been collected, studied and analyzed

on the basis of ecological setting, ecosystem and biodiversity, rate of wetland changes, resource degradation and on some other factors that are making an impact to people's livelihood and lifestyle in that area. The aim of this article is to present a comparative analysis of the changes in the wetland ecosystem and diversity of Tanguar haor for giving policy makers and researchers some valid ideas about the causes and effects of the changes with some recommendations so that the ecosystem and the biodiversity of Tanguar haor could be saved from future long term detrimental effects.

2. **Methods:** To fulfill the objectives of the paper, literature were reviewed to find out relevant data about Tanguar Haor as a secondary source. In addition, images and maps from different research findings were also collected to identity the Tanguar Haor from topographic map and satellite (Landsat) images so that it becomes possible to explore the trends of spatial changes of the Tanguar Haor.

3. **Study area:**

Tanguar Haor is situated in the northeastern part of Bangladesh, between 25_ 120 2.57200 and 25_ 50 47.98900 North Latitude and 90_580 49.42600 and 91_ 100 0.01800 East Longitude. The total area of Tanguar Haor is approximately 160 square kilometers including all Geographic features and land cover. It shares a border of approximately 17 km with Nongstoin (Meghalaya), India in its north. The Haor is almost 2.5 km away from neighboring Netrokona district in the west. Tanguar Haor possesses 88 villages. Fig. 1 shows the location of Tanguar haor and its surroundings. The haor is located at an altitude of only 2.5–5.5 m above mean sea level. The landscape topography of Tanguar Haor is uneven. Because of its bowl shape nature, it acts like a natural reservoir. The Haor consist of 46–50 beels of various sizes (BFD, 2012). Within 160 square kilometers 2802.36 ha is permanent waterbodies (Banglapedia, 2006). Total river area within the Tanguar Haor is 359.39 ha (Sobhan et al., 2012). Tanguar Haor act as the flood plain complex of Surma-Kushiyara river system. These two rivers are important tributaries of Meghna River and also connected with Dhanu, Baulai and Jadukata River through the extended floodplain of Tanguar Haor.

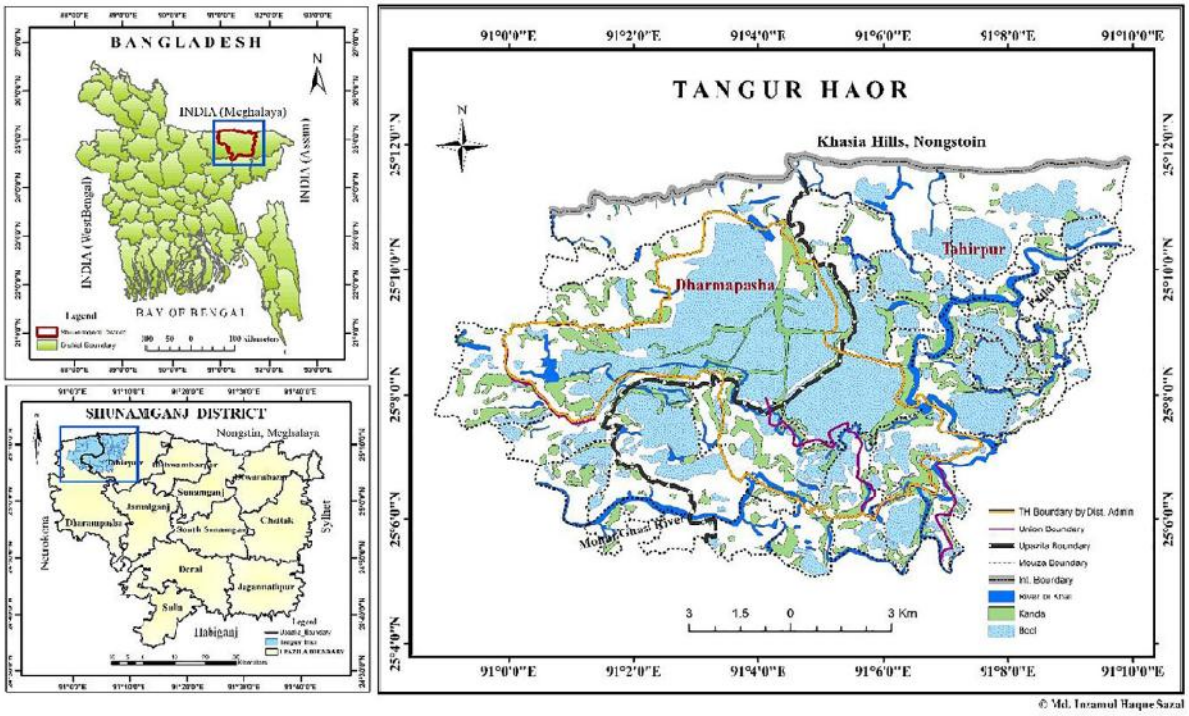

Figure 1: Map of Tanguar Haor, Source : Haque and Basak, 2017

4. Major Changes in the Biodiversity and Ecosystem of Tanguar Haor:

In this article major changes of Tanguar haor have been presented in two separate sections; firstly the changes in the biodiversity and secondly the changes in the ecosystem have been presented.

4.1. Changes in the Biodiversity: Variety

Over the time, the biodiversity of Tanguar haor area has been changed due to several reasons, including flash flood, community control and exploitation, and government participation in consider to resource management. It is facing overwhelming threats due to natural resource depletion, soil erosion, forest degradation, habitat degradation, water imbalance, unbalanced human interference and illegal poaching (Sobhan et al. 2012). Swamp forests that were once common at the haor, have now become very rare due to clearing, cutting and burning (Haque and Basak 2017). The current leasing system is seen as one of the major threats to sustainable management of the area, as it encourages maximum exploitation, and marginalizes the local community (Haque and Basak 2017). Forest areas have declined (BCAS 1997) from 18% to 5% since 1971 and most of these areas have been convened into agricultural land. Rapid population

104 growth is a common and most serious factor around Bangladesh which also extremely influences
105 this part of the country. During the last few decades, extensive agricultural activity has been
106 expanded in the Haor area which forces the Haor ecosystem to be a vast agricultural space. To
107 cope up with population pressure more and more settlement is built around the haor area which
108 directly and indirectly disturbs the wildlife specially the waterfowls and the fish habitats and
109 about 40% land cover of the total area has been converted over 30 years period (Haque and
110 Basak 2017).

111 Overwhelming use of agrochemicals e.g. insecticides, fertilizers made the condition worst too.
112 Flash flood is the most prominent natural calamities that lead to alter livelihood by disrupting
113 agricultural production and ecosystems, enhancing water pollution, destroy local road network
114 that critically hamper poverty alleviation strategies and local economy (DeClerk et al. 2006).

115 ### 4.2. **Changes in the Ecosystem: Community**

116 Ecosystem refers a setting of living organisms and nonliving components, which includes plants,
117 animals, and people and their environment. It addresses the interactions between organisms and
118 their environment as an integrated system. In Bangladesh, the wetland ecosystem is identified as
119 a floodplain ecosystem having a crucial natural resources. A floodplain is a kind of ecosystem
120 that is seasonally inundated and dried (Bayley 1995); it is also called a “flood-pulse” ecosystem
121 (Junk et al. 1989; Bayley 1995).

122 Forest and fishery resources are critical components of wetland ecosystems. But ecosystem
123 cannot be identified as specific or static entity rather it has dynamic characteristics. Living and
124 non-living organisms vary from year to year due to ecological attribute and function. The regular
125 changes make an effect on the ecosystem processes into a longer-term changes that also shape
126 ecosystem processes. These changes alter the structure of populations, communities, and
127 ecosystems and cause changes in resources availability or the physical environment. As a result,
128 the wetland ecosystem of Tanguar haor basin has been changed having numerous actions by the
129 inhabitants and their access and exploitative nature to the environmental components.

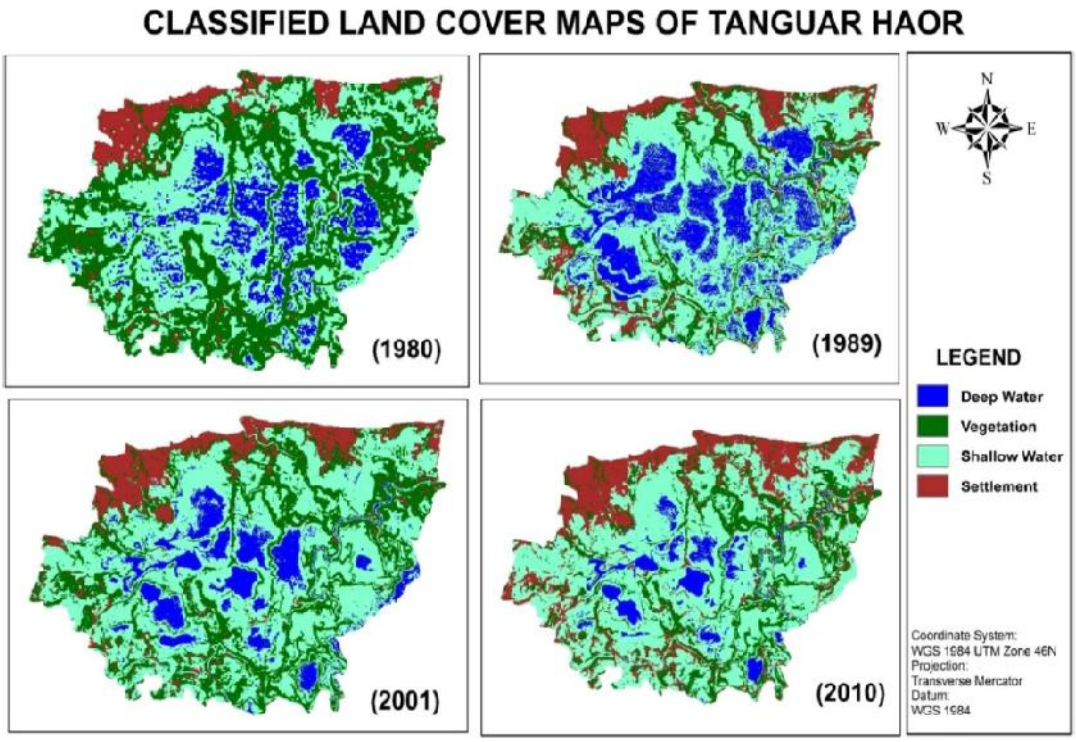

Figure 2a: Classified land cover maps of Tanguar Haor (1980-2010) Source: (Haque and Basak, 2017)

Table 1: The forest areas have declined /The conversion of marginal wetlands for agriculture:

Year	Area (ha)	Lost Area from 1955 (ha)	Percentage of Lost from 1955
1955	23230	-	-
1975	19000	-4230	-18.20 %
1995	14000	-9230	-39.73 %
2015	10360	-12870	-55.40 %

Source: (Hussain and Islam, 2017)

Both the tables explained the total change scenario between past and present time with the transformation statistics of each class. From the table 1, it is clear that 55.40% area (ha) have lost between the years of 1955 and 2015. In table 2, in the case of Settlement class, around 77% of initial settlement (1980) remain the same class in the final state (2010). Moreover 21% of vegetation converted into settlement in the final state and approximately 13% of shallow water changed to settlement in the final state. The image difference row shows the direction or behavior of change. Negetive values indicates decrease and positive values indicates increase in land cover feature.

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145 Table 2: The Percentage of Ecological Changes in Tanguar Haor from 1980 to 2010

	Initial state (1980) Percentages(%)						
Final state (2010)		Deepwater	Vegetation	Shallow water	Settlement	Row total	Class total
	Deepwater	28.707	0.397	6.175	0	99.964	100
	Vegetation	0.613	35.768	7.473	13.542	99.748	100
	Shallow water	69.825	41.766	73.327	4.304	99.816	100
	Settlement	0.836	21.34	12.586	77.357	99.795	100
	Class total	100	100	100	100	0	0
	Class change	71.293	64.232	26.673	22.643	0	0
	Image diff	-49.071	-52.899	33.582	140.789	0	0

146 Source: (Haque and Basak 2017)

147 #### 4.2.1. Plants and Trees:

148 Forests in the wetland area of Bangladesh, especially in Tanuar haor, are typically flooded forest
149 or swamp forest locally called Hijol-Koroch Bak. Most commonly found tree species are locally
150 called Hijol (Barringtonia acutangula), and Koroch (Pongamia pinneta). A study conducted by
151 CNRS (2013) on the current state of swamp forests in wetland areas of Sunamganj district found
152 that there were around 42,670 Hijol and Koroch trees in 12 forests at the initial period whereas
153 currently there are only 2,336 Hijol and Koroch trees.

154 According to Information Sheet on Ramsar Site (RIS) – Swamp forests that were once
155 common at the haor, have now become very rare due to clearing, cutting and burning and human
156 activities of overexploitation and damages of natural resources based on their need. It is evident
157 that the haor area consists of about 800 more than 100-year-old, pollarded Barringtonia
158 acutangula (hijal) and Pongamia pinnata (koroch) trees and reed beds dominated by Phragmites
159 karka have been severely reduced in area because of collecting for fuel and thatch. Moreover, the
160 increasing percentage of agricultural land has an effective factor in conversion of wetlands.
161 Certain species of aquatic plant that were common in the area, have now disappeared or become
162 very rare, probably due to a combination of overutilization and changes in water quality (Mayor-
163 gordove 2014).

4.2.2. Birds:

The wetlands of the northeast regions are worldwide famous for being the habitat of migratory birds. The Ramsar Convention on Wetlands of Importance, especially as Waterfowl Habitat was the outcome of an international meeting in 1971 at Ramsar, in Iran. This convention outlined specific criteria on water fowl count to declare a wetland of international importance. When the wetland regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity, it becomes a setting for the migratory birds. During Flood Action Plan surveys (1992) for the northeast haor areas, It was found that, only two sites out of them named, the Tanguar Haor and the Hakaluki Haor supported more than 20,000 waterfowls. But in recent years the environmental changes impacted upon the sheltering migratory birds. Due to biodiversity and ecological changes, migratory birds are become disappeared in compare to the previous availability. Moreover, the nature of hunting birds by people is also a cause of disappearances of these bird species.

4.2.3. Fishes:

It is evident that the amount of fish production of Tanguar haor is decreasing day by day due to degradation of swamp forest and some other fish species have also declined considerably. The estimated fish production of TH in 2008 was 6,500 MT (Ahmed 2012). But the fisheries resource is decreasing day by day including specialist bodies for changes on ecosystem (Mamun et al. 2013: 104). Swamp forests are natural sanctuaries for fish species, and other species, like birds. Branches of tress from swamp forest, usually branches of Hijol (Barringtonia acutangula) are used in water bodies (beel) to increase fish production (Choudhury 2015). Current fishing and crop cultivation practices of community people are affecting ecosystem structure and function adversely. Crop cultivation patterns and fishing practices are associated with the food web, and plant ecology. Peasants use various types of chemical fertilizers to increase production and insecticides for pest (invasive species) control, these over-used chemicals are considered as hazards for ecosystem. Current fishing practices are environmentally unsustainable because fishers tend to fish down the food web. Fishery resources are leased out through an open bidding policy where the main goal is revenue collection. To maximize profit, lease holders use destructive ways of fishing. Khan (2012) documents the fact that leasing policy is one of the causes of destructive fishing practices.

194 Table 3: Degradation of fish species

Critically endangered or near extinct: Fish species are put on this status which fishers do not or rarely notice.	Indian Mottled Eel (Anguilla bengalensis), Mahseer (Tor tor),Gangetic latia (Crossocheilus latius), Gongota Loach (Somileptes gongota), Pungas (Pangasius pangasius),
Vulnerable: According to fishers' knowledge, these fish species are comparatively less available	Zebra Danio (Brachydanio rerio), Catla (Catla catla), Bengal Loach (Botia daria), Walking Catfish (Clarias batrachus), Freshwater Shark (Wallago attu), Butter Catfish (Ompok bimaculatus)
Not threatened: According to fishers' knowledge, these species are available but declined in number.	Cuchia (Monopterus cuchia), Ocellated Pufferfish (Tetraodon cutcutia), Freswater garfish (Xenentodon cancila), Blue Panchax (Aplocheilus panchax).

195 Source: Field survey data, 2014 (Chowdhury 2015)

196 #### 4.2.4. Water Quality:

197 The rivers adjacent to the haor have also lost their water carrying capacity due to sedimentation.
198 Indiscriminate harvesting of mother fishes, use of agrochemicals, sedimentation on haor basin
199 and habitat destruction were found as major causes of fisheries resources degradation (Mamun et
200 al. 2013). During agricultural production, people use various chemical materials that makes an
201 effect to the water quality. Moreover, certain species of aquatic plant that were common in
202 Tanguar haor have now become very rare due to a combination of overutilization and changes in
203 water quality (Mayor-gordove 2014). It is also found that water pollution is a cause of fisheries
204 resource declination.

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4.2.5. Agrarian Fields and Reduction of Wetlands:

Rapid population growth is a common and most serious factor around Bangladesh which also extremely influences this part of the country. During the last few decades, extensive agricultural activity has been expanded in the Haor area which force the Haor ecosystem to be a vast agricultural space. In 1955, 1975, 1995 and 2015 the area of Tanguar Haor are 23,230 ha 19,000 ha, 14,000 ha and 10360 ha respectively. On an average, every year about 214.5 ha haor area has been lost from 1955 to 2015, which is 1.17% of the total haor area. At present the haor area is reduced to almost half of the total area as it was in 1955. During the last 60 years, spatial changes represents that the haor have lost 12,870 ha of water body. (Hussain and Islam 2017, 34).

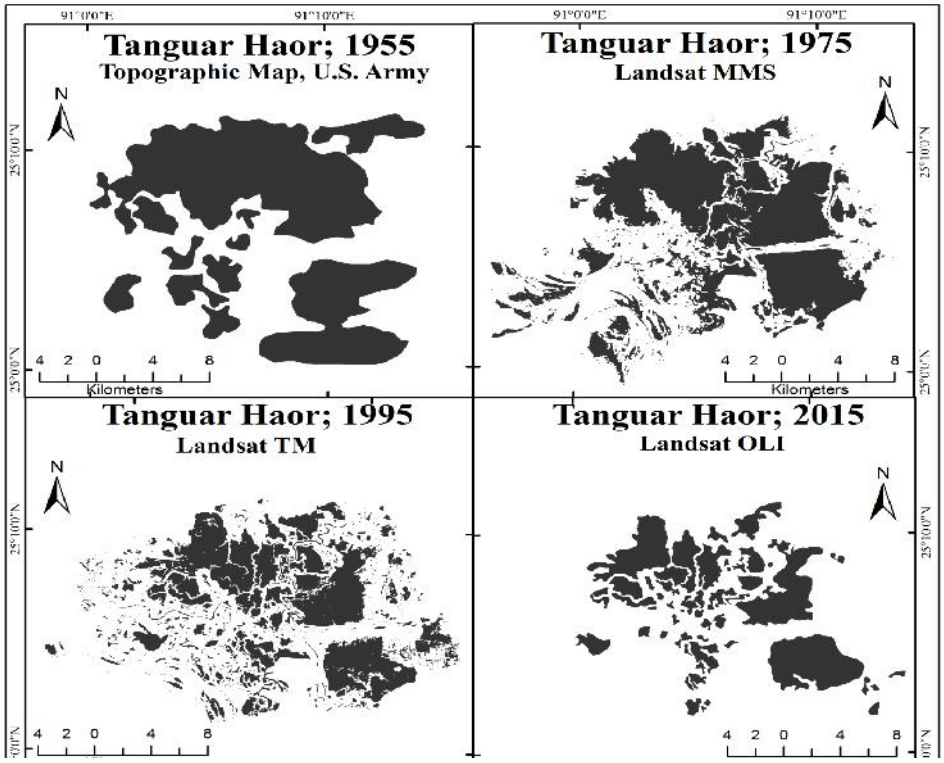

Figure2: Spatial Changes of Haor Area from 1955 to 2015, Source: (Hussain and Islam 2017)

4.2.6. Increased of the Human Localities:

The population has been increasing rapidly in the haor area due to socio-economic condition; as a result the economical use of haor land has been increasing (Hussain and Islam 2017: 40).

Due to increased pressure of population growth and density on natural resources, community people are degrading swamp forests, using unsustainable fishing and crop cultivation practices, which significantly erode wetland-social-ecological resilience. Population pressure results in increased pressure on forest for fuel woods, and encroachment of forest land for production purposes, including extension of agriculture and housing. To cope up with population pressure more and more settlement is built around the Haor area which directly and indirectly disturb the wildlife specially the waterfowls and the fish habitats. Overwhelming use of agrochemicals, including insecticides, fertilizers, made the condition worst.

4.2.7. The Changes of Livelihoods

Because of marginalization, exclusion and resources degradation, community people are taking different strategies to raise household incomes. The two main sources of livelihood options for the majority of the local people are fishing and crop cultivation (Choudhury 2015). The strategies taken by fishers' and peasants' households can be divided into two parts that are intrasectoral and intersectoral diversification. Intrasectoral diversification means diversification with the existing livelihood options (Salagrama & Koriya 2008).

Limited options exist for peasants and fishers for intrasectoral diversification. Such diversification also involves high risk, because if the crop is damaged by early flash flood, the loss would be severe. Paddy business is another strategy of intrasectoral diversification. Peasants having financial capital can normally afford this type of diversification. In this case, peasants typically buy paddy from other small and marginal peasants just after the harvesting period and sell them to big businessman with some profits.

On the other hand, fishing is one of the major livelihood activity as an alternative of agricultural work for the local people in haor area. But fishers are excluded from their customary rights of fishing due to the leasing policy, local power structure and exclusionary social-ecological network. As a consequence, fishers either opt for fish related business like buying and selling or the business of dry fish (Choudhury 2015). To opt for dry fish business, fishers need to invest large sum of money for buying fish, make a bamboo roof to dry fish and hire labor to process the fish. Another way of diversifying is to share fishing with lease holders. When fishers do not have any other option, they go for shared fishing, but may not get adequate remuneration. Lease

holders often ask fishers to catch fish for them. Payment for fishing is determined by lease holders, and is done on the basis of verbal agreement. But lease holders do not give a fair portion in such arrangement.

People tend to inter-diversify their livelihood options because of lack of limited options available for intrasectoral diversification and lack of capital. Fishers are involved in work with multiple sectors, like agriculture, day labor, fish business, and other self-employed occupations. People go to Bhulaganj to work at sand and stone quarries in consider to an alternate livelihood activity (Choudhury 2015). Apart from working in other sectors by community residents, community people often seasonally migrate to other places for work; though few households were bound to migrate permanently.

4.2.8. The Effects of Flashflood in Tanguar Haor

The north-eastern part of Bangladesh is most prone to flash flood hazards because these regions are low-lying and located at the foot-hills of Meghalaya mountain chain (Choudhury 2015). Overflowing of hilly rivers causes the flash flood that rises and falls rapidly, typically within a few hours or days, and most prevalent in the north-eastern part of the country (National Plan for Disaster Management 2010; Brammer 1990). This low-laying part consists of a bowl shaped depression containing many wetland areas, locally known as haor (wetland). Communities living in the Tanguar haor area rely upon a single crop in a year. Flash floods and early floods often cause significant volume of crop loss in this region. It is found that the percentage of damage is higher when there is an early flooding. For example, a report published by CNRS (2009) shows that percentage of damage is higher in March (75%) and April (70%-90%) compared to May (15%-40%). A report of Local Consultative Groups (LCG) Bangladesh (2012) indicates that around 318,000 people were affected by the 2012 flood directly or indirectly. But the recent flash flood in Sunamganj, especially in Tanguar haor area, has changed and affected on the wetlands ecosystem. As a consequence, water, agricultural land and bare soil have been damaged for the sudden flash flood in 2017 (Hossain et al. 2017).

Table 4: Changes in land cover in Tanguar haor before and after the flash flood in April 2017

Value	Km2	Before (%)	After (%)	Total Change
Water Body	67.77594	23.28	70.14332	46.87
Agriculture Land	139.3621	47.86	14.22841	-33.64
Bare Soil	84.02778	28.86	15.62827	-13.23
Total	291.1658	100	100	

(Source: Hossain et al. 2017)

The intensity and variability of flash flood is found to be linked with climate change. Hydrological changes, such as changes in the frequency and intensity of precipitation pattern are linked to global warming. Wetland-communities in Bangladesh, basically the people of Tanguar haor, are situated in the foot-hills of Meghalaya mountain chain. Annual precipitation pattern in the Indian state of Meghalaya has increased over the past hundred years but the numbers of rainy days have decreased (Jain & Kumar 2012); therefore, wetland-communities in Bangladesh are now at more risk of flash flood hazards than ever before. Flash floods play a dual role in shaping ecosystem services and affecting ecosystem as a whole. However, siltation has negative impacts on haor ecosystem in the long run, as such siltation gradually reduces the water carrying capacity of water bodies (beels) inside the haor and adjacent rivers.

5. Recommendations:

In this situation, the management and protection of this wetland ecosystem require an emergency attention from the concern bodies. Recommendations are required to:

(a) Prepare a master plan for the comprehensive development of haors integrating all sectors like water resources, fisheries, forestry, wetland and khas land distribution.

(b) Develop an early warning system for flash floods in the haor basin to reduce the extent of flood damage

(c) Plant hijal, koroch and other variety of trees to restore the ecological balance and protected homesteads from river erosion of the haor basin.

(d) Conduct more research on haor economy and ecosystem focusing on identifying the problems in different dimensions and discovering prospects in the corresponding fields for pragmatic and urgent policy implications.

(e) Comparative study with other people in other haors to share experience and other coping strategies in food security.

(f) To formulate and implement policies so that the Tanguar haor area and its biodiversity could be saved from all types of detrimental effects of ecotourism which is becoming very popular there now-a-days.

6. Conclusion:

Tanguar Haor is one of the largest wetland systems in the northeast region of Bangladesh and plays a significant role in the economy of Bangladesh with its natural richness and diversity. It is found that considerable changes have been prompting due to flash flood in haor basin, which destroy thousand hector of rice crop with agricultural land. Flood damage the rice production in the haor area and its lead to the negative impact on the food security and as well as the national economic condition.

On the other hand, it is also evident that a major impact has appeared on the biodiversity of critical ecosystem of the haor basin based on the changes of water bodies, vegetation, forest resource, alteration of land cover, fishery resource etc. The present condition of the ecological setting in Tanguar haor regime reflects that a remarkable change has been occurred making imbalances on the biodiversity. To conserve the Tanguar haor area and its ecological balances, the government of Bangladesh has been following several conservation strategies and plans for a long duration of time, but it cannot make a sound contribution to protect the environment and critical ecosystem of that area.

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