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# Consequences of climate change on fish diversity in Dekhar Haor Bangladesh

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**Abstract**
The study has explored the implications of climate change on fish biodiversity as experienced by the local people of Dekhar Haor. It also expressed the local community's perceptions about the manifestations and consequences of climate change. In the study area, about 77.5% of people were involved with full-time fishing and 16.3% with part-time fishing. About 78.33% respondents thought that the weather has changed abruptly within the last 10 years. The study showed that the first and foremost factor is high temperature (100%). Considering biodiversity aspects, a total of 63 species under 20 families were found during the study period whereas 80 fish species under 29 families found 10 years back. The species availability status was remarked in four categories and obtained as 22 species highly available, 25 species moderately available, 16 species very low in availability and 17 species are not available. Alteration in several climatic factors like temperature, rainfall, increased drought, siltation and early flood caused overall 21.25% fish biodiversity loss where 16.67% carps, 27.27% catfishes, 10% barbs and minnows, 20% snakeheads, 20% eels, 23.08% perches, 50% featherbacks, 33.33% loaches and 16.67% miscellaneous species have been lost over a decade. Climate change in Dekhar Haor resulted in a shift to the breeding season, reduced fish biodiversity, wide variations in fish growth and taste.

**Keywords:** Climate change, climatic factors, fish diversity, Dekhar Haor, Haor community

## 1. Introduction
The vulnerability of the fisheries sector in Bangladesh is very much linked to the climate change effects due to the dependency on the fisheries sector for her economics, diets and socioeconomics. Climatic changes affect natural and human systems independently or in combination with other determinants to alter the productivity, diversity, resources, functions of ecosystems and livelihoods [1, 2]. Therefore, the effect of climate change will not only depend on the climatic changes themselves in that area but also ecological, social and economic factors [3]. Climate change is likely to affect adversely both the freshwater and marine fisheries in Bangladesh. It may directly affect fishery production along with many pathways [4]. Temperature, rainfall and hydrology all affect fish reproduction, growth and migration patterns [5, 6].

Climate change has both direct and indirect impacts on aquatic biodiversity which are exploited commercially [7]. Brander (2007) identified that the direct effects of climate change act on physiology, behavior, growth, reproduction, mortality and distribution and the indirect effects alter the productivity, structure and composition of the aquatic ecosystems on which fish depend for food and shelter [8]. Climate change stresses will have complex pressure on fisheries and aquaculture and threatened the fish production and livelihood of the communities. These changes have major consequences for the productivity and species composition of fisheries resources in the region [7]. Climate change impacts gradually over a wide range of livelihoods in different settings. Drought and siltation together are reducing overwintering habitat for the self-recruiting fish species resulting in less recruitment in the grazing field to grow open water inland fisheries [9]. This is limiting the livelihoods of the thousands of the fishers who are poorest of the poor. Hossain (2015) described that, reduce water flow in the Ganges river basin has resulted in a severe depletion of fisheries [9]. The floodplains of the country are now among the fastest disappearing of ecological systems. Fishing pressure from an ever-growing population has increased dramatically and has seriously affected the abundance of inland fishes of Bangladesh, particularly small fishes like minor carps, loaches, minnows, small catfishes, gobies, featherbacks, snakehead and eels.

Haor is the important capture fisheries resource which are large saucer-shaped floodplain depressions located mostly in the north-eastern region of Bangladesh covering about 1.99 million ha area and accommodating about 19.37 million people. There are about 373 Haors located in the districts of Sunamganj, Sylhet, Maulovibazar, Habiganj, Brahmanbaria, Netrokona and Kishoreganj, and covering an area of about 858,000 ha which is around 43% of the total area of the Haor region [8]. Haors are unique, in terms of rich ecosystems and biodiversity. Over the years, due to natural and manmade causes, aquatic biodiversity especially fish diversity and other aquatic organisms have been declining sharply. Despite the economic importance of the Haors, people in the region are poorer than in any other part of the country. More than 28% of the total population here lives below the lower poverty line (LPL) [8].

Natural disasters are the main reason for poverty, which is aggravated by the lack of availability of basic infrastructure and social amenities, inequity in resource acquisition and poor access to natural resources [10]. Haor fisheries are under great stress and their sustainability is in danger due to changing aquatic ecosystem, siltation, unplanned construction of flood control and drainage structure, water drainage, agro-chemical and industrial pollutants, use of destructive fishing gears and climate change effects [10, 11].

The climate in Bangladesh is changing and it is becoming more unpredictable every year. The higher temperatures, more variable precipitation, more extreme weather events, and sea-level rise impacts are already experienced in Bangladesh and will be intensified shortly [12]. Climate change poses nowadays severe threat mostly in the fisheries sector and food security among all other affected sectors. However, climate change is likely to pose a threat to water resources and fishery resources like Haor fisheries in Bangladesh. This is visible in the form of temperature increase, enhanced anomalies in the rainfall pattern and frequency and severity of extreme events like rainfall may increase causing frequent and devastating flash floods. A large portion of the area could face major challenges in terms of displaced populations and their loss of income due to climate change induced inundation. As the agriculture and fisheries sector are the largest consumer of water, so these sectors are highly vulnerable due to its direct dependence on climate parameters. As a consequence of climate change; pH change, temperature increase may affect the fish species and also increase the occurrence of intensive natural disasters. The main objectives of this study are to examine the impacts that climate change poses on the Haor resources.

## 2 Materials and Methods

### 2.1 Study area

Dekhar Haor is located in the North-East part of Bangladesh, lies between 24°34´N to 25°12´N and 90°56´E to 91°49´E. The Haor covers four upazilas namely Sunamganj Sadar, Dakshin Sunamganj, Dowarabazar and Chhatak under the Sunamganj district. The total area of the Dekhar Haor is about 11,516 hectares. Dekhar Haor wetland is made up of 36 small, medium and large interconnecting *beels* (both perennial and seasonal), canals, rivers and croplands. In monsoon, the Haor is full of water and in the dry season, it becomes almost dry except for some deeper *beels* [13]. Fishermen living in 9 villages named Joykalash, Chandrapur, Enatnagar, Parbotipur, Raypur, Kadipur, Modonpur, Ujanigoan and Noyagaon were selected for this study.

### 2.2 Data sources for the study

The study was conducted for a period of twelve months from July 2015 to June 2016. Primary and secondary sources of data were considered for this study. Primary data were collected from fishermen through Face to Face (F2F) questionnaire interviews, Focus Group Discussions (FGD) meeting and Key Informant Interview (KIIs) were conducted from different actors related to fisheries. The secondary information was collected from different sources, books, journals and thesis. A total of 160 fishermen were randomly selected for questionnaire interviews where 4 FGDs were made at different places of the study areas each with 12 to 20 members and 8 KIIs data was collected under this study. Upazila Fisheries Officer (UFO), District Fishery Officer (DFO), UP Chairman and Members, leaders of the fishermen community, fish market leaders and school teachers were interviewed for KIIs.

### 2.3 Data processing and analysis

The collected data were computed for analysis after verified to eliminate all possible errors and inconsistencies. Data were analyzed by using Microsoft office excels 2013 and SPSS version 22. The tabular technique was applied for processing the data by using simple statistical tools.

## 3 Results & Discussions

### 3.1 Fish diversity in the study areas

Haor region is naturally a fishery resourceful zone of Bangladesh because it is rich in fish and other aquatic biodiversity. The Haor ecosystems play a vital role in sustaining the biodiversity of fish fauna and contribute to the supply of animal protein and the overall economy of the country through fish production. According to the availability of fish species (Table 1), they were categorized into four groups like Very low (+), Moderate (++), Higher (+++) and Not available (NA). According to IUCN categories of fishes, the threatened species were considered as critically endangered (CR), endangered (EN), and vulnerable (VU) [14]. The least concerned (LC) and exotic species were also identified (Table 1). The fish species which were found 10 years back but presently unavailable in the study areas are presented in both Table 1 and Table 2.

**Table 1:** A list of different fish species as recorded during the study period

| S. No. | Family | Local name | English name | Scientific name | Availability | Remarks (IUCN, 2015) |
|---|---|---|---|---|---|---|
| 1 | Cyprinidae | Catla | Indian Major Carp | *Catla catla* | ++ | LC |
| 2 | | Rohu | Indian Major Carp | *Labeo rohita* | +++ | LC |
| 3 | | Mrigal | Indian Major Carp | *Cirrhinus cirrhosus* | +++ | LC |
| 4 | | Carpio | Common Carp | *Cyprinus carpio* | ++ | Exotic |
| 5 | | Kalibaush | Black Rohu | *Labeo calbasu* | ++ | EN |
| 6 | | Grass Carp | Grass Carp | *Ctenopharyngodon idella* | ++ | Exotic |
| 7 | | Goniya | Kuria Labeo | *Labeo gonius* | + | EN |

| | | | | | | |
|---|---|---|---|---|---|---|
| 8 | | Silver Carp | Silver Carp | *Hypophthalmicthys molitrix* | ++ | Exotic |
| 9 | | Bata | Minor Carp | *Labeo bata* | + | EN |
| 10 | | Lachu | Reba Carp | *Cirrhinus reba* | ++ | VU |
| 11 | Bagridae | Tengra | Striped Dwarf Catfish | *Mystus vittatus* | +++ | LC |
| 12 | | Bujuri | Long Bled Catfish | *Mystus tengra* | +++ | LC |
| 13 | | Golsha | Long Whiskered Catfish | *Mystus cavasius* | ++ | VU |
| 14 | | Rita | Rita | *Rita rita* | + | CR |
| 15 | | Ayre | Long Whiskered Catfish | *Mystus aor* | + | VU |
| 16 | | Gagla | Menoda Catfish | *Hemibagrus menoda* | + | LC |
| 17 | Schilbeidae | Batashi | Indian Potasi | *Pseudeutropius atherinoides* | + | LC |
| 18 | | Bacha | Batchwa Bacha | *Eutropiichthys vacha* | + | CR |
| 19 | | Gharua | Gharua Bacha | *Clupisoma garua* | ++ | CR |
| 20 | | Kajoli | Gangetic Ailia | *Ailia coilia* | ++ | LC |
| 21 | Siluridae | Pabda | Pabo Catfish | *Ompok pabo* | +++ | EN |
| 22 | | Modhu Pabda | Butter Catfish | *Ompok pabda* | +++ | EN |
| 23 | | KaniPabda | Indian Butter Catfish | *Ompok bimaculatus* | ++ | EN |
| 24 | | Boal | Freshwater Shark | *Wallago attu* | ++ | LC |
| 25 | Chacidae | Chaka | Indian Chaca | *Chaca chaca* | NA | EN |
| 26 | Pangasidae | Pangus | Indigenous Pungus | *Pangasius pangasius* | NA | CR |
| 27 | Sisoridae | Gang Tengra | Clown Catfish | *Gagata chenia* | NA | LC |
| 28 | | Baghair | Gangetic Goonch | *Bagarius yarrellii* | NA | CR |
| 29 | Plotosidae | Gang Magur | Canine Catfish | *Plotosus canius* | NA | VU |
| 30 | Olyridae | Bot Shingi | Himalayan Olyra | *Olyralongic audata* | NA | DD |
| 31 | Clariidae | Magur | Walking Catfish | *Clarius batrachus* | +++ | LC |
| 32 | Heteropneustidae | Shing | Stinging Catfish | *Heteropneustes fossilis* | +++ | LC |
| 33 | Cyprinidae | Mola | Carplet | *Amblypharyngodon mola* | +++ | |
| 34 | | Dhela | Cotio | *Osteobrama cotio* | ++ | EN |
| 35 | | Chela | Finescale Razorbelly Minnow | *Chela phulo* | ++ | LC |
| 36 | | Darkina | Flaying Barb | *Esomus danricus* | + | DD |
| 37 | | Tit Punti | Ticto Barb | *Puntius ticto* | +++ | VU |
| 38 | | Jat Punti | Spot Fin Swamp Barb | *Puntius sophore* | +++ | LC |
| 39 | | Teri Punti | One Spot Barb | *Puntius terio* | +++ | LC |
| 40 | | Raj Punti | Java Barb | *Puntius gonionotus* | ++ | Exotic |
| 41 | | Shar Punti | Olive Barb | *Puntius sarana* | + | CR |
| 42 | | Kosa Punti | Cosuatis Barb | *Puntius cosuatis* | NA | LC |
| 43 | | Nanid | Nandi Labeo | *Labeo nandina* | NA | CR |
| 44 | | Mohashol | Tor Mahseer | *Tor tor* | NA | CR |
| 45 | Clupeidae | Chapila | Indian River Shad | *Gaduasia chapra* | + | LC |
| 46 | | Kachki | Ganga River Sprat | *Corica soborna* | ++ | LC |
| 47 | Channidae | Cheng | Asiatic Snakehead | *Channa orientalis* | +++ | VU |
| 48 | | Taki | Spotted Snakehead | *Channa punctatus* | +++ | LC |
| 49 | | Shol | Snakehead Murrel | *Channa striatus* | ++ | LC |
| 50 | | Gozar | Giant Snakehead | *Channa marulius* | + | EN |
| 51 | | Pipla Shol | Barca | *Channa barca* | NA | CR |
| 52 | Mastacembelidae | Tara Baim | One Striped Spiny Eel | *Macrognathus aculeatus* | +++ | VU |
| 53 | | Baro Baim | Two-track Spiny Eel | *Mastacembelus armatus* | ++ | EN |
| 54 | | Guchi Baim | Striped Spiny Eel | *Macrognathus pancalus* | +++ | LC |
| 55 | Sybranchidae | Cuchia | Gangetic Mud Eel | *Monopterus cuchia* | + | VU |
| 56 | Anguillidae | Bamosh | Indian Longfin Eel | *Anguilla bengalensis* | NA | VU |
| 57 | Anabantidae | Chota Khalisha | Honey Gourami | *Colisa chuno* | ++ | LC |
| 58 | | Baro Khalisha | Striped Gourami | *Colisa fasciatus* | +++ | LC |
| 59 | | Lal Khalisha | Dwarf Gourami | *Colisa lalia* | + | LC |
| 60 | | Koi | Climbing Perch | *Anabas testudineus* | +++ | LC |
| 61 | Ambassidae | Gol Chanda | Indian Glass Fish | *Parambassis ranga* | +++ | VU |
| 62 | | Lal Chanda | Indian Glass Perchlet | *Parambasis lala* | + | EN |
| 63 | | Lamba Chanda | Elongated Glass Perchlet | *Chanda nama* | ++ | VU |
| 64 | Cichlidae | Tilapia | Mozambique Tilapia | *Oreochromis mossambicus* | ++ | Exotic |
| 65 | Gobiidae | Bele | Bar Eyed Goby | *Glossogobius giuris* | ++ | LC |
| 66 | | Nuna Bele | Bumblebee Goby | *Brachygobius nunus* | NA | LC |
| 67 | Nandidae | Meni | Mud Perch | *Nandus nandus* | +++ | VU |
| 68 | Mugilidae | Khorsula | Corsula Mullet | *Rhinomugil corsula* | NA | LC |
| 69 | Pristolepidae | Napit Koi | Blue Perch | *Badis badis* | NA | EN |
| 70 | Notopteriidae | Foli | Bronze Featherback | *Notopterus notopterus* | ++ | VU |
| 71 | | Chital | Humped Featherback | *Notopterus chitala* | NA | EN |
| 72 | Cobitidae | Gutum | Guntea Loach | *Lepidocephalichthys guntea* | +++ | LC |
| 73 | | Bou Rani | Bengal Loach | *Botio dario* | + | EN |
| 74 | | Maitta Rani | Hora Loach | *Botia dayi* | NA | DD |
| 75 | Beloniidae | Kakila | Fresh Water Gar Fish | *Xenentodon cancila* | ++ | LC |

| | | | | | | |
|---|---|---|---|---|---|---|
| 76 | Hemiramphidae | Ekthute | Congaturi Halhbeak | *Hyporamphus limbatus* | NA | LC |
| 77 | Tetraodontidae | Potka | Ocellated Puffer fish | *Tetraodon cutcutia* | + | LC |
| 78 | Palaemonidae | Golda | Prawn | *Macrobrachium rosenbergii* | ++ | LC |
| 79 | | Sada Icha | Prawn | *Macrobrachium sp.* | +++ | LC |
| 80 | | Kalo Icha | Monsoon River Prawn | *Macrobrachium malcolmsonii* | ++ | LC |

NA: Not available; +: Very low; ++: Moderate; +++: Higher.
CR= Critically endangered; EN= Endangered; VU= Vulnerable; LC= Least concern; DD= Data deficient.

**Table 2:** Changes in fish availability of different group at Dekhar Haor

| Name of the fish groups | No. of available fish species 10 years before | No. of available fish species at present | Fish biodiversity loss over 10 years (%) |
|---|---|---|---|
| Carps | 12 | 10 | 16.67% |
| Catfishes | 22 | 16 | 27.27% |
| Barbs and Minnows | 10 | 9 | 10.00% |
| Clupeids | 2 | 2 | 0.00% |
| Snakeheads | 5 | 4 | 20.00% |
| Eels | 5 | 4 | 20.00% |
| Perches | 13 | 10 | 23.08% |
| Featherbacks | 2 | 1 | 50.00% |
| Loaches | 3 | 2 | 33.33% |
| Miscellaneous | 6 | 5 | 16.67% |
| Total | 80 | 63 | 21.25% |

Among 63 available fish species, the highest percentage of fishes was catfishes (25.4%) and the lowest was featherback (1.59%). Among other groups, there were 15.87% perches, 14.29% barbs and minnows, 15.87% carps, 6.35% snakeheads as well as eels, 3.17% loaches as well as Clupeids and 7.94% other miscellaneous fish species (Figure 1).

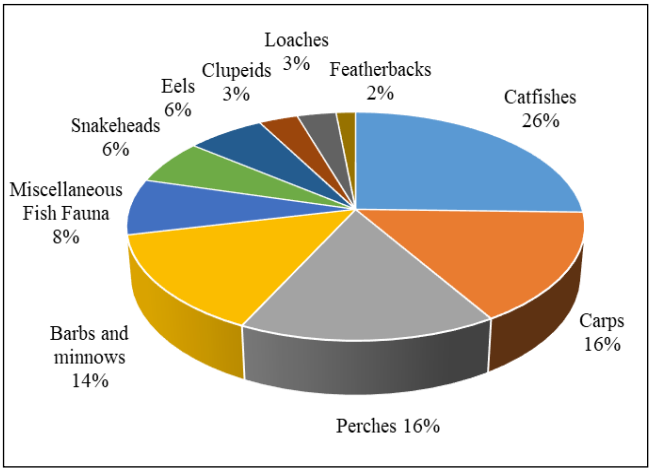


**Fig 1:** Different types of fish groups recorded during the study period

### 3.2 Impact of climate change on fisheries

#### 3.2.1 Temperature and rainfall fluctuation of Haor operation

Temperature and rainfall fluctuation greatly affects the fish living and breeding condition of the Haor areas [15]. Majority of the fish farmers, *beels* owners mentioned that various problems occurred due to climate change such as over heat of Haor and *beels* water, bad water quality or quality loss, disease prevalence, insufficient water in the *beels* and reduce feeding area hampered the fish growth and survival in the open water body.

#### 3.2.2 Delay spawning

During high temperatures, the brood fish stay at the bottom of the waterbody to keep their body temperature in normal condition. This condition hampers the spawning of brood fish. During low temperature, fish body metabolism becomes slow. Thus reducing the spawning rate.

#### 3.2.3 Reduce body immunity

Temperature fluctuation reduces body immunity. Different unwanted diseases may take place. As a result, fish mortality may increase.

#### 3.2.4 Stress of mother/brood fish

Fluctuation of temperature increase fish mobility and thus may cause serious stress of brood fish.

#### 3.2.5 Suffocation of brood fish

Temperature change causes loss of dissolved oxygen and creates suffocation of brood fish. Brood fish seem to gulp at the surface of the pond.

#### 3.2.6 Fermentation of fish food

During high temperatures, some microorganisms may grow. They are responsible for the fermentation of fish food. Thus, fish nutrients may reduce in the ponds. As a result, brood fishes face malnutrition problems. This reduces the spawning rate.

#### 3.2.7 Alter spawning

Brood fish requires a good spawning environment. Without proper rainfall, the spawning rate may reduce. Even in the artificial environment created by the hatchery operators giving a shower of water, the spawning rate is not so high as the natural one.

#### 3.2.8 Elevate mortality

Improper rainfall elevates mortality. The availability of dissolved oxygen depends greatly on proper rainfall. As a result, the lack of rainfall causes fish mortality.

### 3.3 High temperature and less rainfall hampered Haor fish

100% respondents of both non-fishermen and fishermen perceived that temperature is increasing (Table 3). Approximately 75% and 62.5% respondents of fishermen and non-fishermen perceived incidents of drought have increased, while 25% and 37.5% respondents of fishermen and non-

fishermen perceived decrease of drought respectively. 100% respondent of both fishermen and non-fishermen perceived that rainfall is decreasing.

Favorable temperature and good rainfall are most important for successfully fish breeding as well as the nursery of this area [15]. However, high temperatures and less rain restrict fish breeding and the nursery of Dekhar Haor. *Beels* owners of the Haor areas mentioned that various factors like fish do not ovulate, eggs not fertilized or less fertilized and lower hatching rate occurred.

### 3.4 Siltation and sedimentation

Approximately 68.75% and 50% respondents of fishermen and non-fishermen respectively perceived increased siltation (Table 3). Due to increasing siltation in the canals and *beels*, the quantity of water flow reduced and made many of the *beels* much shallower, which in turn has declined the fish production [9].

**Table 3:** The respondents' perceptions of the change of climatic factors in Dekhar Haor

| Perceived effects | | Fishermen /Fish farmers (%) ( No. of respondent, n = 64) | Non- fishermen (%) (No. of respondent, n = 64) |
|---|---|---|---|
| Temperature | Warmer | 100% | 100% |
| | Colder | 0% | 0% |
| | No change | 0% | 0% |
| Rainfall | Increased | 0% | 0% |
| | Decreased | 100% | 100% |
| | No change | 0% | 0% |
| Flood | Early | 0% | 0% |
| | Late | 87.5% | 81.25% |
| | No change | 12.5% | 18.75% |
| Drought | Increased | 75% | 62.5% |
| | Decreased | 25% | 37.5% |
| Siltation | Increased | 68.75% | 50% |
| | Decreased | 12.5% | 18.75% |
| | No change | 18.75% | 31.25% |
| Cyclone | Frequent | 0% | 0% |
| | Rare | 87.5% | 68.75% |
| | Not occur | 12.5% | 31.25% |
| Wind flow | Changed | 81.25% | 62.5% |
| | No change | 18.75% | 37.5% |

### 3.5 Erratic or untimely flooding

Flood is one of the important climatic variables. According to the questionnaire interviews, farmers mentioned that flood causes disastrous problems in aquaculture. Approximately 87.5% and 81.25% respondents of fishermen and non-fishermen perceived late arrival of floods (Table 3). Farmers identified that fishes of Dekhar Haor suffered devastating floods in 1974, 1987, 1988, 1998, 2004, and 2007. Floods are becoming more frequent allegedly due to erratic rainfall which is the outcome of climate change. Farmers stated that it has several impacts on fish biodiversity of Haor with its grow-out operation as well as production.

### 3.6 Increased intensity of cyclone and winds

Approximately 81.25% and 62.5% respondents of fishermen and non-fishermen respectively perceived that the flow of wind in the Haor areas is changed (Table 3). IPCC (2007) reported that there is evidence of a 5-10% increase in intensity (wind speed) that would contribute to enhanced storm surges and coastal flooding and also project a 20% increase in the intensity of associated precipitation that would contribute to flooding [16]. Cyclone winds are likely to increase in intensity because of the positive correlation with sea surface temperature. In November 2007, for example, the tropical cyclone Sidr, with a 100 miles long front covering the breadth of the country and with winds up to 240 km per hour, hit Bangladesh [17, 18]. This was noted to be an unusual occurrence given the intensity and timing of the storm, particularly given that it occurred in the same year as two recurrent floods [17]. The IPCC also noted that climate change will be associated with greater precipitation extremes, which includes more intense monsoonal rainfall.

### 3.7 Increasing drought

According to the questionnaire interviews, farmers identified drought was one of the most important climatic variables that have a negative impact on freshwater aquaculture. Approximately 75% and 62.5% respondents of fishermen and non-fishermen, respectively perceived increasing drought (Table 3). They reported that droughts are common in Haor and affects water supplies. Drought affects plant growth leading to loss of primary production, food shortage and increases fish mortality during the dry season [19]. "*Rought*" is a local term used in Haor area which refers that in the winter season mostly in *Chaitro* mash due to continuous sunshine the *beels* of Haor suddenly dried out fully, as a result, the fisherman catches the all of the fish from the bottom of the *beels* which has negative effects on the fish diversity [19].

### 3.8 Climatic change reduce the fish diversity

The number of available fish species during the study period was 63 (Table 2). Although the Haor was rich with 80 fish species according to the questionnaire interview survey. Less rainfall, prolonged drought and sifting season had drastically reduced fish diversity and other organisms in open water bodies in the study area [9, 10].

Climate changes affect the fisheries through a diversity of direct and indirect pathways whose importance varies depending on the type of fishery and ecosystem. During the survey, the local personnel outlined some major causes of lower fish diversity in the Haor area (Table 4). Based on the overall study, some of the pathways regulating climate change scenarios identified during this study are pointed out as follows.

1. Precipitation and evapotranspiration change the hydrology of inland waters: river flows and flood timing and extent change, affecting fish reproduction, growth and mortality, as well as other elements of wetland-based livelihoods (agriculture, pastorals, forestry).
2. Haor, *beels* including river water temperature changes the aquatic ecology; shifting range of fish species, change in habitat for fish species, appropriate environment for breeding, disruption to fish reproductive patterns and migratory routes.
3. Increased frequency of extreme events: more frequent loss of fishing days due to bad weather, increasing loss of nets, traps and long lines, damage to boats, increased loss of life among fishermen, increase damage to wetland communities.

**Table 4:** Major causes for diminishing local fishes outlined from the questionnaire interview

| Causes | Fishers (%) (n = 20) | Fish farmer (%) (n = 20) | Local leader (%) (n = 10) | School teacher (%) (n = 10) | Housewife (%) n = 10 | Fish traders (%) (n = 10) |
|---|---|---|---|---|---|---|
| Changes of climatic parameter | 80 | 85 | 80 | 85 | 70 | 70 |
| Lack of water around the year | 65 | 70 | 65 | 70 | 60 | 70 |
| Fishing through drying of *beels* | 70 | 65 | 62 | 80 | 60 | 70 |
| Chemicals use in fishing | 45 | 45 | 78 | 75 | 50 | 60 |
| Fishing broods | 55 | 60 | 72 | 70 | 60 | 70 |
| Lack of awareness | 60 | 55 | 48 | 60 | 50 | 50 |
| Use of current *jal* and *kuna jal* | 45 | 40 | 40 | 50 | 30 | 60 |
| Fishing of mother fishes | 30 | 40 | 30 | 40 | 30 | 40 |
| Obstacle in entering water such as embankments, dams | 20 | 25 | 15 | 20 | 20 | 30 |
| Disobey the fishing act | 45 | 55 | 25 | 30 | 20 | 30 |

n = No. of respondent

During the period of study, total 63 species of fish fauna under 20 families including prawn species were available in the study areas (Table 2). Among them, 10 species of carps, 16 species catfishes, 9 species of barbs and minnows, 2 species of clupeid, 4 species of snakeheads, 4 species of eels, 10 species of perches, 1 species of featherback, 2 species of loaches and other miscellaneous 5 species were found including 3 species of prawns with varying level of availability. Bangladesh has a globally important wetland ecosystem and associated with approximately 260 indigenous freshwater fish species [20], but during the study period, only 63 species were found in the study areas. Therefore, fish biodiversity is very little in comparison with the total freshwater fish biodiversity of Bangladesh.

According to the statement of local fishermen, ten years ago Dekhar Haor was rich with various types of fish species. At that time, there were 80 species of fishes which included carps (12), catfishes (22), barbs and minnows (10), clupeids (2), snakeheads (5), eels (5), perches (13), featherbacks (2), loaches (3) and other miscellaneous (6) (Table 2). Fishermen were then satisfied with their everyday catch from the wetlands.

It is revealed that there has been a gradual reduction in the fish diversity in the Haor areas that is from the earlier recorded 80 species to present 63 species (21.25% declined within a decade) in the Dekhar Haor. This situation reflects the current scenario of fishes in the open waterbodies of Bangladesh that fish diversity is rapidly decreasing.

## 4. Conclusion

The study was conducted to understand the implications of climate change on fish diversity as experienced by local people of Dekhar Haor, Sunamganj, Bangladesh. The study was based on a field survey method, where an appropriate questionnaire was prepared and used for collecting data from the villages surrounding the Haor. Most of the respondents mentioned that flood, drought, rainfall, and temperature is responsible for decreasing fish diversity in the Haor. Moreover, respondents mentioned increased temperature is also responsible for diminishing fish breeding. Besides, seasonal changes, pollution, lack of water, habitat destruction, fishing by completely drying and siltation are also important causes of fish diversity degradation of the Haor area. The study has identified that fish diversity severely affected by climate change. Climate change is a challenge for aquaculture in that region. Awareness training program on improved management of environmental risk and adaptive capacity would be very effective to conserve and enhance fish diversity in the Haor region of Bangladesh.

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