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Live and livelihoods in wetland waterlogging: Study from southwest Bangladesh

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ABSTRACT

Waterlogging is a major hazard that often underestimated even by scientists and policymakers because of its slow onset effects on environment and society. However, it habitually brings miserable sufferings for the communities living around low-lying wetlands, generally called 'Beel' in Bangladesh and primarily depending on the natural resources of those wetlands for their livelihoods. The study examines the causes of prolonged waterlogging in Bhutiar Beel situated in Khulna district of southwest Bangladesh and how this hazardous event impacts on the livelihoods of the communities living around the wetland. The study has followed a mixed approach through using both quantitative and qualitative methods for collecting empirical data with questionnaire survey, in-depth interviews, and focus group discussion. Besides, satellite images from Landsat MSS, Landsat TM and Landsat ETM of different years have also been analysed to identify how the territory and area of Bhutiar Beel has been shrunk over the last couple of decades. Apart from increasing fish production, the study explores that crop production has drastically been decreased and the cropping pattern has been changed due to the localized wetland based livelihoods. The present study, however, recommends community based action plans such as disaster risk management and wetland based natural resource management may assist policymakers to formulate appropriate policies for sustainable livelihoods in wetlands.

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Introduction

Bangladesh is well-known as one of the most vulnerable countries to natural hazards across the globe. Water sector of the country would likely be affected significantly due to anticipated changes (Ahmed, 1998; 2005). Most of the adverse effects of climate change are in the form of extreme weather events, while water related hazards such as floods and waterlogging are likely to be exacerbated (Asaduzzaman, 1997; Choudhury, 2005; Huq, 1996; Mohammad, 2016).

Waterlogging is the recent concern at the backdrop of climate change that becomes worsens in the southwest Bangladesh (Awal,

2014). The study argued that the prolonged waterlogging had caused significant displacement presenting humanitarian challenges in safe water supply, sanitation, shelter, food security, employment opportunity and so on. There are areas where people are compelled to live in waterlogged condition for nine months in a year; even many cultivated croplands are permanently inundated losing valuable agricultural production especially, the rice production. Socio-economic and agricultural activities have largely been hampered due to waterlogging (Adri, 2010; Islam, 2012). Lives and livelihoods of the people in the southwest Bangladesh are greatly influenced by water availability. Water resources offer enormous potentiality in this region by providing income and employment opportunity for most of the people. Conversely, water resources have particularly detrimental impacts on the peoples' lives and livelihoods as well as biodiversity and environment (Masud, 2014). The rivers of southwest Bangladesh are characterized by active deposition of sediment causing significant reduction in their drainage capacity.

The rural people are seriously facing devastation when peak monsoon intercepts the region. Loss of livelihoods due to submergence of land often forces male to go far away for weeks in search of alternative livelihoods. Rural women being the primary care giver of the family are compelled to live within the waterlogged premises, shouldering the entire burden for managing and cooking food, collecting drinking water, taking care of the family members and their livestock as well. Social demoralisation, diseases, unemployment and migration have increased in the locality where the places protracted by waterlogging (Ahmed, 2000; Awal, 2014; Neelormi, 2009; Salauddin, 2011; Sarker, 2012).

Besides, construction of coastal polders that de-linked the flood plains from the rivers, and diminished upstream flow during the dry season deteriorated the sedimentation problem in the region. Consequently, the area has been experiencing severe drainage congestion and water logging since the early 1980s. In Khulna and part of Jashore districts, 39 polders (about 410,392 hectares) were constructed (Unnayan Onneshan, 2006). Sedimentation in the tidal rivers in the moribund delta of Southwest Bangladesh is the main reason behind waterlogging problem. These troublesome sediments have blocked the rivers and caused upstream drainage congestion and flooding (Tutu, 2009).

Millions of people, especially the poor and landless farmers, sharecroppers, agricultural wage workers, petty traders and others lost their livelihoods because of waterlogging. Waterlogging induced salinity has already damaged almost all varieties of vegetation in the region. Agricultural production has drastically reduced and even homesteads vegetation and cattle rearing become quite impossible (Moni, 2014).

Waterlogging is a complex hydro-geomorphological challenge in Bangladesh. Waterlogging has created a dynamic change in Bhutiar Beel at Terokhada Upazila (sub-district) in Khulna district where this study was conducted. In the wetland, continuous waterlogging for the last couple of decades is mainly due to river bed siltation and intensive rainfall. About 13 square kilometres area is covered by this waterlogging at Bhutiar Beel. Massive amount of crops is damaged regularly because of waterlogging. It also destroys the fisheries sector, particularly local shrimp farms and natural vegetation.

Aim and objectives of the study

The aim of the study is to examine the causes and impacts of waterlogging in the study site and how the livelihoods of the communities living around the wetland affected. The specific objectives of the study are:

i. To explore the reasons behind creating waterlogging in Bhutiar Beel;
ii. To understand vulnerability conditions occurred in the wetland due to waterlogging; and
iii. To investigate how the lives and livelihoods of the communities living around the wetland affected by waterlogging.

Research methods

Study area

The study area is Bhutiar Beel situated at Terokhada Upazila in Khulna district. The drainage system of the wetland is directly linked with the Atharobaki-Chitra River basin. The wetland that constituted from Shachiadah, Chagladah and Terokhada unions of Terokhada Upazila drains to adjacent Chitra River (Figure 1). The river finally drains to Atharobaki River and Kaliabordia River. Presently Atharobaki River is partially dead due to siltation; however, Kaliabordia River is still alive. Nevertheless, 5,329 hectares croplands of Bhutiar Beel become waterlogged due to recent siltation of Chitra River. Bhutair Beel is situated the northeastern part of Khulna district. Field works were undertaken in each of the nine villages over which the wetland spread such as Balardhana, Adampur, Saciadha, Pathla, Kushlo, Noliarchar, Kamarol, Indurhati and Adalatpur in three Unions (e.g. Terokhada, Saciadha and Pathla).

Data collection

To fulfill the objectives of the study both primary and secondary data were used. Data were collected from both formal and informal interviews, and focus group discussion (FGD) with community people living surrounding the wetland. A semi-structured questionnaire was developed, pretested and adopted prior to the actual survey properly. The key issues incorporated into the questionnaire are: (i) present status of the various habitats under Bhutiar Beel; (ii) fish biodiversity; and (iii) causes of habitat and biodiversity degradation and their possible mitigation measures. A total of 80 stakeholders including fishers, fish farmers, Upazila fisheries officers, local leaders, school teachers and housewives participated in this study. Nine FGD sessions were conducted in nine villages of Bhutiar Beel. The characteristics of the stakeholders were including the nature of any primary dependency on the wetland. Stratified scatter sampling was used for questionnaire survey. All the respondents have more than 20 years' experience on agriculture.

Data analysis

The spatial data has been analysed by using some GIS software namely ArcGIS 10.3 and statistical analysis by MS Excel. Finally, the both types of analysed data have been integrated and presented as maps, tables and graphs in the Study.

Results and discussion

Changes in the size and shape of the wetland basin

Earlier waterlogging in the wetland was a normal situation. During the dry seasons the wetland was used to dry out. Around 3.63 square kilometres that is the core point of Bhutiar Beel was deepest part of the wetland that was full of water year round (Figure 2).

That was the lower part of the basin. But after waterlogged the shape of the basin were changed. The area of deepest part also changed. Nowadays an area about six square kilometers of the wetland is inundated round the year. It seems to be a radical change of the shape and size of Bhutiar Beel basin. Waterlogging has made a dynamic change in the basin. This also affected the crops land around the wetland. These are the main causes for reducing crops production in this area.

Changes of soil quality

In the past, most of the area of the wetland was dried every year during the summer season. Then the farmers ploughed the land and harvested several rice varieties such as Aus, Aman and Boro. After some months, in rainy season the wetland again turned into a basin with full of water. It helps to maintain a balanced wetland ecosystem. Then water submerged the soil of the wetland only few months. Rainwater drained with sediments and other soil nutrients into the wetland which helped the local farmers to produce a variety of crops and vegetables round the year. But now the scenario is totally changed. A substantial part of the wetland is submerged round the year. It has a great impact on soil quality of the wetland. As the water cannot dry any time of the year, soil cannot be close to the atmosphere. So, soil cannot contain sufficient oxygen, nitrogen and other essential

micro-elements which come directly from the atmosphere. Besides, sunlight cannot reach on the surface of the wetland. Waterlogging, however, creates favourable environment for growing of some water loving plants like water lily, lotus, water hyacinth and different types of darnels. The dead parts of these plants mix with the surface soil of the wetland. Thus, the soil quality of submerged surface of the Bhutiar Beel has been changed.

Fishes

Fisheries is one of the main means of the people living surrounding the wetland. However, a fish catch monitoring programme was introduced in the wetland area in 1997 through Community Based Fisheries Management (CBFM) Project. The project focused on developing community based approaches which would encourage participation of community people, particularly the fishers in sustainable fisheries management. The study explored the amount and varieties of fishes have increased from the past. According to the local authority, "due to waterlogging, water is available year round in the wetland. It helps for the production of fishes. Present varieties of fishes increased as well as the total amount. In the past, the wetland was dried out during the summer. Then most of the fishes were caught by the fisherman, farmer and even by other common people. So, the growth of most fish varieties is hampered. Some of them were relieved for the next generation. Some small fishes were grown enormously because they hatched on the dried field. Some of the varieties are Koi (Badis), Taki (spotted snakehead), Shing (torrent catfish), Puti (Pool Barb), roina (mottled Nandus), Khalisha (banded gourami), Shoil (striped snakehead), Gojal (butter catfish), Tangra (Tista Batasio), etc. Now many fishermen live their livelihood by catching fish through Bhutiar Beel. The inland fishery of Bangladesh is considered the most important aquatic resource of the country. How much of fish are being caught every year by the fishermen and how much money they get from this profession?

Croplands and cropping pattern

Unlike fish production, the croplands of Bhutiar Beel have decreased with apprehension rate. Before waterlogging the whole area was under cultivation. But now about 25-30% land are used as cultivable land. Most of the farmers have changed their occupation. They diverted their occupation and some of them lead hand to mouth life. Waterlogging of Bhutiar Beel also shrunk the crop land.

Cropping pattern does not exist in the wetland which was continued in the past. Waterlogging has brought a radical change in cropping pattern. In the past, the whole area of the wetland was used to produce Aus and Aman rice varieties. The production of Aman rice was very good. The farmers were very happy because they more production of crops made them well off. But they became poorer because of lack of agricultural land. Waterlogging has brought about a huge change in crops production and pattern. Most of the upper land is not suitable for Aman production. So they have to change their cropping pattern and the local farmers have to switch from one crop to others. The study also found that the production of other crops is not well than the before.

Flora and fauna

There have been a comprehensive changed in flora and fauna at Bhutiar Beel. As the wetland maintained alternately a wetting and drying cycle is suitable for growing and living a diverse nexus of flora and fauna. Nowadays the wetland does not get dry up even in winter due to waterlogging. About 60-70% of the total area of the wetland is submerged round the year. Thus, some new types of flora and fauna grow. The plants which can grow in water and can live on or under water are available in Bhutiar Beel such as water lily, lotus, water hyacinth, and different types of darnels.

Availability of birds

The numbers of birds have increased due to waterlogging in Bhutiar Beel. The number of local birds has increased as well as a substantial number of migratory birds are available. The wetland is full of many types of small fish and

insects which are being used as feed of birds. On the other hand, different type of water plants and darnels helps birds to make their nest.

Level of water

The average water level has been increased due to waterlogging. Every year in rainy season, floods occur in the wetland. Floods regularly damage shrimp farms surrounded by the wetland. On the other hand, some crops are cultivated around the side of the Bhutiar Beel. But sudden flood hampers these crops. In the past the water level was very low which was suitable for crop production and shrimp culture. But, nowadays, high floods hamper the local livelihoods and put the communities at risk.

Impact of waterlogging on livestock

There were around 3,000-4,000 cows rearing surrounded villages of Bhutiar Beel and primarily depended on the wetland for their fodder. Nowadays grass cannot grow properly in submerged areas. Although some water grasses grow, the production is low and cattle do not like to eat them. Meanwhile, the price of industry based fodder is gradually increasing. As a result, traditional dairy farmers are reducing their cows and searching alternate way of living.

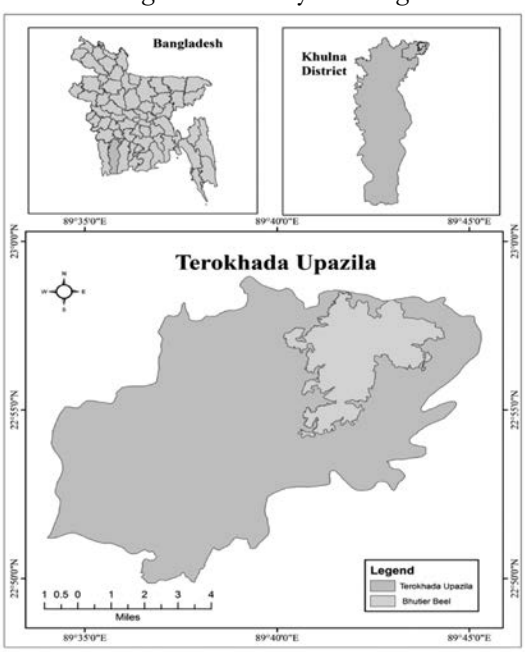

Figure 1: Map of the study area

Waterlogging and community vulnerability

The associated communities are directly affected by waterlogging of Bhutiar Beel in many ways. This study has a special emphasis on to find out the relation between waterlogging and surroundings community. This study found that waterlogging has many type of impact on associated community. Waterlogging has created many social disruptions like children school dropout, housing, healthcare, drinking water, sanitation and hygiene, market facilities, women's mobility and so on. The opportunities of paid work e.g. reduced crop production, transport disrupted, stifled non-farm activities are gradually declining. In agriculture sector, depressed Aman season production; possible reduced yield and returns from Boro. Conversion of crop land to shrimp farm has great impact on localized livelihoods. Earlier sharecroppers could produce rice by leasing or rented lands from others but after introducing shrimp farming this group of landless sharecroppers have no choice to either work as wage labourers in shrimp farms or migrate outside their localities. Such observation has already been addressed in a number of previous studies, for example, Mohammad (2016). The findings of FGD sessions indicate that there are some other direct impacts of waterlogging in terms of increasing community vulnerability such as shrunk crop land, reduction of crop production, particularly rice, jute, wheat, sugarcane, etc., unexpected floods, loss of plants, shrimp culture and other fisheries, and increase of poverty and malnutrition.

Causes of waterlogging

There are many causes of waterlogging in Bhutiar Beel. However, the main cause is inadequate drainage system. Velocity of river water is very low. It increases the pattern of siltation on wetland bed and decreases the drainage capacity. Over the period, the natural drainage system has been collapsed and created waterlogging in the wetland.

Intensive rainfall is another main cause of waterlogging of this wetland. From FGD session,

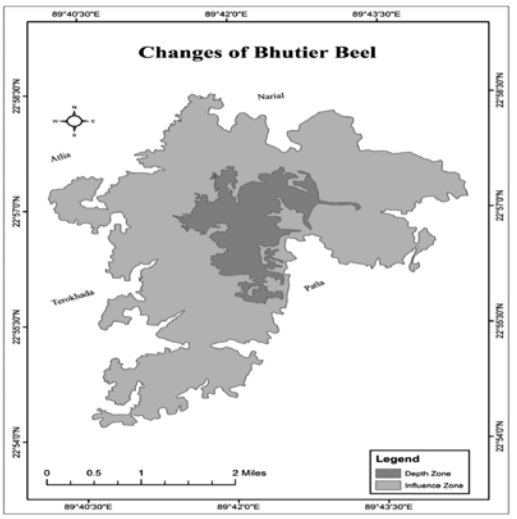

Figure 2: Changes between before and after waterlogging of Bhutiar Beel

heavy rainfall of July 2015 turned it into flooding and became a permanent waterlogging scenario. About 81% of the respondents considered intensive rainfall as one of the main causes of waterlogging of Bhutiar Beel. Sometimes water from linked wetlands accelerates the situation of waterlogging. Besides, river tides play a vital role increasing the water level of Bhutiar Beel.

Impact of waterlogging

Almost all respondents (95%) opined that waterlogging has negative impact in every aspect. Most of the farmers lose their valuable land. At present it is very challenging to maintain their livelihoods. However, a little number of the respondents (5.0%) gave positive answer because they are fishermen.

Waterlogging of Bhutiar Beel declined crop production around 1,300 ha land (Table 1). Like the rest of the country, rice is the main crop of this wetland mainly Boro. Earlier Aman was famous variety of rice of this Beel. Jute, wheat and sugarcane etc. also produced in this area. Nowadays the economic condition of most of the local farmer is miserable.

Table 1: Impact of waterlogging

Types of impact	Parentage (%)
Declined crop production	100
Damaged shrimp culture and pisciculture	76
Shrunk cultivable land	85
Create unusual flooding	64
Affected livelihoods	93
Impact on natural vegetation	57
Others	12

Many shrimp farms were prepared in Bhutiar Beel during mid-80s and early 90s of the last century. After waterlogging the wetland inundated every year. So farmer cannot continue the loss; they stopped it. This waterlogging also destroyed all types of pisciculture. It has a negative impact on our national economy. The land which was the main resource of their economy is now inundated. The impact of water logging is immeasurable.

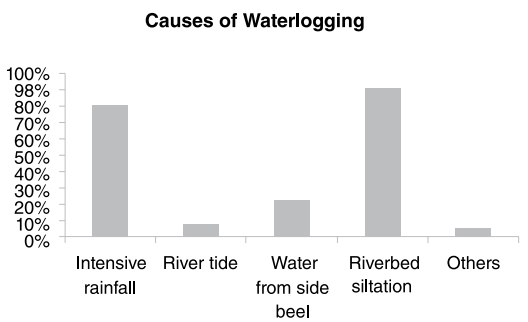

Figure 3: Causes of waterlogging

Waterlogging and changes of land use pattern

Waterlogging has direct impact on local land use pattern. To explore the actual condition of this study area, satellite image analysis has been done and for that reason three satellite images have collected and interpreted with interval of 20 years (1973, 1995 and 2015). Waterlogging shrunk the cultivate land. At present the amount of cultivate land is 820 acre which was 3,417 acre in 1995. Water body contains 4,541 ha at present and it was 752 in 1995.

In 1973, estimated agricultural land in Bhutiar Beel was 28% (Table 2). In that time a substantial area of the wetland was useable for agriculture (Figure 4). It is observed from the map that there were few deepest parts of the wetland. The amount of core water body of the

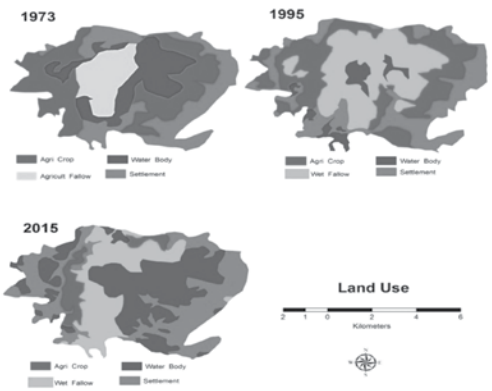

Figure 4: Satellite image analysis of 1973, 1995 and 2015 (**Sources**: Landsat MSS, Landsat TM, and Landsat ETM)

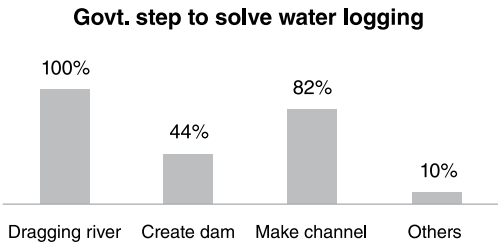

Figure 5: Causes of waterlogging

wetland was 21.83%. Aman rice was cultivated about total area of the study area. In the side of the wetland rest of highland are shown in that map. That represent the residential areas and some are cultivated over the year.

In 1995, the agricultural land (28.39%) was slightly increased whereas amount of water body (6.25%) was dramatically declined compared to 1973. However, the deepest part of the wetland also increased. The amount of Wet fallow land (34.08%) increased very rapidly whereas cultivable croplands decreased at the same time.

In 2015, waterlogging situation has changed the land use pattern of Bhutiar Beel. Around 37% of the

Table 2: Land use data of Bhutiar Beel in 1973, 1995 and 2015

Name of the villages	Year	Water body	Agriculture fallow land	Agriculture cropland	Settlement	Grand total
Atlia	1973	218	584	698	608	2108
	1995	56	916	345	787	2104
	2015	628	821	143	529	2121
Chamta	1973	177	0	308	407	892
	1995	1	273	295	270	839
	2015	381	0	0	515	896
Joy Sena	1973	150	0	0	490	640
	1995	0	87	207	358	652
	2015	219	0	59	374	652
Kamarol	1973	1134	39	1118	1256	3547
	1995	76	1170	1066	1179	3491
	2015	1459	522	128	1475	3584
Patla, Nachunia & Gobindapur	1973	868	1023	1270	844	4005
	1995	572	1504	1310	618	4004
	2015	1672	1360	204	839	4075
Terokhada	1973	99	111	0	717	927
	1995	47	152	194	553	946
	2015	182	72	286	406	946
Grand total	**1973**	**2646**	**1757**	**3394**	**4322**	**12119**
	1995	**752**	**4102**	**3417**	**3765**	**12036**
	2015	**4541**	**2775**	**820**	**4138**	**12274**

total area of the wetland became water body. Not only low land it also submerged the major portion of the high cultivate land. 60% of the wetland is covered by water over the year. The rest of 40% is also covered by water for about 10 months of the year. Aman production is totally destroyed. Water also shrunk the Boro cultivated land. About 80% of Boro cultivation reduced for waterlogging.

Government initiatives to address waterlogging

The government has taken some steps to solve this problem. Dredging the Atharobaki and Chitra Rivers is the big government project in this area (Figure 5). Most of the respondents are concerned about the project activities. Although the local government institutions have taken some steps like building earthen dams and cutting channels, they created many dams around the wetland that may stop water flows from the surrounding wetlands. They made five channels which may discharge water from the wetland.

Figure 5: Government steps to solve waterlogging problem

Are the government initiatives sustainable?

When this question was asked to the local farmers, 76% of them gave negative voice. But most of them said that "these activities will solve the problem for a short time. After 1-2 years we will face this problem again". They argued dredging rivers and wetlands was an expensive option and drained public money into inappropriate solutions. Besides, dredged soil is often piled off along the riversides and within few months the soil slop down on river bed. Such activities hamper riverine and wetland ecosystems. On the other hand, rest of 24% of the respondents agreed to dredge works and canal cut in immediate actions but they also claimed that we looked for a sustainable solution. When it was asked about what the sustainable solution is, they simply replied that we should accumulate both scientific and local knowhow but we should sincerely consider phenomena such as river morphology, wetland and riverine ecosystems, local lives and livelihoods.

Conclusion and recommendations

Exploring the best adaptation practices are time demanded with the prevention and mitigation of waterlogging in the region (Awal, 2014). Local government institutions (LGIs) like Union Parishad and even Upazila Parishad have few options to solve the issue. However, both LGIs take some immediate actions to help affected people. Nonetheless, the concerned Upazila Parishad pursued to the central government taking permanent solutions through the relevant departments. An appropriate coastal zone water management policy can guide the local level practitioners taking sustainable solutions.

Farakka Barrage reduced the water flow of Padma River and her tributaries (Kawser & Samad, 2016) and that has a direct impact on wetlands of southwestern Bangladesh like Bhutiar Beel. Water velocity of the Chitra and the Atharobaki Rivers is very low which increases the riverbed siltation. Finally, interrupts on water discharge from Bhutiar Beel creates waterlogging. The study has already highlighted that a substantial number of farmers ware losses their cultivable lands in Bhutiar Beel. Local initiatives especially by the LGIs failed to solve the problem. Thus, continuous and sustainable channelization of river flows is a main solution with the special attention to societal issues like local lives and livelihoods. Appropriate policies such as coastal zone water management and wetland management will guide local practitioners to implement sustainable community based projects and programmes. Then we can hope the communities, particularly 6,000 marginal farmers in Bhutiar Beel protect their cultivable lands from waterlogging.

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