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Local Government Engineering Department

Haor Infrastructure and Livelihood Improvement Project (HILIP)

Level-3, RDEC Bhaban, LGED H/Q

Sher-e-Bangla Nagar, Agargaon, Dhaka-1207

Final Report

Action Research on Analysis of the Environmental Impacts of Large Scale Expansion of Pond Fisheries and Climate Change Effects under HILIP, LGED

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List of Abbreviations and acronyms

BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
BWDB	Bangladesh Water Development Board
CALIP	Climate Adaptation and Livelihoods Protection Sub-project
CBFM	Community-Based Fisheries Management
CBRMP	Community-Based Resource Management Project
CEGIS	Center for Environmental and Geographic Information Services
CRDS	Center for Resource Development Studies Ltd
CREL	Climate Resilience Ecosystem and Livelihoods
DBHWD	Department of Bangladesh *Haor* and Wetlands Development
DFO	District Fishery Officer
DoF	Department of Fisheries
DoE	Department of Environment
DPC	District Project Coordinator
DPP	Development Project Proposal
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FGDs	Focus Group Discussions
FFP	Fourth Fisheries Project
GDP	Gross Domestic Product
HILIP	*Haor* Infrastructure and Livelihood Improvement Project
IDI	In-Depth Interview
IECs	Important Environmental Components
IEE	Initial Environmental Examination
IFAD	International Fund for Agricultural Development
IPAC	Integrated Protected Area Co-management
IUCN	International Union for Conservation of Nature
KIIs	Key Informant Interviews
LGED	Local Government Engineering Department
MACH	Management of Aquatic Ecosystems through Community Husbandry
SCBRMP	Sunamganj Community Based Resource Management Project
SPSS	Statistical Package for the Social Sciences
SRDI	Soil Resource Development Institute
ToR	Terms of Reference

Executive Summary

Background: The Center for Resource Development Studies (CRDS) Ltd. has received a research grant from HILIP, LGED to conduct a study on "Analysis of the Environmental Impacts of Large-Scale Expansion of Pond Fisheries and Climate Change Effects under HILIP, LGED". This is a one-year HILIP-funded action research study started in May 2018.

Objectives: The objectives of the study is to identify the potential environmental impacts and influence of climate change on scaling up of pond fisheries in *haor* region and assessment of bio-diversity as well as exotic species rearing in ponds and the impact of their presence on the local species through environmental baseline analysis.

Study area and Methodology: The study area comprises five haor districts namely Netrokona, Sunamganj, Habiganj, Kishoreganj and Brahmanbaria in the North-Eastern Bangladesh, wherein lies 165 unions under 28 upazilas.

Based on methodology, the study completed i) 28 Focus Group Discussions (FGDs), ii) 92 In-Depth Interviews (IDIs) with pond owners, iii) Key Informant Interviews (KIIs) in each project district and iv) collected water quality data on important parameters from 20 ponds at the rate of four (4) ponds from each project district.

Major Findings and Conclusions: Demographically the fish farming households of the HILIP area have 118 males for every 100 females. The average sizes of the households were 5.73, 5.57, 5.62, 6.89 and 5.38 in Brahmanbaria, Kishoreganj, Netrokona, Habiganj and Sunamganj respectively.

The education level of the household members above 5 years of age 90.06% were literate. The main occupation was found to be fish culture and 64% of households were occupied with it. However, Agriculture, business, fish trading, service, skilled labour sale, pottery, and fishing comprised occupation of about 34% households. The land holding pattern of the sample pond owners shows that it is a mixture of landless, marginal, small, medium and large farmers, with highest (25%) concentration in the marginal farmers' group.The homestead patterns of the sample households were mostly similar in all the districts. In the project area, fish farmers have living room with CI sheet roof, semi pucca house and pucca house for 65.2%, 32.6% and 2.2% households respectively.

Summary of the FGDs results were as follows:

1. Discussion participants were in favour of developing fish sanctuary and they were aware that it was the best measure to stop extinction of different varieties of local fish and increase production in general.
2. Occurrence of the early flood/flash flood was stated to be frequent in the Haor areas and among the perceived causes they mentioned, onrush of water from the mountains, excessive rainfall and disruption of link with the local rivers.
3. Most of the groups did not experience problems of fish diseases in their areas. Only a few of those, who came across any problem had contacted local officials of the Department of Fisheries (DoF) for overcoming the problem.
4. Selection criteria of pond for fish culture as stated by them were, raised dyke of the pond, enough sunlight, availability of natural feed for fish etc.

5. FGD participants mostly felt that there was no effect of cultured fish on the local fish production, as they do not culture any carnivorous species.

Summary of the KIIs were as follows:

1. Due to the intensity of fish culture in both perennial and seasonal ponds is lower in haor districts so fish culture in haor pond does not create any adverse or conflicting impact on ecology. However, it needs further research.
2. Respondents' opinion is that pond culture interventions did not produce any negative results on the environment.
3. Water level rises in lean season (winter) due to sea level rise is very uncommon in the haor region, so adverse effects do not arise. However, in Itna, Mithamoin, Austagram upazilas of Kishoreganj district, water level rise in lean season (winter) due to sea level rise is observed to some extent.
4. Climate change, especially temperature has adverse effect on spawning of fish species.

The study reveals that the average areas of perennial ponds in Brahmanbaria, Kishoreganj, Habiganj, Sunamganj and Netrokona districts are 79, 71, 42, 34.5 and 71 decimals respectively. Simultaneously, the average of areas of seasonal ponds are found to be 43.6, 80, 92, 54.1 and 42.4 decimals in Brahmanbaria, Kishoreganj, Habiganj, Sunamganj and Netrokona districts respectively.

Typical fish yields from perennial pond aquaculture are between 23.2 and 30.3 Kg/decimal compared to fish yields of 12.6 – 26.8 Kg/decimal from seasonal pond aquaculture. The average fish price from perennial pond aquaculture are between Tk. 97 and 123 per Kg compared to fish price of Tk. 106 – 172 per Kg from seasonal pond. The average benefit per decimal from perennial ponds varies between Tk. 1134 and Tk. 2113 and that from seasonal ponds varies between Tk. 1143 and Tk. 1664. Using cost benefit information for both perennial and seasonal ponds the study reveals that the maximum benefits from perennial and seasonal ponds varied between Tk. 103,956 (US$ 1268) and Tk. 130,247 (US$ 1588) minimum benefits varied between Tk. 40,377 (US$500) and Tk. 61,843 (US$ 754).

Haor pond aquaculture yields are mostly comprised of both indigenous and exotic fish species. The study area comprises exotic species, e.g., Tilapia, mono-sex Tilapia, Silver carp, Thai pangus, Common carp, Thai sarputi, Grass carp, and most of these are available in culture fishery. Overall fish production yields from both perennial and seasonal ponds are comprised of 22% indigenous cultured fish, 67% exotic fish and 11% indigenous non-cultured fish. Among indigenous species, Mola carplet comprised about 1% and 2.88% of fish harvest in perennial and seasonal ponds respectively.

Traditionally, Bangladeshi women are involved in fish culture or fishing related activities in pre as well as post-harvest stage of the production process. *Haor* pond aquaculture diversified their scope of their involvement, through the service providing opportunities, such as cleaning weeds, carry soil up pond bank, pond cleaning, testing water quality, applying fish feed, fertilizer and lime, and taking decision in respect of fish culture. About 76% and 11% women are directly involved with grading and fish drying respectively.

Flash floods are common phenomena in the haor area and usually these damage pond fisheries and create negative impacts on the local economy. Flash floods cause damage to ponds, wash out fish and destroy dikes of ponds in 23%, 28% and 20% cases respectively.

The study reveals that, 29% of the respondents, who are pond fish farmers, said that no detrimental effect will occur if pond culture is increased in the haor areas. However, 22% respondents' reveals that this increase may affect local natural species of fishes and 21% respondent views that agricultural land will decrease, if pond aquaculture is increased in haor areas. Besides 6% respondents, views that this might destroy the environmental balance and may cause of decrease of water lily, which occur very commonly in haor area of Bangladesh.

According to the study, 67% of the pond farmers said that financial loss will occur when cultured fish escape into haor water. However, 27% respondents reveal that no impact will occur.

According to the study, 45% respondents reveal that there will be no impact on pond aquaculture if insecticides are applied in agriculture according to the prescribed dose. However, 22% respondents reveal that agricultural insecticide will reduce fish growth and about 22% respondents view that fish disease will occur because of agricultural insecticide.

Water quality in the monsoon in the haor area is of normal quality, clean and transparent. Water is somewhat turbid in the river flow area. The water quality in the dry season undergoes sufficient changes as the beels and haors become confined or semi confined.
Water quality tested in April 2019 in HILIP area ponds depicts that temperature varied from 28^0 -33^0 C, pH varied from 6.8 – 9.3, dissolved oxygen varied from 5.5 mg – 6.71mg/litre, electrical conductivity varied from 74 - 560 micro Siemens/cm, total dissolved solid varied from 39–373 mg/litre, nitrate content varied from 0 – 2 mg /litre, nitrite varied from 0 – 0.3 mg/litre and Ammonium content varied from 0.5 – 1 mg/litre. The Secchi depth varied from 0.18m – 0.55m but most being around 0.30m. High pH was observed in ponds, which were almost dry. In all cases, the contents were within allowable limits.

The project area occupied mainly by silt loam, silty clay loams, non-calcareous loam, clayey and permeable loamy soils.

Ecology is generally broad based as floral ecology and fauna ecology.Some key ecological indicators have been identified based on literature review, review of project documents, secondary data analysis, i.e. In Depth Interviews (IDIs), Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) with knowledgeable senior people in the project areas. Flora identified have been classified under five categories viz. Aquatic flora, creepers, herbs, shrubs and terrestrial trees. Trend of occurrence of flora present, i.e., Aquatic plant, Creeper plant, Terrestrial herbal flora, Shrubs and Terrestrial Trees over the study area depicts and decreasing in occurrence. Trend of the occurrence of animal life presents i.e., Amphibians, Mammals, Reptiles, Birds and Fishes over the region depicts and decreasing in occurrence.

Bangladesh is one of the most vulnerable countries affected by climate change.The major disasters concerned here are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion and landslide.The situations are quite different in different seasons, especially in the wet and dry seasons. Fish and shellfish are potentially impacted by climate-driven changes in a suite of abiotic factors including the acidification of waters. The trend analyses of peripheral stations depict that the average highest temperatures and lowest temperatures are increasing.

Long-term data of three stations in the periphery of the Project area have been collected for the period 1970 -2017. The rainfall patterns of Sylhet, Mymensingh and Comilla, the peripheral stations, depict that the trend of all high rain seasons is decreasing all throughout. However, the pre-monsoon rainfall at Sylhet is found to have an increasing trend. The rainfall in dry seasons depicts that at Mymensingh and Comilla the trend is decreasing while that at Sylhet the trend is increasing.

Water levels of six WL stations in haor area maintained by BWDB were reviewed. Sunamganj recorded rise in high water level but low water kevel in dry season remains unchanged. However, at Bhairab Bazar, where some tidal influence exists, high water level has a declining trend while the low water level has an increasing trend.

The haor areas have aquifers of semi-confined to confined types. The groundwater recharge in the haor areas is high due to high rainfall, and extensive, deep and extended period of flooding. In the study area, the main source of irrigation water is mainly being both surface andgroundwater.Almost 80% of total cultivated area of haor districts is covered by Boro rice, while only about 10% area is covered by T. Aman production. In the haor areas under the five districts, some other crops such as vegetable, mustard, groundnut, wheat, chili,jute, pulses, potato, onion, watermelon, spices, sweet guard etc. are grown.

Fisheries are one of the most significant renewable resources that haor regions have for food security, livelihoods and economic growth. Environmental management is essential to ensure that impacts identified are prevented and mitigated by the Environmental Management Plan (EMP). Present study formulated an Environmental Management Plan for maintaining a good pond fish's environment.

Research need in Haor areas was as follows:

i. Research on maintaining ecology and conserve native fish species
ii. Protecting fish from adverse effect of chemicals & indiscriminate use of chemicals
iii. Research on the breeding capacity of cultured fish species and use of medicine
iv. Research on yield variety of fish culturing with and without predator
v. Research on best structural pond design in the haor region
vi. Research on round the year water quality in sample ponds

Conclusion: The intervention has resulted in the improvement of yield from ponds and generated higher income and nutritious food for the fish farmers. Existing cultural practices could support experimentation and learning under future initiatives in the *haor* area. A good number of exotic species has been introduced in Bangladesh. The study revealed that exotic species have provided socio-economic benefits for a vast number of poor and vulnerable people in the haor region. However, very limited studies have been done, so far, in order to bring these species into the culture. Fisheries are one of the most significant renewable resources that North-East region of Bangladesh have for food security, livelihoods and economic growth. The adoption process for fish culture in the study area is still in its beginning. Some farmers are still in a state of trial and ready to interrupt the activity as soon as problems occur.

Recommendations: The study has provided evidence that haor pond aquaculture approach aimed at improving the lot of the poor and vulnerable is effective in the study area. The study revealed the future initiative should carefully weigh both positive and negative impacts for each exotic species and need to develop a well planned research program to assess the impacts of exotic species in Bangladesh. The use of environmental management plan for pond fish culture, which has a potential for significant environmental impact, also ensures that natural resources including biodiversity will be also available to future generations. Pond fishery in the *haor* area mainly has an income-generating feature and less probability of being affected by climate change impacts on culture fishery. The approach should be extended beyond study areas and be adopted as a key strategy for development of haor fisheries resources in Bangladesh.

1. INTRODUCTION

The International Fund for Agricultural Development (IFAD) is working together with the Government of Bangladesh through the Local Government Engineering Department (LGED) under the Climate Adaptation and Livelihoods Protection Project (CALIP), a supplementary Project of *Haor* Infrastructure and Livelihood Improvement Project (HILIP), to enhance the resilience of local communities to climate change impacts in the five-*haor* districts. The Center for Resource Development Studies (CRDS) Ltd. has received a research grant from HILIP, LGED to conduct a study on "Analysis of the Environmental Impacts of Large-Scale Expansion of Pond Fisheries and Climate Change Effects under HILIP, LGED". The HILIP was launched in 2012 and the supplementary project CALIP started in July 2014. CALIP is being implemented in five-*haor* districts covering 28 upazilas selected on their exposure to climate risks and poverty context. CALIP is scheduled to end in September 2020.

HILIP brings together a number of improvements, which helps building an inclusive *hoar* community and conservation resilience to climate change. The purpose of the project is to improve the living standard and reducing vulnerability of the community in the project area.

Bangladesh's natural *haor* fisheries remain vital in providing food, income and employment opportunities for millions of poor people in Bangladesh. However, pressure on this important resource is abruptly increasing and there are fears that Bangladesh's natural *haor* fisheries may be in a state of irreversible decline. Besides, *haors* are extremely vulnerable to ecological systems, where local people rely on aquatic animal such as fishes from both pond and floodplain for protein and nutrition to meet food security. However, there is less focus on *haor* pond both perennial and seasonal fishery, which is the rapidly growing as a safe aquaculture practice in Bangladesh and is considered as highly productive and safe. Besides, the effects of climate change on pond aquaculture and sustainable extension of the perennial and seasonal pond aquaculture are rather, over looked until now. The present study has been conducted as an action research on the impact of large-scale expansion of both perennial and seasonal pond aquaculture to assess the climate change effects in the *haor* areas of Bangladesh.

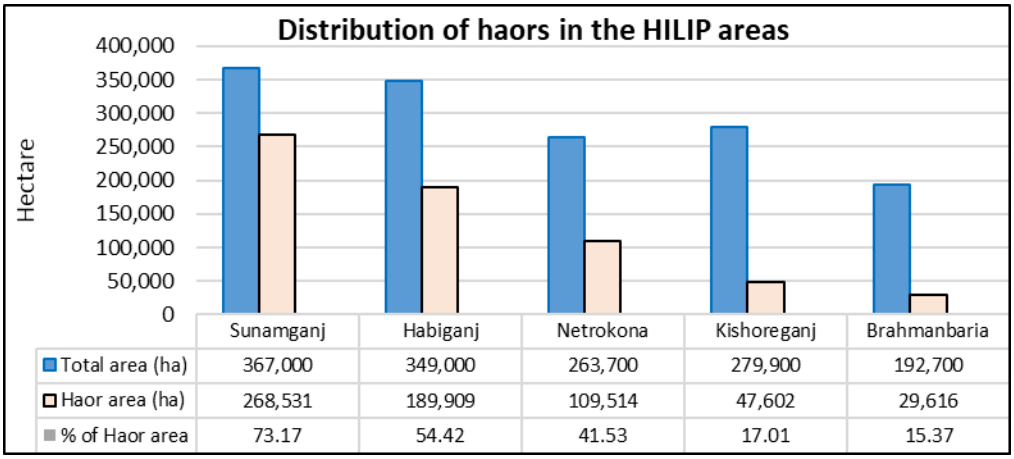
2. BACKGROUND

This is a one-year HILIP-funded action research study under HILIP, which LGED started in May 2018. Bangladesh is one of the world's leading fish producing countries with a total production of 4.134 million Mt, where aquaculture contributes 56.44 percent of total production (DoF, 2017). According to FAO statistics 2016, Bangladesh was ranked fifth in world aquaculture production. Recently the Food and Agriculture Organization (FAO) of the United Nations has recognized Bangladesh as the third top aquaculture fish producing country in the world (FAO 2018). The fisheries sector (capture fisheries and aquaculture combined) contributed to 3.61 percent of national gross domestic product (GDP) and 24.41 percent of agricultural GDP in 2017 (DoF, 2017). The peoples per capita fish consumption reached to 62.58 grams (DoF 2017, SYB Bangladesh 2018). The fish biodiversity in the *haor* areas is now facing a big challenge, due to indiscriminate use of chemicals in paddy fields and the adverse effects of residues of such deadly chemicals on fish larvae in waters. This has been causing a decline in fish biodiversity and productivity. However, production from pond has gradually been increasing since 1996-97 (DBHWD 2017).

The introduction of pond fish culture in haor areas is aimed at ensuring access to fish by rural households. Fish is an important source of protein; though, natural fishes are not easily accessible by rural communities. In addition to providing nutritional benefits, pond fish culture has the potential of meeting the demand for fish, as well as alleviating the pressure on over fished natural stocks and contributing to livelihoods through employment and income generation through fish sale (Rutaisire et al 2013, Kimar and Quisumbing 2011). The growth of aquaculture, to meet demand is occurring, mainly, from freshwater aquaculture. Climate change may result in favourable or unfavourable changes in *haor* aquaculture sector. Therefore, it is essential that we understand the effects of climate change on the *haor* pond's aquaculture sector from the broad to the finest spatial scales. The knowledge gaps that exists and socio-economic transformation may hinder adaptation of sustainable aquaculture, especially in the *haor* areas.

The uncertainties related to climate change – aquaculture sector was not prioritized earlier. To date, the climate related issues considered in research have, mainly, included short-term aquaculture. Examples of short-term impacts include loss of production or that to infrastructure due to extreme events, diseases, toxic algae and parasites.

North-east region of Bangladesh comprises of large bowl shaped depressions, known as haor, which belong to seven districts (Sunamganj, Habiganj, Netrokona, Kishoreganj, Sylhet, Maulvibazar and Brahmanbaria). 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 at large (DBHWD 2017). *Haor* basin under the HILIP project comprises large areas of five districts, namely Sunamganj, Habiganj, Kishoreganj, Brahmanbaria and Netrokona covering an area of about 6452 square kilometres, which is 44.42% of the total haor area of Bangladesh (DBHWB 2017). Distribution of haors in the HILIP project districts is shown in Figure 1.



	Sunamganj	Habiganj	Netrokona	Kishoreganj	Brahmanbaria
Total area (ha)	367,000	349,000	263,700	279,900	192,700
Haor area (ha)	268,531	189,909	109,514	47,602	29,616
% of Haor area	73.17	54.42	41.53	17.01	15.37

Figure 1: Distribution of *haors* in the HILIP areas (source MPHA 2012)

Haor area of Netrokona, Kishoreganj and Brahmanbaria is designated as floodplain haor area, while Sunamganj and Habiganj area are deeply flooded haor. Haor area comprises 73%, 54%, 42%, 17% and 15% of the total area of Sunamganj, Habiganj, Netrokona, Kishoreganj and Brahmanbaria districts respectively. These haor districts produced 76112, 48428, 54707, 58367 and 94271 Mt. of fishes respectively in financial year 2016-17 (DoF 2017). Annual fish production from various sources in HILIP districts (2016-17) is shown in Figure 2. Pond and seasonal ponds fishery produced 33%, 55%, 58%,

31% and 10% of the total fish production of Kishoreganj, Netrokona, Brahmanbaria, Habiganj and Sunamganj districts respectively during that period. The HILIP is working in five *haor* districts, which contributed 18.82% to inland capture fisheries and 4.84% to inland culture fishery (DoF 2017).

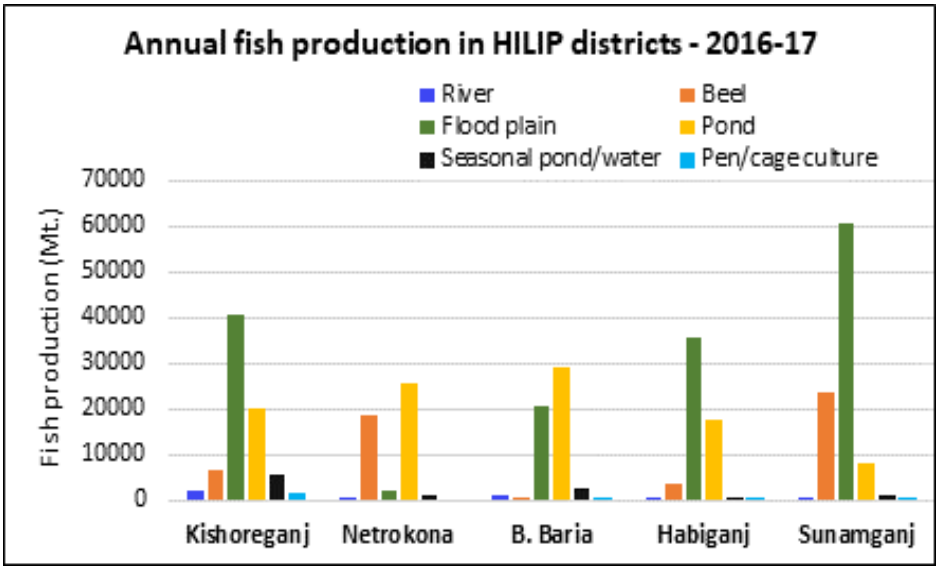


Figure 2: Annual fish production in HILIP working districts 2016-17)

The ponds in *haors*, especially, in the upper part of the *haor*, become seasonally submerged during high flood and some of these ponds are seasonally cultivated with native fish e.g. Rohu, Catla, Mrigal, Kalbasu or domesticated exotic species e.g. Silver carp, Grass carp, Mirror carp, Thai sarputi etc. However, fish culture in Bangladesh over last several decades, has resulted in the introduction of various native and exotic fish species, which were not properly investigated for suitability in the local environment. The management necessary for successful *haor* (floodplain) aquaculture effectively turns an open access common property resource into a closed private property resource and this raises a number of social and environmental issues that must be considered, relative to production and economic gains (Gregory and Toufique 2007). Climate Change impacts in the *haor* areas of Bangladesh include floods, flash floods, cyclones and storm surges, salinity intrusion and extreme temperature and drought. Besides, the fisheries sector has also experienced an adverse effect because of the impacts of Climate Change. Some pictures of perennial ponds at Joykalas, Dakshin Sunamganj, Dowarabazar, Sunamganj and Jamalganj, Sunamganj are shown in photos 1 to 8.

Photo 1. Picture of a Perennial Pond in Baniachong, Habiganj

Photo 2. Picture of a Perennial Pond, Kalmakanda, Kishoreganj

Photo 3. Perennial pond, Basudeb, B. Baria Sadar

Photo 4. Picture of a Seasonal Pond in Dowara Bazar, Sunamganj

Photo 5. Picture of a Perennial Pond in Jamalganj, Sunamganj

Photo 6. Picture of a Seasonal Pond in Dowarabazar, Sunamganj

Photo 7. Picture of a perennial Pond in Mohonganj, Netrokona

Photo 8. Picture of a Perennial Pond in Austogram, Kishoreganj

3. OBJECTIVE OF THE STUDY

The objectives of the study is to identify the potential environmental impacts and influence of climate change on scaling up of pond fisheries in *haor* region and assessment of bio-diversity as well as exotic

species rearing in ponds and impact of their presence on the local species through environmental baseline analysis.

4. METHODOLOGY

4.1 Study Area

The study area comprises five haor districts namely Netrokona, Sunamganj, Habiganj, Kishoreganj and Brahmanbaria in the North-Eastern Bangladesh, where in lies 165 unions under 28 upazilas. The five districts are hydrologically connected, and function as a unique ecosystem. The study area is shown in **Figure 3** and **Table 1**.

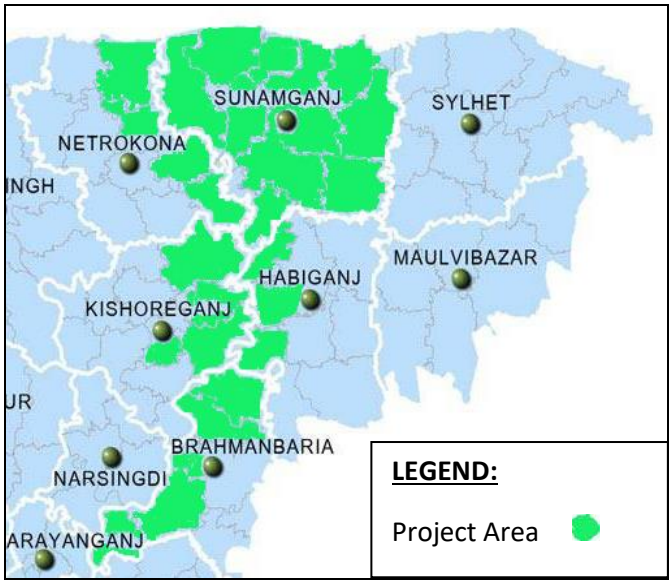


Figure 3: **Study Area Shown on North East Regional Map of Bangladesh**

Table 1: List of Upazilas Covered under HILIP.

Division	District	Name of Upazilas
Sylhet	Sunamganj	Sadar, Dakshin Sunamganj, Dherai, Bishwambarpur, Tahirpur, Jamalganj, Sulla, Dowarabazar, Dharmapasha, Chhatak, Jagannathpur
	Habiganj	Azmiriganj, Lakhai, Baniachong
Mymensingh	Netrokona	Khaliajuri, Kalmakanda, Madon, Mohanganj
Dhaka	Kishoreganj	Itna, Mithamoin, Astagram, Nikli
Chittagong	Brahmanbaria	Nasirnagar, Nabinagar, Sarail, Ashuganj, B. Baria Sadar, Bancharampur

4.2 Data Collection through FGDs, KIIs, In-depth Interviews (IDIs) and Survey

All working upazilas of the five districts and have been included in the sample design. From each upazila at least two Unions, one from a low depth area (If available), other from high depth area (If available) have been selected randomly.

The study has been conducted, purposefully, covering all 28 project upazilas of five project districts (Brahmanbaria, Habiganj, Kishoreganj, Netrokona and, Sunamganj). Randomly selected (using https://www.surveymonkey.com/mp/sample-size-calculator/) a total of 92 *haor* ponds have been sampled from 58 unions. Alternative unions were also sampled for use, in case of, absence of suitable ponds in the initially randomly selected unions. Subsequently, using random numbers in the MS-Excel sheet name of the unions was defined randomly and a number of ponds distributed according to the selected (including alternative) union. Data and information have been gathered using In-Depth Interview (IDI), Focus Group Discussion (FGD), Key Informant's Interview (KII) and ecological (Flora and Fauna) survey. Collected data have been stored in database using MS-Access and MS-Excel software. After compilation and checking, all data have been analyzed by the application of MS-Excel and SPSS software, as applicable. A simplified flow chart of data collection, data quality control and analysis plan are shown in Figure 4. Data collection sites along with districts, upazilas and unions, and number of *haor* ponds, number of FGDs and Flora & Fauna data collection location is given in **Annexure-1**. The following formula was used to calculate the number of unions/ponds:

$$\text{Sample size} = \frac{\frac{z^2 \times p\,(1-p)}{e^2}}{1 + \left(\frac{z^2 \times p\,(1-p)}{e^2 N}\right)}$$

Where, N = Number of Unions/Ponds, e = Margin of error (percentage in decimal form)

z = 1.96 (95% confidence level) score and p is sample estimate of population proportion. The z-score is the number of standard deviation.

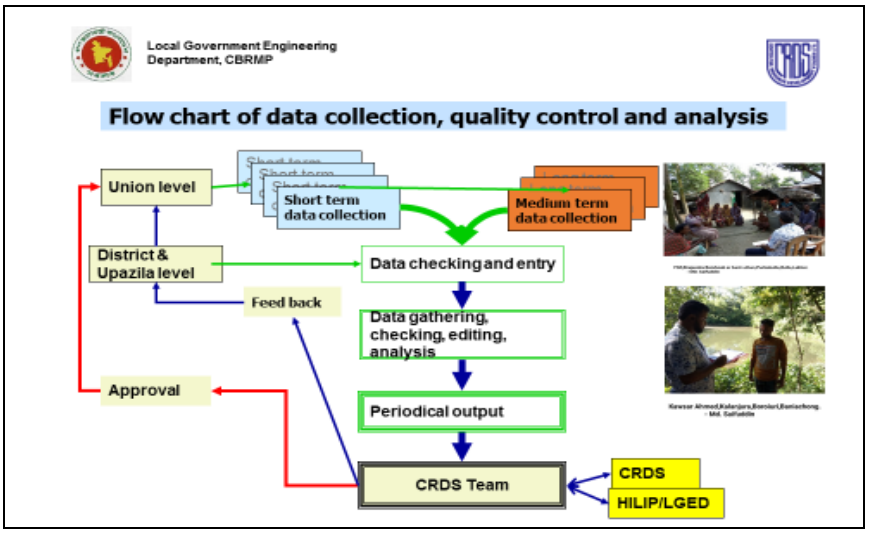


Figure 4: Flow Chart of Data Collection, Quality Control and Analysis

4.3 Development of Tools of Data Collection

This study makes use of both secondary and primary data. Secondary data came from literature research while primary data were obtained by interviews, FGDs, KIIs and surveys. A guideline has been prepared for FGD (Appendix 1a: Bengali; Appendix 1b: English) with the stakeholders at field level. Similarly, Key informants Interview (KII) checklist has been used to conduct interview at the experts' level (Appendix 2a: Bengali; Appendix 2b: English). Simultaneously a set of Questionnaires has been used for in-depth Interview (IDI) with pond fishers (Appendix 3a: Bengali; Appendix 3b: English). A

comprehensive checklist has also been used to collect information on flora and fauna (Appendixes: 4a - Trees, 4b - Shrubs, 4c - Creepers, 4d - Herbs, 4e – Aquatic plants, 4f - Amphibians, 4g - Mammals, 4h - Birds, 4i - Fishes and 4j and 4k – Reptiles).

4.4 Qualitative Data Entry to the Computer and Compilation

Data entry was done using the MS-Access data input software for quantitative and qualitative data from fishers' household and MS-excel for KII, FGD and ecological survey. MS-excel and SPSS have been used for data analysis. The responses in the FGDs checklists have been coded and entered into the software. The KII opinions from experts or those, who are now involved in the development of fishery sector have been compilid and incorporated in this report. Areas of investigation were mainly fish culture methods, prospects and problems, acclimatization of external species, risk of exotic species for food and food chain on local fish species, extension, procedure etc. However, data obtained from in-depth interview on fish culture and harvesting had been assembled on a district basis. Data collected on flora and fauna had been analyzed for abundance, diversity, status and causes of adverse effects. All data, thus entered through data entry software became a a part of the database.

5. RESULTS

5.1 Tasks Based Activities and Achievement

Following the methodology, the study covered 6,452 km^2 of *haor* areas in five districts in the North East of the country. Activities have been undertaken following the research methodologies to fulfill given tasks (Tasks I to Tasks IX) according to the scope of works. Achievements made during the study period are given in the **Annexure 2**.

During the study periods, the CRDS, based on methodology, worked on the following:

i) Completed 28 Focus Group Discussions (FGDs) in 28 project upazilas.

ii) Completed 92 In-Depth Interviews (IDIs) with pond owners in randomly selected 58 unions covering five project districts.

iii) Conducted Key Informant Interviews (KIIs) at Netrokona, Sunamganj, Habiganj, Kishoreganj and Brahmanbaria.

iv) Collected water quality parameters from 20 ponds at the rate of four (4) ponds from each district.

Review of relevant project documents: The CRDS consultants have collected basic documents/ publications from secondary sources are given in **Annexure 3.**

Important Environmental component (IECs) and Achievement made during the study period is given in the **Annexure 4.**

5.2 Outcomes through In Depth Interviews (IDIs) and Focus Group Discussions (FGDs)

In Depth Interview were conducted covering 92 pond owning households. Details information on their current socioeconomic conditions, pond fish culture related knowledge and daily activities in their ponds, their perception of the prospects and problems of pond fish culture in the haor areas

has been collected, data analysis and report preparation. In Depth Interviews compares aspects of the population profile, income, occupation, landholding, assets, food security, mobility, and institutional involvement and infrastructure changes.

According to research plan and field records, 92 IDIs has been completed in HILIP areas. These In-Depth Interviews (IDIs) have been carried out with 22 ponds owners in 11 unions of Brahmanbaria, 14 pond owners in 8 unions of Kishoreganj, 13 pond owners in 7 unions of Netrokona, 9 pond owners in 7 unions of Habiganj and 34 pond owners in 25 Unions and of Sunamganj district. Data had been thoroughly checked both for completeness and consistency. Coding was carriedout at CRDS office. The data entry template was prepared at the CRDS office and data entry was completed accordingly.

5.2.1 Demographic Characteristic

Data were collected from 92 pond owners of 05 districts. Distribution of household members of pond owners according to sex is shown in Table 2. Total population of 92 households found was 522, of which 283 (54%) were male and 239 (46%) were female. The male female distribution depicts that fish farming household in HILIp project area has 118 males for every 100 females. The average sizes of the households were 5.73, 5.57, 5.62, 6.89 and 5.38 in Brahmanbaria, Kishoreganj, Netrokona, Habiganj and Sunamganj respectively. The overall size of sampled households was 5.67, which was higher than the national average of 4.06 (Bangladesh HIES, Dec. 2016). Population per household was found highest in Habiganj (6.89) as indicated in Table 2. However, national statistics reveals that household size is higherin Sunamganj, Habiganj and Brahmanbaria districts (5.29-5.86), than that in Netrokona and Kishoreganj districts (4.85-5.28) (BBS 2015).

Table 2: District Wise Distribution of Household Members According Sex and Household Size

Demographic characteristics	B. Baria	Kishoregonj	Netrokona	Habiganj	Sunamganj	All districts
Total sampled household	22	14	13	9	34	N=92
Male	69	40	42	36	96	283
Female	57	38	31	26	87	239
Total population	126	78	73	62	183	522
Population per household	5.73	5.57	5.62	6.89	5.38	5.67
Male female ratio (No of males for 100 females)	121	105	135	138	110	118

5.2.2 Education Level

The education level of the household members engaged in pond culture was found to be highly encouraging, as out of total population above 5 years of age, 90.06% were literate, which was higher than the national literacy rate of 72.76% (Unesco 2016). Moreover, 374 or 79.07% of the population had formal education ranging from primary to post graduate level. Among the five districts, Sunamganj was found have the highest literacy rate of 92.86% and Netrokona had the lowest rate of 84.62% (table 3). Majority of the population possess primary to graduate level, so, it is expected that they would have access to information of fish culture, climate change effects and adaptation strategies.

Table 3: Educational Status of Household Members

Level of Education	B. Baria		Kishoregonj		Netrokona		Habiganj		Sunamganj		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Age below 5 years	8	6.3	11	14.1	8	11.0	7	11.3	15	8.2	49	9.4
Illiterate	12	9.5	7	9.0	10	13.7	6	9.7	12	6.6	47	9.0
Can read & write	12	9.5	14	17.9	7	9.6	4	6.5	15	8.2	52	10.0
Primary	36	28.6	16	20.5	17	23.3	21	33.9	60	32.8	150	28.7
JSC	24	19.0	12	15.4	19	26.0	19	30.6	46	25.1	120	23.0
SSC	17	13.5	4	5.1	7	9.6	3	4.8	22	12.0	53	10.2
HSC	11	8.7	8	10.3	5	6.8	0	.0	7	3.8	31	5.9
Graduate	3	2.4	4	5.1	0	.0	2	3.2	4	2.2	13	2.5
Post graduate	3	2.4	2	2.6	0	.0	0	.0	2	1.1	7	1.3
Total	126	100	78	100	73	100	62	100	183	100	522	100

5.2.3 Main Occupation of Pond Owner's

Pond owners were asked to describe their main occupations and income from different sources prior to the IDIs. The main occupation was found to be fish culture and 64% of households were occupied with it. However, Agriculture, business, fish trading, service, skilled labour sale, pottery, and fishing comprised occupation of about 34% households. Besides 2% households reveals dependents and students. **Figure 5** shows detail status of main occupations of pond owner's household.

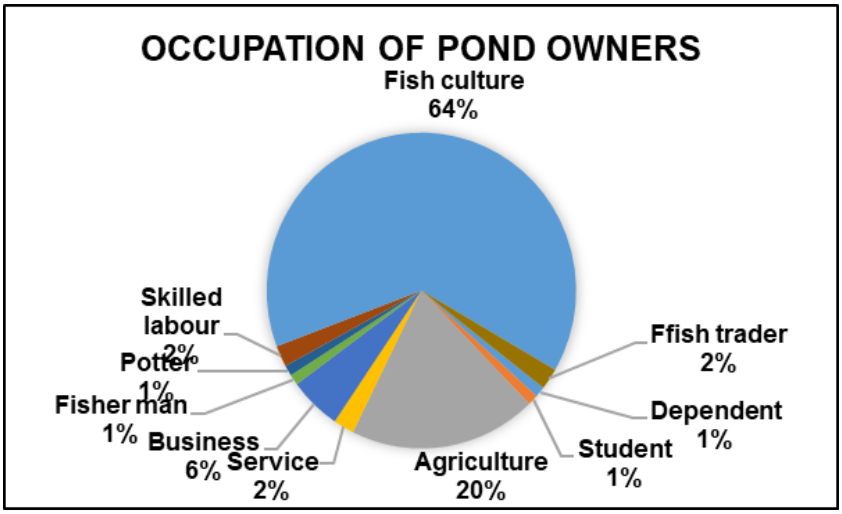


Figure 5: Main occupation of Pond owner's in HILIP study sites

5.2.4 Land Holding

The land holding pattern of the sample pond owners shows that it is a mixture of landless, marginal, small, medium and large farmers, with highest (25%) concentration in the marginal farmers' group. However, there are variations among different districts, as in Brahmanbaria 77.3% of the respondents belonged to landless and marginal groups, while in Kishoreganj 64.3 were medium and large farmers. It may be mentioned that, while calculating ownership pattern, homestead, own cultivable land, leased out land, fruit garden/orchard and permanent fallow lands were considered and pond areas were excluded (Table 4).

Table 4: Land Ownership Pattern of the House Holds

Categories	B. Baria		Kishoreganj		Netrokona		Habiganj		Sunamganj		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Landless Farmer (05-49 decimal)	9	40.9	1	7.1	1	7.7	2	22.2	7	20.6	20	21.7
Marginal Farmer (50-149 decimal)	8	36.4	1	7.1	4	30.8	2	22.2	8	23.5	23	25.0
Small Farmer (150-249 decimal)	3	13.6	3	21.4	2	15.4	4	44.4	7	20.6	19	20.7
Medium Farmer (250-749 decimal)	2	9.1	4	28.6	5	38.5	0	.0	9	26.5	20	21.7
Large Farmer (750 decimal & above)	0	.0	5	35.7	1	7.7	1	11.1	3	8.8	10	10.9
Total	22	100	14	100	13	100	9	100	34	100	92	100

5.2.5 Homestead Pattern

The homestead patterns of the sample households were mostly similar in all the districts, with 65.2% of the total houses having a living room with tin shed and 32.6% semi Pucca. Only two households had pucca living room (Table 5). This indicates only well to do are involved in fish culture in the project area and the future project design has to take this aspect in consideration.

Table 5: Homestead Patterns of the Pond Owners

House Type		B. Baria		Kishoreganj		Netrokona		Habiganj		Sunamganj		Total	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Living room	Tin shed	16	72.7	10	71.4	10	76.9	7	77.8	17	50.0	60	65.2
	Semi pucca	6	27.3	3	21.4	3	23.1	2	22.2	16	47.1	30	32.6
	Pucca	0.0	0.0	1	7.1	0.0	0.0	0.0	0.0	1	2.9	2	2.2
Kitchen	Tin shed	17	77.3	14	100	13	100	7	77.8	26	76.5	77	83.7
	Semi pucca	1	4.5	0	.0	0	.0	1	11.1	4	11.8	6	6.5
	Kancha	4	18.2	0	.0	0	.0	0	.0	3	8.8	7	7.6
Cow shed	Tin shed	7	31.8	7	50.0	10	76.9	4	44.4	22	64.7	50	54.3
	Semi pucca	0	.0	0	.0	0	.0	0	.0	2	5.9	2	2.2
	Kancha	2	9.1	0	.0	0	.0	1	11.1	1	2.9	4	4.3
Store room	Tin shed	2	9.1	0	.0	0	.0	3	33.3	10	29.4	15	16.3
Total		**22**		**14**		**13**		**9**		**34**		**92**	

5.2.6 Livestock Assets

It was found that only half (51%) of the households were rearing cows, having a total of 171 cows with an average of 3.6. Only 14% households were rearing goat or sheep, having an average number of 5.08. However, having huge water area ducks dominated the bird species along with fowl/pigeon. In total, 72 households (78.3%) were rearing the birds with an average number of 12.96 (Table 6). On the whole each household has on average 1.85 No. of cows, 0.7 No. of goats and 10.5 No. of poultry birds.

Table 6: Livestock Assets of the Pond Owners

Name of District	Cow				Goat/Sheep				Duck/Fowl/Pigeon/Bird			
	No. of HH	%	No. of Animals	Av.no.	No. of HH	%	No. of Animals	Avg.no.	No. of HH	%	No. of Animals	Avg.no.
B. Baria	7	31.8	49	7	0	.0	0	-	16	72.7	218	13.6
Kishoregonj	4	28.6	9	2.3	3	21.4	11	3.67	14	100.0	285	20.4
Netrokona	9	69.2	34	3.8	1	7.7	3	3	10	76.9	92	9.2
Habiganj	6	66.7	13	2.16	2	22.2	9	4.5	8	88.9	64	8
Sunamganj	21	61.8	66	3.14	7	20.6	43	6.14	24	70.6	274	11.4
Total	47	61.1	171	3.6	13	14.1	66	5.08	72	78.3	933	12.96

5.2.7 Possession of Household Articles

Possession of household articles by the pond owners indicates that, except two households in Sunamganj, 97.8% possessed Mobile phone and 63% had television sets at their residences. Moreover, 31.5% of the households had refrigerator. This indicates that the wells to does are involved in Fish culture (Table 7).

Table 7: Household Articles of the Pond Owners

Type of assets	B. Baria		Kishoreganj		Netrokona		Habiganj		Sunamganj		Total	
	No. HH	%	No. HH	%	No. HH	%	No. HH	%	No. HH	%	No. HH	%
Electric Fan	22	100	14	100	13	100	9	100	30	88.2	88	95.7
Television	20	90.9	8	57.1	9	69.2	6	66.7	15	44.1	58	63.0
Mobile Phone	22	100	14	100	13	100	9	100	32	94.1	90	97.8
Refrigerator	11	50.0	8	57.1	3	23.1	1	11.1	6	17.6	29	31.5
Almirah	11	50.0	4	28.6	6	46.2	7	77.8	24	70.6	52	56.5
Cot	20	90.9	14	100	11	84.6	9	100	31	91.2	85	92.4
Sofa Set	5	22.7	5	35.7	1	7.7	2	22.2	8	23.5	21	22.8
Showcase	18	81.8	14	100	8	61.5	6	66.7	17	50.0	63	68.5
Bicycle	9	40.9	2	14.3	4	30.8	0	.0	7	20.6	22	23.9
Motor Cycle	1	4.5	2	14.3	2	15.4	2	22.2	5	14.7	12	13.0
Motor Pump	2	9.1	0	.0	2	15.4	1	11.1	8	23.5	13	14.1
Ornaments	16	72.7	14	100	12	92.3	3	33.3	19	55.9	64	69.6
Total	**22**		**14**		**13**		9		**34**		**92**	

5.2.8 Possession of Agriculture Equipment

Among the agricultural equipment, being haor area and fishing or fish culture being their major economic activity 56 or about 61% of the households possessed fishing gears. Among the five districts, 12 out of 13 households (92%) in Netrokona district possessed fishing gears. Besides, 26% were found to have country boats (table 8).

Table 8: Possession of Agricultural Equipment

Name of District	No. households	Power Tiller		Shallow Pump		Country Boat		Engine Boat		Fishing Gears	
		No. HH	%	No. HH	%	No. HH	%	No. HH	%	No. HH	%
B. Baria	22	-	-	4	18.2	3	13.6	-	-	16	72.7
Kishoreganj	14	-	-	5	35.7	2	14.3	3	21.4	9	64.3
Netrokona	13	-	-	5	38.5	6	46.2	2	15.4	12	92.3
Habiganj	9	-	-	-	-	3	33.3	1	11.1	5	55.6
Sunamganj	34	5	14.7	5	14.7	10	29.4	5	14.7	14	41.2
Total	92	5	5.4	19	20.7	24	26.1	11	12.0	56	60.9

5.2.9 Availability of Basic Utility Services

Availability of electricity, water and sanitation in a household is considered as an indicator of quality of living conditions in a household or locality.

5.2.9.1 Electricity Connection

It was found that, out of 92 households, 85 (92%) had electricity connections in their house. Only seven or 8% had no electricity and all those were found in Sunamganj District (Table 9).

Table 9: Distribution of Household by Having Electricity in the Household

District Name	Yes		No		Total	
	No.	%	No.	%	No.	%
B. Baria	22	100.0	0	.0	22	100.0
Kishoregonj	14	100.0	0	.0	14	100.0
Netrokona	13	100.0	0	.0	13	100.0
Habiganj	9	100.0	0	.0	9	100.0
Sunamganj	27	79.4	7	20.6	34	100.0
Total	85	92.4	7	7.6	92	100.0

5.2.9.2 Drinking Water Facilities

Having safe and pure drinking water facilities in the household is a sign of ensuring comparatively healthy life for the family members. It was found that, 100% of the houses use hand tube well as their source of drinking water, which is very encouraging (Table 10).

Table 10: Status of Drinking Water Status of Households

District Name	Pond		Hand Tubewell		Total	
	No.	%	No.	%	No.	%
B. Baria	0	.0	22	100.0	22	100.0
Kishoregonj	0	.0	14	100.0	14	100.0
Netrokona	0	.0	13	100.0	13	100.0
Habiganj	0	.0	9	100.0	9	100.0
Sunamganj	0	.0	34	100.0	34	100.0
Total	0	.0	92	100.0	92	100.0

5.2.9.3 Sanitation Facilities

Safe water improved sanitation are powerful determinants of health. Sanitary latrine along with safe drinking water facilities almost ensures health and hygiene facilities in the house. In the sampled household 79 or 86%, possess sanitary latrines and the rest (14%) use Kancha latrines. Among the districts, all the sample households of Kishoreganj and Netrokona possess sanitary latrine (table 11).

Table 11: Distribution of household by type of Latrines

District Name	Sanitary		Kancha		Total	
	No.	%	No.	%	No.	%
B. Baria	21	95.5	1	4.5	22	100.0
Kishoregonj	14	100.0	0	.0	14	100.0
Netrokona	13	100.0	0	.0	13	100.0
Habiganj	6	66.7	3	33.3	9	100.0
Sunamganj	25	73.5	9	26.5	34	100.0
Total	79	85.9	13	14.1	92	100.0

5.3 Final Outcomes through Focus Group Discussions (FGDs)

Focus Group Discussions (FGDs) were carried out in an environment of participation using a checklist at sampled unions covering 28 project upazilas. Through FGD collective opinions of the local people were reflected in their current practices of pond fish culture, types of species, impact of pond fish culture on the environment and economy, problems encountered and their opinions/suggestions on different issues related to pond fisheries.

A total of 28 FGDs covering 28 project upazilas has been conducted with HILIP beneficiaries. FGDs were carried out using an appropriate checklist. According to field records, a total of six (6) FGDs has been completed in Brahmanbaria, four (4) FGDs in the Kishoreganj, four (4) FGDs in the Netrokona, three (3) FGDs in the Habiganj and 11 FGDs in Sunamganj districts. Besides, In-Depth Interviews (IDIs) have been carried out with 22 ponds owners in 11 unions of Brahmanbaria, 14 pond owners in 8 unions of Kishoreganj, 13 pond owners in seven (7) unions of Netrokona, nine (9) pond owners in seven (7) unions of Habiganj and 34 pond owners in 25 Unions and of Sunamganj district. Some pictures of FGDs are shown in **photos 9 to 16**.

Summary of Environmental Impact related Findings at FGDs is as follows:

1. **Discussion participants were in favour of developing fish sanctuary and they were aware that it was the best measure to stop extinction of different varieties of local fish and increase production in general.**
2. **Occurrence of the early flood/flash flood was stated to be frequent in the Haor areas and among the perceived causes they mentioned, onrush of water from the mountains, excessive rainfall and disruption of link with the local rivers.**
3. **Most of groups did not experience problems of fish diseases in their areas. Only few of those, who came across any problem had contacted local officials of the Department of Fisheries (DoF) for overcoming the problem.**
4. **Selection criteria of pond for fish culture as stated by them were, raised dyke of the pond, enough sun light, availability of natural feed for fish etc.**
5. **FGD participants mostly felt that there was no effect of cultured fish on the local fish production, as they do not culture any carnivorous species.**
6. **Local people did not perceive any rise of water level during dry season (winter) in their area. So, impact of sea level rise could not be perceived in the study area.**

Summary of findings of the FGDs conducted are presented below:

1. Participants expressed that, due to fish culture in the haor pond, their income has increased, employment has been generated for both male and female members of the family, nutrition intake have increased, some fish-centered business have been generated etc.
2. Participants gave a number of suggestions on expansion of fish culture in the haor ponds, which included financial support for digging of ponds, raising the heights of dikes of pond and arranging aquaculture training.
3. Due to lack of permanent ponds, fish culture was not so much prevalent in their area. Those who had ponds used traditional methods of fish culture.
4. Those who have permanent ponds, use ponds for fish culture, and besides that, some also use ponds for fish culture as well as for irrigation purpose.
5. Major problems of fish culture in the *haor* pond as mentioned by the participants were- dykes of the pond gets damaged, fish flows out of the pond due to flash flood, different fish diseases, high price and non-availability of fish seed/fries/fingerlings, lack of skill etc.
6. Participants elaborately stated about the contributions of HILIP-LGED on fish culture in *haor* ponds. Major points mentioned by them were- helping farmers to lease-in ponds (part of government khas land - *jalmohol*), forming groups, providing training and credit facilities, re-excavating ponds, arranging exchange visits etc.
7. Due to lack of permanent pond in Sunamganj District, farmers lease-in government khas land (*jalmohol*) and culture native fish by releasing fish fries. However, in the permanent ponds, among various methods of fish culture practiced were mixed culture, mono-sex Tilapia, mola fish with polyculture etc. In Netrokona District, major method of fish culture stated by the group participants was cage culture.
8. Most of the FGD participants stated that they provide limited amount of feed to the cultured fish in the haor ponds.
9. All the participants in the FGDs conducted in Sunamganj district felt that it was important to develop sustainable fish culture in haor ponds for food security and economic development. All of them also expressed that, fish culture in haor pond has provided them with the opportunity of both income and fish for family consumption.
10. Fish is harvested mostly twice in a year in the haor areas; May-June and November-December. Fishing gears used in the area are nets of different types, such as kona jal, ber jal, pona jal, tana jal, ghori jal etc.
11. FGD participants in the area stated that approximate production of fish was 20 -25 kg per decimal. Composition of different species of fish in the jalmohol was stated to be Ruhi, Grass Carp, Carp and Tilapia. In the ponds, composition of species stated was Carp and Tilapia. In some cases, they stated 100% mono sex tilapia.
12. FGD participants gave number of suggestions on expansion of fish culture in the haor ponds, which included financial support for digging and raising the dikes pond and aquaculture training. In the government khas lands (*jalmohol*) area their suggestions included, releasing fish fries through government initiative, annual re-excavation of government khas land (jolmohol) areas, planting hijol-tomal trees in the khas land (*jolmohol*) areas, building fish sanctuary etc.
13. Almost all the groups stated that Robi crops are cultivated widely in Sunamganj. Fertilizers like, urea, phosphate and TSP are in common use and all types of pesticides are used in the area. Participants could not clearly explain about the impact of use of pesticides on the fish.

However, some of them mentioned about open wounds or ulceration of fish was sometimes observed.

14. Most of the group participants informed that they use weedicides to remove grass/weeds in their agricultural fields. They used different types of weedicide to remove grass.
15. In reply to a question, whether they found or heard, anyone found chemical or waste materials coming with early flood /flash flood; most of them replied in the negative.
16. In response to a query, whether in-migration and out-migration of fish was observed in their area during flood, all of them replied in the positive.
17. While discussing the scope of sustaining the benefits of pond fish culture through extension, the FGD participants mostly referred to jalmohol and suggested for long term lease agreement of jalmohol, registration of CIG groups, re-excavation of beels, training and financial support to the farmers etc.

Photo 9. FGD at Dharmapasha, Sunamganj

Photo 10. FGD at Haldarpaur Baniachong, Habiganj

Photo 11.FGD at Lakhai, Habiganj

Photo 12. FGD at Dowarabazar, Sunamganj

Photo 13.FGD at Madan, Netrokona

Photo 14.FGD at Ebrahimpur, Nabinagar

Photo 15.FGD at Rupshudi, Bancharampur

Photo 16.FGD at Itna, Kishoreganj

5.4 Final Outcomes through Key Informants' Interview (KII)

Fish production through pond fish culture presents an opportunity to reduce overfishing and raising fish production to match demand and economic benefit. Key Informant Interviews (KIIs) conducted with purposefully selected respondents. To obtain vital opinions and view about the pond fish culture activities in the study areas, some selected key officials who are directly/indirectly involved in the HILIP activities were interviewed through KII Checklist during the study period. In this process, the consultants have already conducted KIIs with the District Management Unit officials (DMU) of the HILIP, District Fishery Officers in Netrokona, Sunamganj, Kishoreganj, Habiganj and Brahmanbaria and Project Leader of WorldFish. Some pictures of KIIs are shown in **photos 17 to 24**.

Summary of Environmental Impacts Stated by Key Informants is as follows:

i. Due to the intensity of fish culture in both perennial and seasonal ponds is lower in haor districts so fish culture in haor pond does not create any adverse or conflicting impact on ecology. However, it needs future research.

ii. Respondents' opinion is that pond culture interventions did not produce any negative results on the environment. Besides, dyke cropping with vegetables can earn higher income.

iii. Water level rise in lean season (winter) due to sea level rise is very uncommon in the haor region, so adverse effects do not arise. However, in Itna, Mithamoin, Austagram upazilas of Kishoreganj district, water level rise in lean season (winter) due to sea level rise is observed to some extent.

iv. Climate change, especially temperature has adverse effect on spawning of fish species. Due to siltation in the haor areas water depth, reducing chronologically and water temperature becomes higher nowadays and high temperature has adverse effect on spawning of fish. On the other hand, optimum temperature (20°C – 39°C) enhances spawning of fish.

v. Respondents' opinion is that Small and Medium Enterprise (SME) development is of outmost importance for sustainable pond aquaculture and growing fisheries to ensure nutritional food security development.

Summary of KIIs is as follows:

i. It is essential to introduce and extend sustainable fish culture practices in *haor* ponds for food security, nutrition and economic development of the nation especially people living in the haor areas.

ii. *Haor* fish farmers have the necessary technical knowledge to continue the *haor* pond fish culture activities. However, more integration with local fishery office is vital to know advanced culture technique as well as a source of good fingerlings and feeds.

iii. Key Informants expressed that the pond fish culture will be sustained in the future and it will definitely continue even without any external help as traditional capacity exists..

iv. Availability of safe and appropriate fish feed and fingerling at a reasonable price is vital for sustainable development of *haor* pond aquaculture.

v. Fish farming training, manual and leaflets are the technical supports that need to be provided to the farmers.

vi. If cultured fish spread in the open water due to submergence of dykes or any other reason may be because a serious problem e.g. African Magur or Piranha may affect local fish population. So, spreading of these carnivorous species in open haor water is to be prevented.

vii. The natural breeding process of fish is hampered by indiscriminate use of chemical/inorganic fertilizers and insecticides. As a result, many species of native fish species decreases.

viii. Various methods of fish culture are being used in haor ponds. Among these mixed culture, monoculture (mostly mono-sex Tilapia) and poly culture are very common in *haor* areas.

ix. Proper guidance and effective training for different organizations facilitate pond owners to develop fish culture and better production and sustainable management.

x. Haor pond related interventions, which were introduced in haor region, have a positive impact outside of this project area. As a result, pond fish culture is increasing day by day.

xi. Structural intervention obviously can help pond fish culture. Seasonal ponds may be made perennial/permanent by increasing the height of the dyke of the pond.

xii. Introduce pen and cage fish culture in haor region.

xiii. Integrated programs should be taken by different agencies and should involve Department of Fisheries for new and innovative technology.

xiv. Usually, soil type of *haor* ponds is mostly clay to clay loam.

xv. To improve and sustain pond fish culture in haor area, the key elements to be taken care of are:

   a) Ensuring reasonable fish price for fish feed
   b) Ensuring quality fingerling at reasonable price
   c) Strengthening monitoring system
   d) Providing all sorts of technical support and intensification of existing technology
   e) Implementing *fisheries law*
   f) Solving pond ownership problem

xvi. Research need regarding fish culture in pond in Haor area
   a) Source of water in *haor* area
   b) Hardening of fish bones
   c) Research on maintaining ecology and conserve native fish species

d) Protecting fish from adverse effect of chemicals& indiscriminate use of chemicals
e) Research on breeding capacity of cultured fish species & use of medicine
f) Research on yield variation of fish culturing with and without predator
g) Research on best structural pond design in the haor region
h) Research on impact on fish resources through round the year water quality monitoring in sample ponds in each of HILIP districts

Photo 17. Discussion with Mr. Md. Aminul Islam, District Fishery Officer, Kishoreganj

Photo 18. Discussion meeting with Dr. Md. Ruhul Amin, District Fishery Officer, Netrokona

Photo 19. Discussion meeting with Mr. Mamunur Rashid, District Fishery Officer, Brahmanbaria

Photo 20. Discussion meeting with District Fishery Officer, Habiganj

Photo 21. Discussion meeting with HILIP officials at DPC Office, Kishoreganj

Photo 22. Discussion meeting with Md. Shariful Hoq Akanda, Senior Upazila Fishery Officer, Sadar, Kishoreganj

Photo 23. Discussion meeting with HILIP officials in Habiganj

Photo 24: Discussion meeting with HILIP Official in B. Baria

5.5 Fish Species Diversity and Abundance through In-Depth Interview

Species diversity data have been collected from pond fishers/owners through in-depth interviews from 92 pond owners in the project area. The data collectors also observed the mode of harvesting, gears used and marketing patterns. Data collectors have also recoded types of species and their composition following Rahman (2005). They also collected data on harvested fish, fish discarded on the pond bank and those used for consumption and marketing. Some pictures of IDIs are shown in **photos 25 to 30**.

Photo 25. IDI with pond owner Rupshidi, Bancharampur, B. Baria

Photo 26. IDI with Pond owner, Lakhai, Habiganj

Photo 27. IDI with pond owner Solimabad, Bancharampur, B. Baria

Photo 28. IDI with Pond owner, Joykalas, DakshinSunamganj

Photo 29. IDI with pond owner, Purbabulla, Lakhai, Habiganj

Photo 30. IDI with pond owner, Khaliajuri, Kishoreganj

5.5.1 Status of Perennial and Seasonal Ponds

Fish culture is rapidly developing in the haor areas. The major drive for this expansion are the potential socio-economic benefits arising from the increasing demand for fish in lieu of declining catches in the open water. In haor areas, fish are cultivated in both perennial and seasonal ponds to

meet the demand of present food supply of the area as well as of the country. The optimum production of fish per hectare in fishponds is vital for benefitting the farmers. Fish production in haor ponds (perennials and seasonal) remains vital in providing food, income and employment opportunities for millions of poor people. Recently, Bangladesh's aquaculture sector has developed rapidly; consequently, the production and system diversity continue to grow. Many people regard aquaculture as the most realistic way to secure the fish supply needs. Besides, production techniques are well established: inputs such as seed and feed are widely available.

Present study determines the average area (decimal) of both perennial and seasonal ponds and it reveals that the average areas of perennial ponds in Brahmanbaria, Kishoreganj, Habiganj, Sunamganj and Netrokona districts are 79, 71, 42, 34.5 and 71 decimals respectively. Simultaneously, the average of areas of seasonal ponds are found to be 43.6, 80, 92, 54.1 and 42.4 decimals in Brahmanbaria, Kishoreganj, Habiganj, Sunamganj and Netrokona districts respectively. Maximal perennial pond size (decimal) was found in Brahmanbaria District and minimal pond size in Sunamganj District.On the other hand, maximal seasonal pond size was found in Habiganj District and minimal pond size in Netrokona. The areas of seasonal ponds are higher than that of the perennial ponds in Kishoreganj, Habiganj and Sunamganj districts. The situation converses in other two districts. Figure 6 shows the average area (decimal) of both perennial and seasonal ponds in HILIP areas.

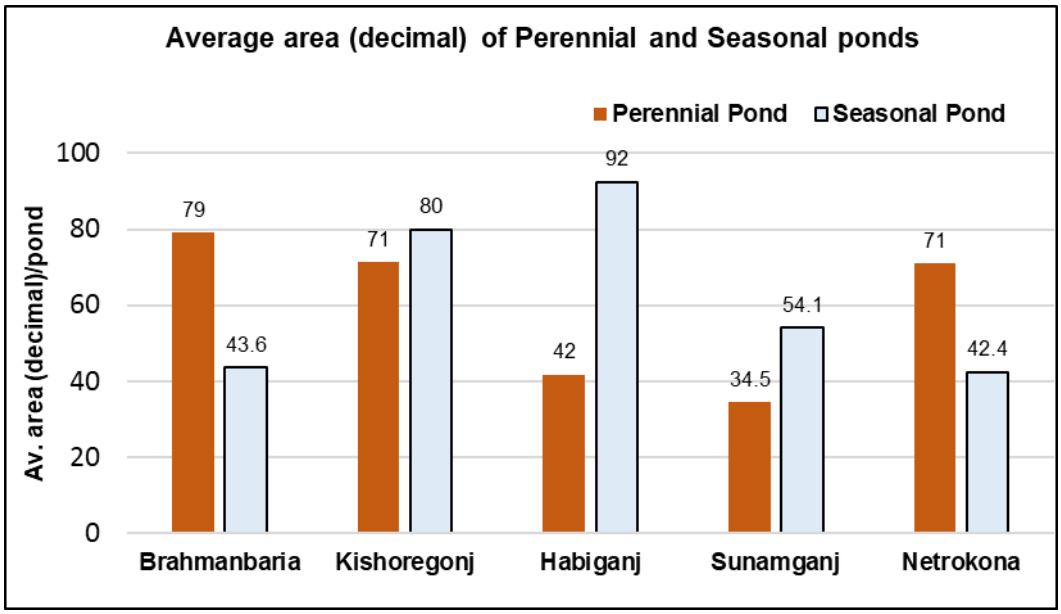


Figure 6: Average Area (decimal) of Perennial & Seasonal Ponds

Typical fish production yields from perennial pond aquaculture are between 23.2 and 30.3 kg/decimal compared to fish yields of 12.6 – 26.8 kg/decimal from seasonal pond aquaculture. Haor ponds yields are comprised of both exotic and indigenous fish species. Besides, a small percentage, (usually 8% in Perennial ponds and 15% in seasonal ponds) of the total catch weight is made up of indigenous haor fish species. Pond fish culture in seasonal ponds shows a maximal production in Kishoreganj District and minimal production in Brahmanbaria District. Fish culture in perennial ponds shows maximum production also in Kishoreganj district and minimal production in Netrokona

District. Figure 7 shows the average production (kg/decimal) of both perennial and seasonal ponds in HILIP areas.

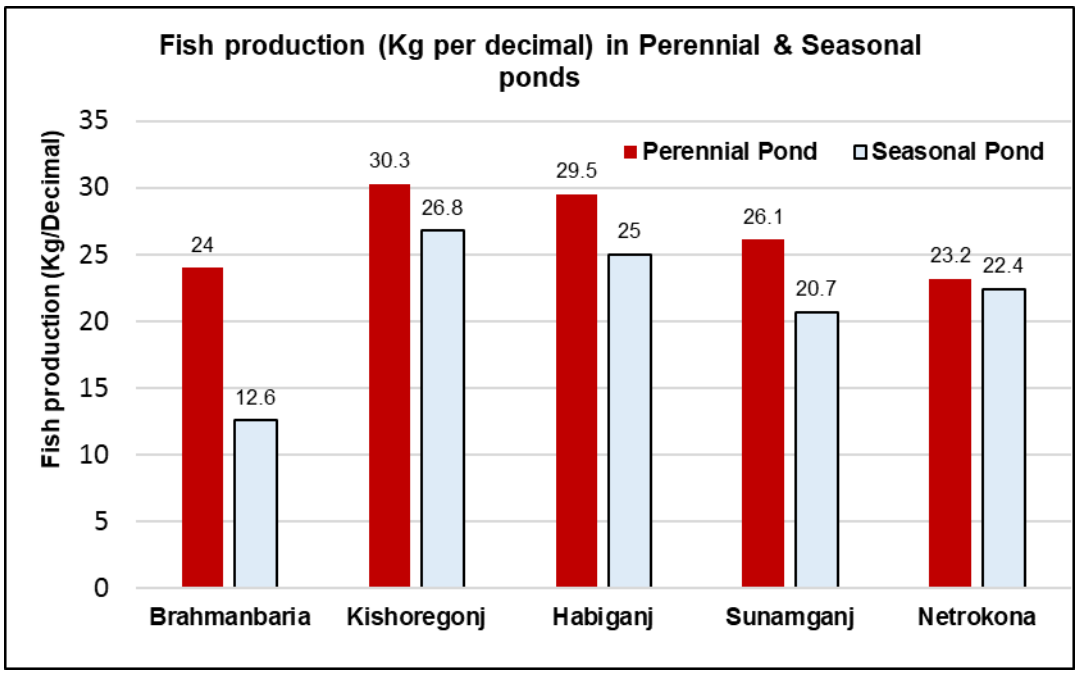


Figure 7: Average fish production (Kg/decimal) in Perennial and Seasonal ponds

5.5.2 Assessment of Impact of Fish Culture

Local economies can gain significantly from both direct benefits of haor pond aquaculture activities, (i.e., increased production, profits, incomes, etc.) and indirect benefits of employment and service provision linkages created by the aquaculture activities. The average fish price (per kg) from perennial pond aquaculture are between Tk. 97 and 123 per kg compared to fish price of Tk. 106 – 172 per kg from seasonal pond aquaculture. Figure 8 presents the average price of fish per kg of both perennial and seasonal ponds in HILIP areas.

Using available information on cost and absulate benefit the study reveals that pond fish farming provided an acceptable benefit in both perennial and seasonal ponds. The average absulate benefit per decimal from perennial ponds varies between Tk. 1134 and Tk. 2113, and that from seasonal ponds varies between Tk. 1143 and Tk. 1664. Pond fish culture in perennial ponds shows lower benefit in Netrokona district and higher benefit in Habiganj District. In contrast, pond fish culture in seasonal ponds shows lower benefit in Sunamganj district and higher benefit in Netrokona District. Figure 9 shows variation of benefits per decimal at different districts for both perennial and seasonal ponds.

Using cost benefit information for both perennial and seasonal ponds the study reveals that the maximum benefits from perennial and seasonal ponds varied between Tk. 103,956 (US$ 1268) and Tk. 130,247 (US$ 1588) minimum benefits varied between Tk. 40,377 (US$500) and Tk. 61,843 (US$ 754). Figure 10 shows variation of benefits per pond at project districts for both perennial and seasonal ponds.

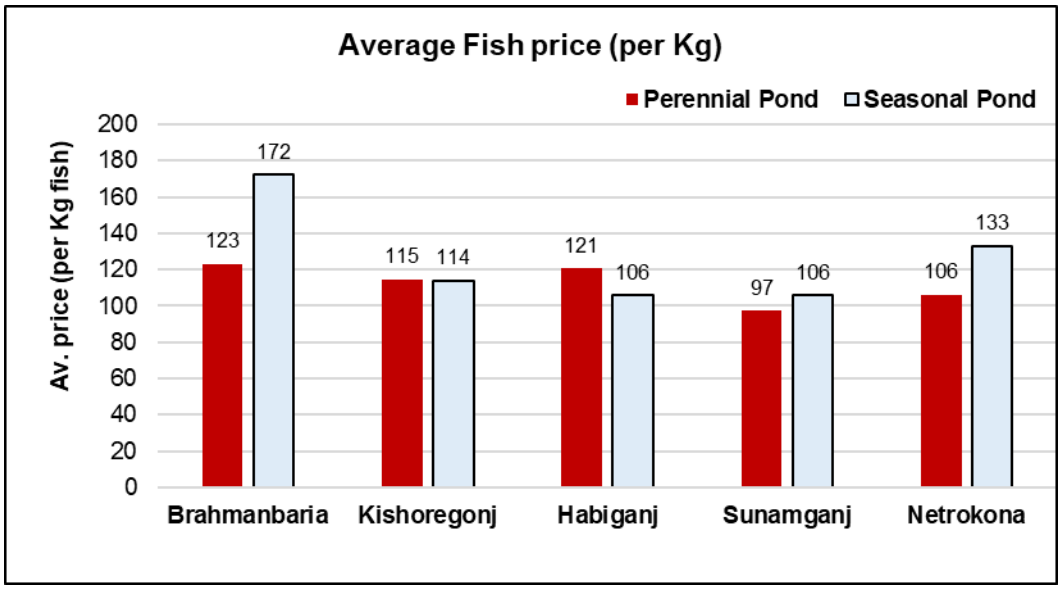


Figure 8: Average fish price (per Kg) in Perennial and Seasonal ponds

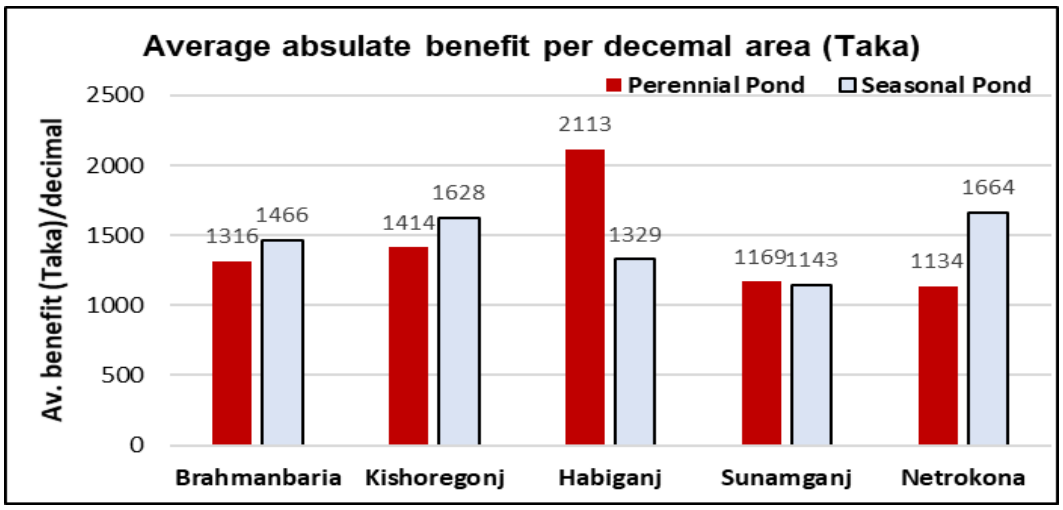


Figure 9: Average absulate benefit (Taka) from Fish Culture at per Decimal Area

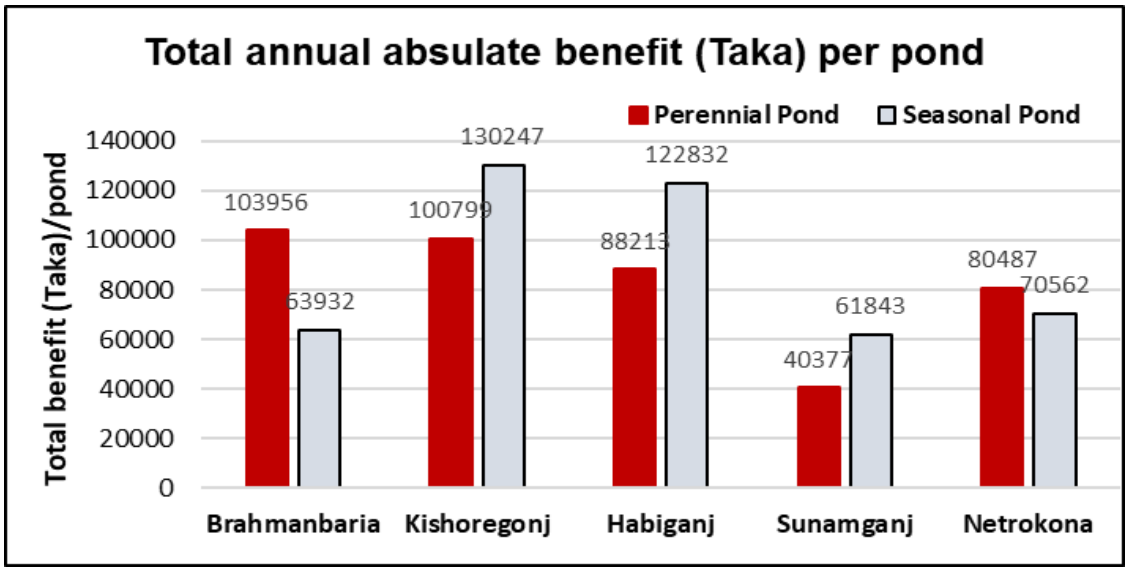


Figure 10: Average annual absulate benefit (Taka) from fish culture in each Perennial (N=53) and Seasonal (N=39) pond.

5.6 Assessment of Fish Culture: Impact of Exotic Species on Natural Fish Population

Haor pond aquaculture yields are mostly comprised of both indigenous and exotic fish species. The fish species in HILIP area comprises exotic species e.g. Tilapia, mono-sex Tilapia, Silver carp, Thai pangus, Common carp, Thai sarputi, Grass carp and most of these are available in culture fishery. Production in floodplains and beels has increased due to stocking with carp fingerlings, Beel nursery program and the strengthening of conservation measures. Besides, the production of *haor* pond fishery has gradually been increasing due to training through several projects, mostly HILIP and CALIP and stocking with carp fingerlings.

Fish production yields from perennial ponds are comprised of 24% indigenous cultured fish, 68% exotic fish and 8% indigenous non-cultured fish (Figure 11). Fish production yields from seasonal ponds comprised 18% indigenous cultured fish, 67% exotic fish and 15% indigenous non-cultured fish (Figure 12). Overall fish production yields from both perennial and seasonal ponds are comprised of 22% indigenous cultured fish, 67% exotic fish and 11% indigenous non-cultured fish (Figure 13). Since the culture technologies are well developed for the exotic species; so, these species accounted for about 67% of the total *haor* ponds production in the study area.

Exotic fishes are those species of fishes, which are not native and introduced for other countries to the local areas. Exotic animals are defined as “species occurring outside of its natural range”. Among numerous reasons for introduction of exotic aquatic animals into countries, aquaculture development is said to be a main motive (Welcomme, 1998). Various sources noted that the introduction of individual fish species occurred in different times and major exotic fishes have been introduced during the last few decades in Bangladesh waters. Exotic species have provided socio-economic benefits through enhanced aquaculture production for a vast number of poor people in Bangladesh. There is no accurate information on their spread and negative ecological impacts in the haor region of Bangladesh. However, major concerns over the introduction of exotic fish are prolific breeding, predation or competition of the introduced species affecting indigenous biodiversity. The

exotic fish species varies predominantly between 6-7 species and these are cultured in the haor ponds. Some of these species may pose a threat to indigenous biodiversity, through their escape and establishment of feral populations in adjacent haor water bodies.
The study revealed that along with cultured species, the natural local fish have provided essential nutrients and socio-economic benefits for a vast number of poor and vulnerable people in the haor region. The approach should be extended with more species of natural local fish beyond study areas to ensured nutrients and biodiversity for the future generations.

Mola carplet (*Amblypharyngodon mola*) is a nutrient-rich small fish that provides essential nutrients, in particular, vitamin A, calcium, iron and zinc, and is used as food fish in Bangladesh. HILIP also introduced Mola carplet fish along with other natural indigenous species in haor ponds. Consequently, a good harvest of mola fish reveals successful HILIP intervention in both perennial and seasonal ponds. Overall, the mola fish harvest comprised about 1% and 2.88% of perennial and seasonal ponds productions respectively. However, in Sunamganj and Habiganj districts mola fish contributed 5.95% and 3.75% in seasonal and perennial ponds respectively. The mola culture has no adverse environmental impact and may be grown without hampering the growth of existing fishes. The mola fish became popular among farmers in haor region in Bangladesh. This fish is available in the rivers, streams, beels and lakes and inundated fields throughout Bangladesh. However, the decline in the areas of inland waters and area of inundation, significantly reduced the vital habitat for its recruitments & stocks. The taxonomic group used in the catch analysis of the pond fishery & taxa contributed to each group (Native cultured fish, Exotic cultured fish and natural non-cultured fish) by % to the catches is given in Annexure 5. The comparison of culture fish in perennial ponds, seasonal ponds and combination of two types of ponds together are shown in Figure 11 , Figure 12 and Figure 13 respectively.

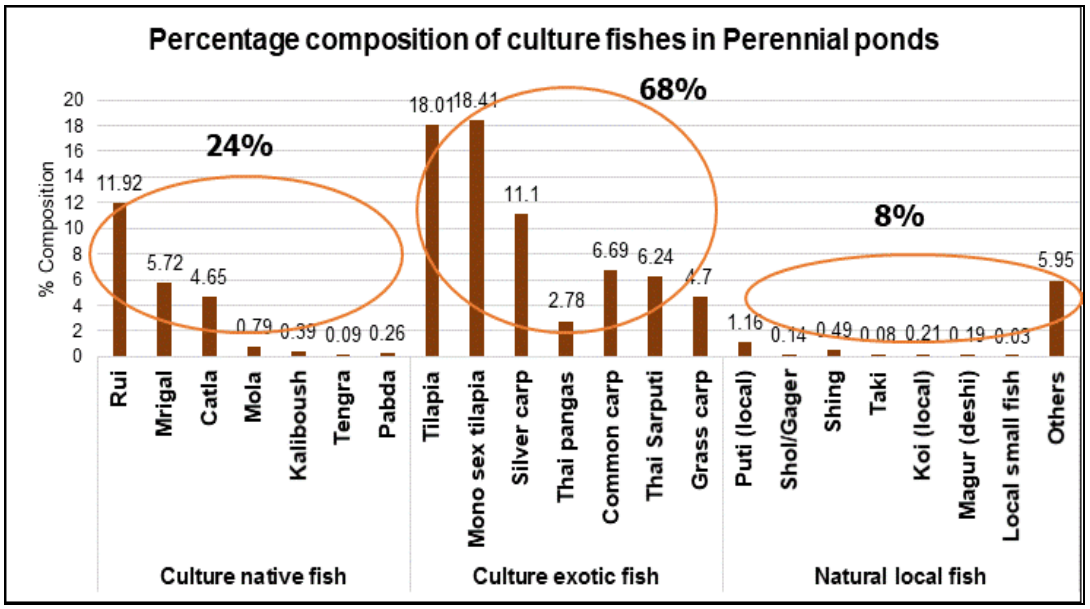


Figure 11: Percentage composition of fishes in perennial ponds

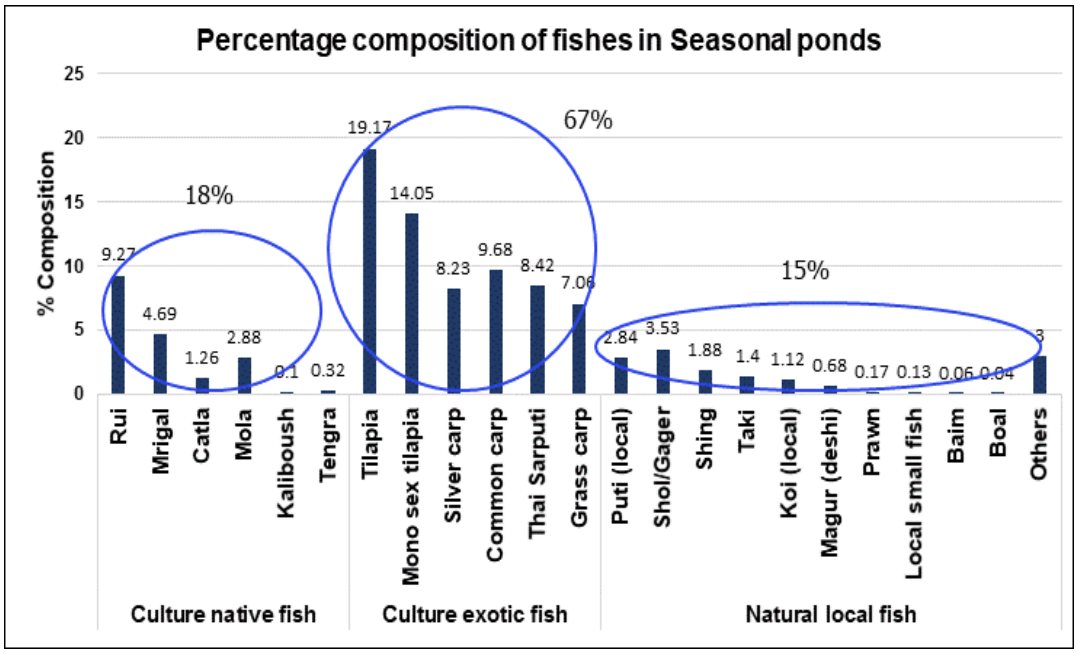


Figure 12: Percentage Composition of Fishes in Seasonal Ponds

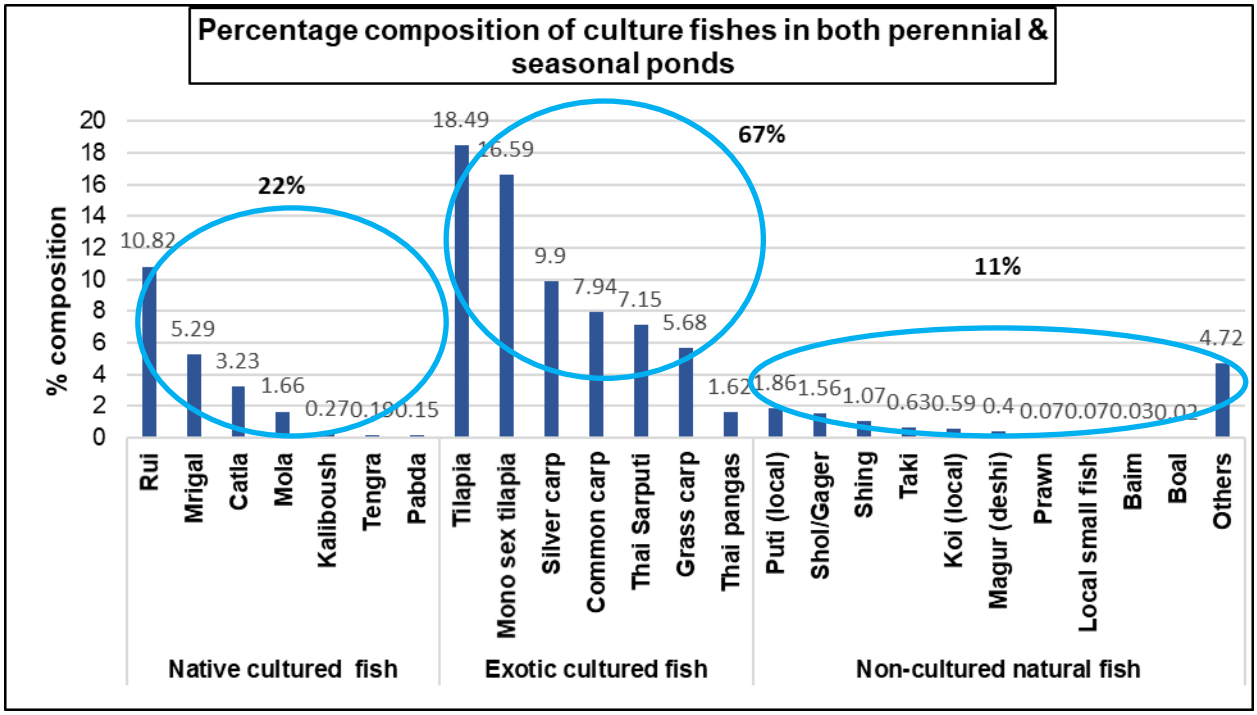


Figure 13: Percentage composition of fishes in both perennial and Seasonal pond

Photos of some common cultured fishes in the study areas (Source: Balaram, M. & M. G. Mustafa, 2011).

Photos: Native cultured fishes in the haor pond.

Local name	Common name	Scientific name	Photo source	Photo
Rui	Ruhu	*Labeo rohita*	Balaram, M. & M G Mustafa, 2011.	
Mrigal	Mrigal carp	*Cirrhinus cirrhosus*	Balaram, M. & M G Mustafa, 2011.	
Katla	Catla	*Catla catla*	Balaram, M. & M G Mustafa, 2011.	
Tilapia	Tilapia	*Oreochromis niloticus*	Balaram, M. & M G Mustafa, 2011.	
Mola	Indian carplet	*Amblypharyngodon mola*	Balaram, M. & M G Mustafa, 2011.	

Photos: Exotic cultured fishes in the haor pond.

Local name	Common name	Scientific name	Photo source	Photo
Tilapia	Nile tilapia	*Oreochromis niloticus*	Balaram, M. & M G Mustafa, 2011.	
Silver carp	Silver carp	*Hypophthalmichthys molitrix*	Balaram, M. & M G Mustafa, 2011.	
Common carp	Common carp	*Cyprinus carpio*	Balaram, M. & M G Mustafa, 2011.	
Thai sarputi	Thai sarputi	*Barbonymus gonionotus*	Balaram, M. & M G Mustafa, 2011.	
Grass carp	Grass carp	*Ctenopharyngodon idella*	Balaram, M. & M G Mustafa, 2011.	

Photos: Non-cultured natural fishes in the haor pond.

Bengali name	English name	Scientific name	Source	Photo
Taki	Spotted snakehead	*Channa punctatus*	Balaram, M. & M G Mustafa, 2011.	
Shol	Striped snakehead	*Channa striata*	Balaram, M. & M G Mustafa, 2011.	
Baim	Eel fish	*Macrognathus pancalus*	Balaram, M. & M G Mustafa, 2011.	
Koi	Climbing perch	*Anabas testudineus*	Balaram, M. & M G Mustafa, 2011.	
Shing	Stinging cat	*Heteropneustes fossilis*	Balaram, M. & M G Mustafa, 2011.	

5.7 Roles of Women in Pond Fish Culture

Traditionally, Bangladeshi women are involved in fish culture or fishing related activities at the post-harvest stage of the production process. However, haor pond aquaculture does create the situations for a diversification of their involvement, through the service provision opportunities, such as cleaning weeds, carrying soil up the pond bank, pond cleaning, testing water quality by visual obsevation of colour of waterapplying fish feed, fertilizer and lime and taking decision.

In perennial ponds, women were observed having a more significant role in the production process, either as pond culture operators or as advisors to the households' heads. In Depth Interviewed revealed that the haor pond culture has greatly enhanced their involvement in pond culture and opened new economic opportunities. The roles of women in pond fish culture over the study area are shown in **Figure 14**.

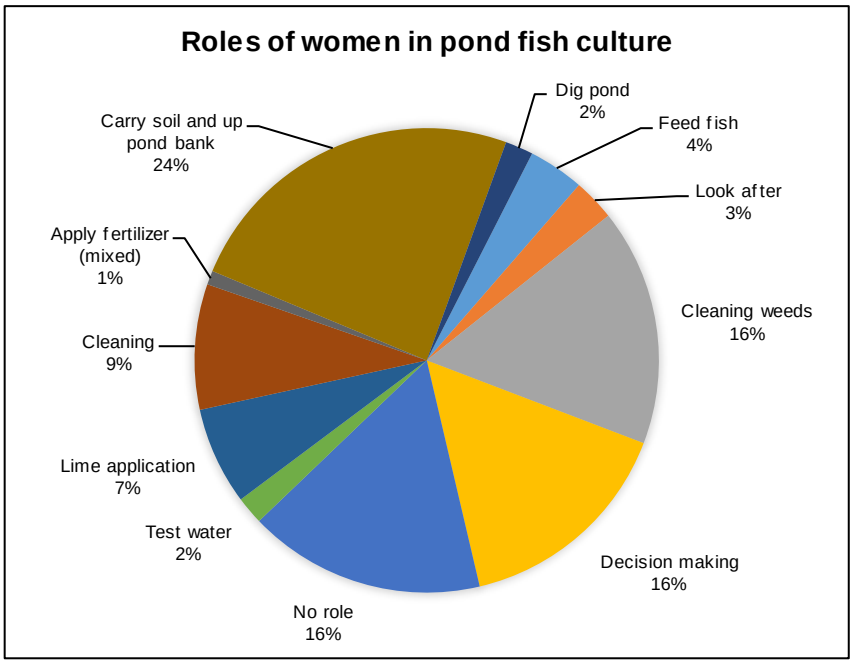


Figure 14: Overall Roles of Women in Pond Fish Culture

Among various roles, feeding is the vital for women. It has been revealed that 48% and 15% of women are directly involved with feeding fish and mixed up feeds respectively. Besides, they are also involved with guarding, cleaning water hyacinth, examining water quality (colour) and looking after other related activities. The roles of women in feeding and caring are shown in **Figure 15**.

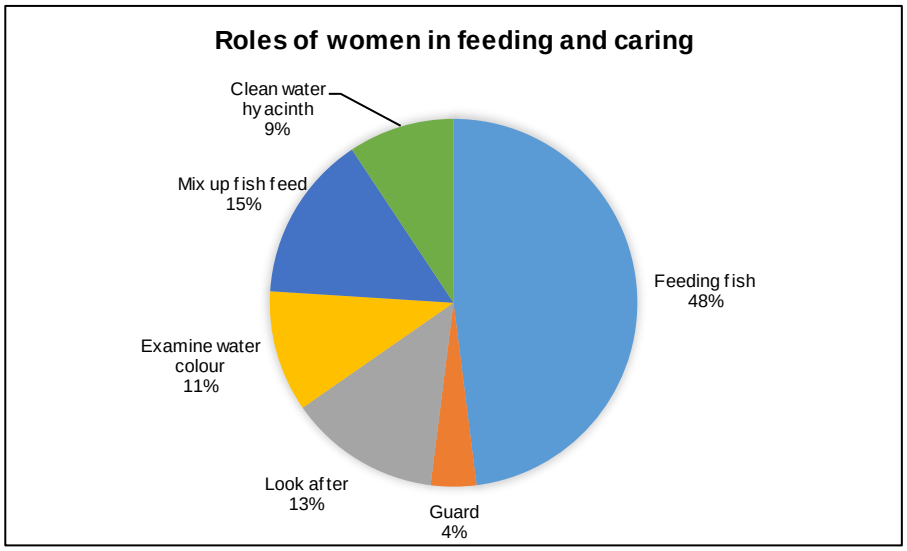


Figure 15: Roles of Women in Feeding and Caring During Fish Culture

In the dry season, post-harvest makes a significant contribution to the economic activities of women in the haor areas. Grading and drying is the most laborious post-harvest activities and it has been revealed that 76% and 11% women are directly involved with grading and fish drying respectively. Besides, they also directly involve with cleaning the fish, maintain accounts and, help during catching fish. The roles of women in post-harvest over the study area are shown in **Figure 16**.

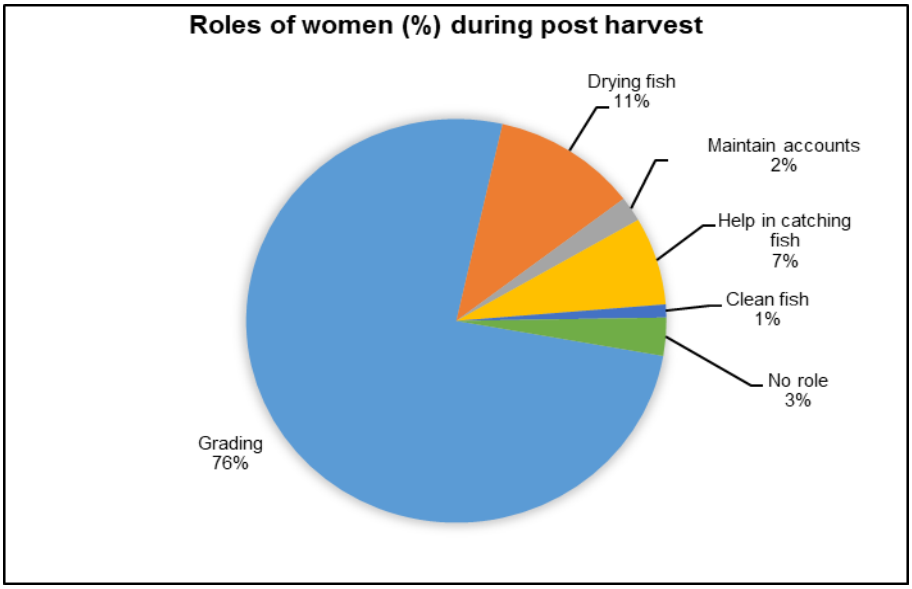


Figure 16: Roles of women during post-harvest

5.7.1 Assessment of Environmental (Physical, Biological and Social) Situation

The project team communicated with the Bangladesh Meteorological Department to collect available data within or adjacent to the project areas. Average annual variation of temperature, seasonal variation of rainfall and high and low, water level characteristics of major rivers have been collected, and analyzed and described in the section 5.10.1; 5.10.2 and 5.10.3.

5.8 Environmental Impact

5.8.1 Impact of Flash Flood

Haor is a basin like structure where water remains either stagnant or flooded during early monsoon due to flash flood or accumulation of rain water from break storms. The haor area is susceptible to flash flooding from water coming down hilly streams emerging out of Khasia- Jaintia Hills located in the Indian Territory. There are many haors in Bangladesh, which remain either full of stagnant water or are flooded during the months of June to November (Khan et al 2012). Flash flood occurring at interval damages crops and flashes out fish in ponds in the haor area. Exotic species of fish cultured in ponds escape, quite often during a flash flood, to wide haor area, exposing the local species to be affected by these species.

Flash floods are common phenomena in the haor area and usually damage pond fishery and create negative impacts on the local economy. Flash floods damage Boro crop and pond aquaculture; so the present study was conducted to know the impact of flash flood on fishery in HILIP area. Primary data were collected through IDIs from 92 pond owning households from 28 project upazilas. Most of the respondents were pond owners as well as farmers. Among the different categories of flood, flash flood damages the pond fishery most. According to the respondents damaged to ponds, washing out of fish and destruction to dykes of the pond occur in 23%, 28% and 20% cases respectively. Only 3% respondents revealed that ponds were totally flooded due to flash flood. However, 26% respondents

stated that no impact occurred on pond aquaculture due to flash flood. Flash flood often causes considerable localized damage to pond fishery, especially, more in the deep flooded area. The north, northeastern part of the haor districts which is relatively high does not face any impact on their perennial pond aquaculture by flash flood. The households in this part make most of the 26% of the households, who felt that flash flood has no adverse effect on aquaculture. Figure 17 shows the impact of flash flood on pond fish as conceived by pond fish farmers in the HILIP areas.

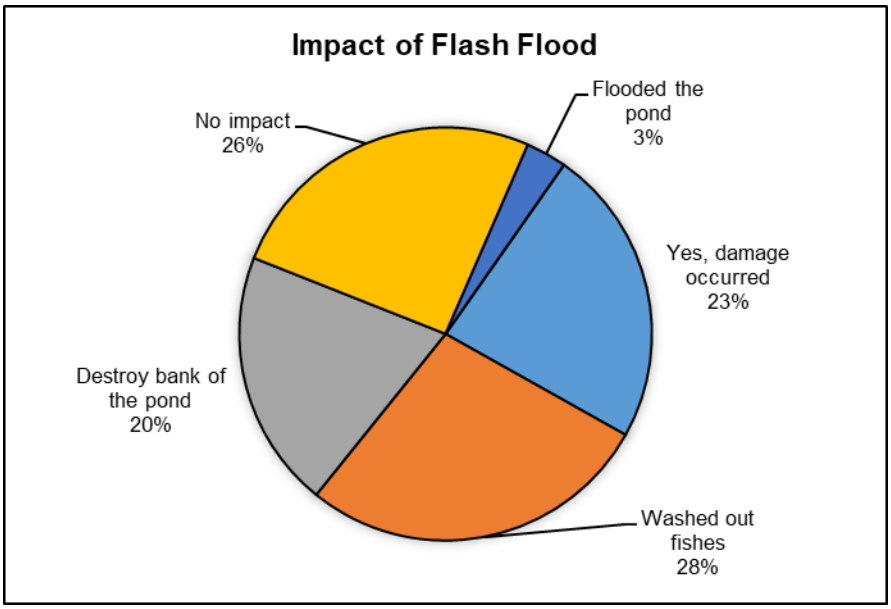


Figure 17: Community Perception on Flash Flood

5.8.2 Impact when Number of Fish Culture Units Increased

Haor area is very important for the production of fish, especially open water fish. However, recently pond aquaculture is increasing in both perennial and seasonal ponds.

From the study, 29% of the respondents, who are pond fish culturists, said that no detrimental effect will occur if pond culture is increased in the haor areas. However, 22% respondents' reveals that this increase may affect local natural species of fishes and 21% respondent views that agricultural land will decrease, if pond aquaculture is increased in haor areas. Besides 6% respondents, views that this might destroy the environmental balance and may cause of decrease of water lily, which occur very commonly in haor area of Bangladesh. **Figure 18** shows respondents' views regarding impact, if the number of units of pond culture is increased in the haor areas.

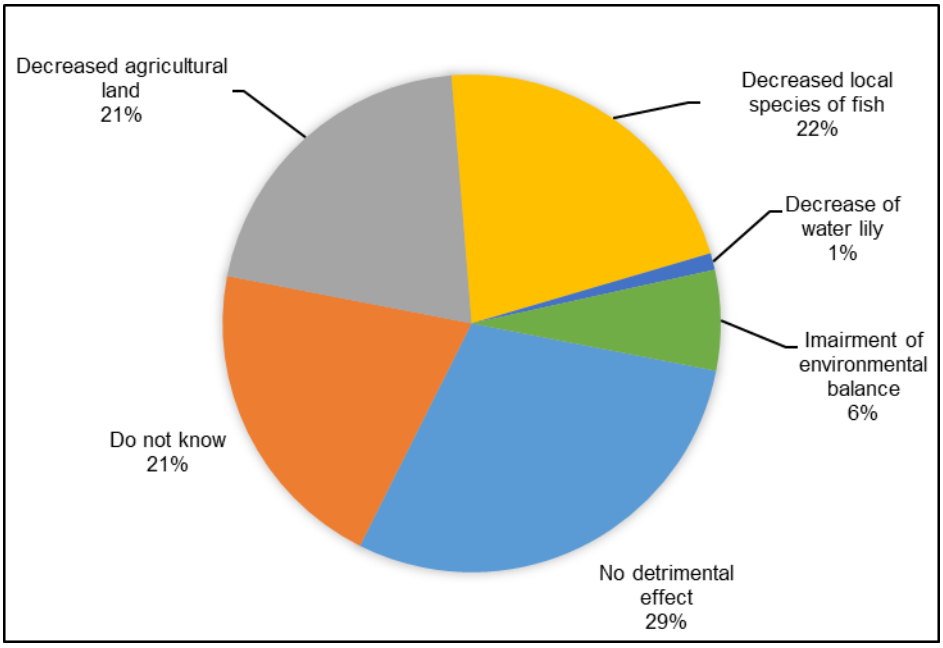


Figure 18: Community Perception on Impact of Increased Pond Culture

5.8.3 Impact of Escape of Cultured Fish to Haor Water

The effect of escape would be psychological as well as financial. According to the study, 67% of the pond farmers said that financial loss will occur when cultured fish escape into haor waters. Climatic effects, like heavy localised rainfall, cyclonic precipitation, strong wind etc, may initiate this escape. Such repeated occurrence may discourage the fish farmers and dissuade them from the activity according to 6%.of the respondents. However, 27% respondents reveal that no impact will occur. **Figure 19** shows respondents' views regarding impacts on fish culture if fish escape to haor waters.

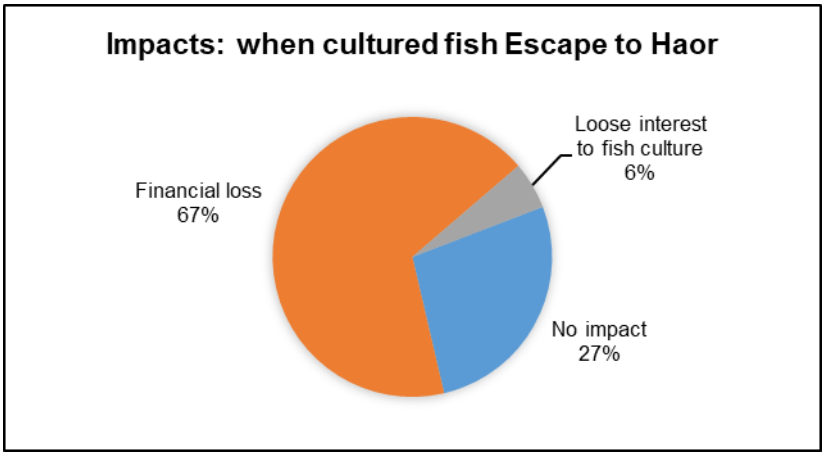


Figure 19: Community Perception on impact on Fish Culture if cultured fish escape to Haor

5.8.4 Impact on Pond Culture – When Insecticide are Applied in Agriculture

Insecticide is one of the toxic compounds linked to human use that have a profound effect on aquatic life especially fishes and water quality. Insecticides are substances used to control pests,

including insects. Insecticide can contaminate soil, water, turf and other vegetation. In addition to killing insects or weeds, insecticide can be toxic to a host of other organisms, including fish, birds, beneficial insects, and non-target plants. According to the study, 45% respondents reveal that there will be no impact on pond aquaculture, if insecticides are applied in agriculture according to prescribed dose. However, 22% respondents reveal that agricultural insecticide will reduce fish growth and about 22% respondents view that fish disease will occur because of agricultural insecticide. Among the different types of impact due to insecticide in the agricultural field, 5%, 2% and 3% respondents reveals that floating dead fish will appear, destroy water quality and infect fish body respectively. Only 1% respondent's reveals that eggs of local fish will be destroyed due to use of insecticide in agriculture field. **Figure 20** shows respondents' views regarding impacts when insecticides are applied in agriculture field in haor area.

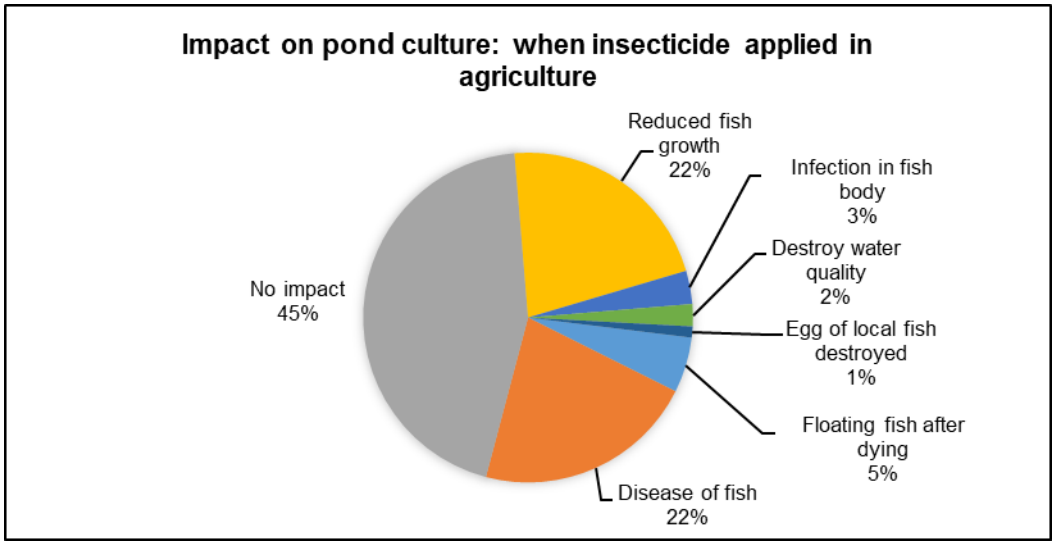


Figure 20: Community Perception: Impact on Pond Culture by the use of Insecticide in Agriculture

5.8.5 Physical Environment

The project area extends from extreme North-East to the mid-South-West of the country. *Haors* as the name implies for low-lying area. The highlands are mostly man made hatches where the habitation area lies. However, a small area in the North covering few upazilas of Sunamganj District and a small segment of Brahmanbaria Sadar Upazila of Brahmanbaria District lies in the terrace and Piedmont area, having high and medium high land.

5.8.6 Water Quality

Water is a valued natural resource for the existence of all living organisms. Water quality is determined by various physicochemical and biological factors, as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals (Moses 1983). The water quality characteristics of different water bodies (perennial and seasonal) are altered after receiving various kinds of pollutants. Such alteration has been reported in different parts of the country by different workers. A sharp drop or an increase in content of dissolved or suspended materials within these limits has adverse effects on the body functions of aquatic organisms (Davenport 1993).

Water quality in the monsoon in the haor area is of normal quality, clean and transparent. Water is somewhat turbid in the river flow area but, it is still much less than other rivers like the Ganges and the Brahmaputra and their branches.

The water quality in the dry season undergoes sufficient changes as the beels and haors become confined or semi confined. Some of Water quality parameters collected during late 2016 in the post monsoon in three haor beels of Kishoreganj District depict that temperature, Electric Conductivity, Dissolved Oxygen, pH and TDS are well within the standard prescribed (Moshtari et al 2018) and presented in **Table 12.**

Table 12: Physicochemical Water Quality Parameters of Haors at Project Sites in Kishoreganj District

Parameters	Months			Standard
	October	November	December	
Temp (°C)	27.5	26.8	24.5	20.0 – 30.0 (EQS, 1997)
EC (µS/cm)	484	553	625	700 (EQS 1997)
DO (mg/a)	6.8	6.7	6.8	> 5.0 (EQS, 1997)
pH	7.23	7.34	7.4	6.5 – 8.5 (ECR, 1997)
TDS	476	540	560	1000 (ADB, 1994)
BOD	2.8	2.7	2.8	Below 2.0 (EQS, 1997)

(Source: Moshtari et al 2018).

5.8.6.1 Determination of Water Quality of Ponds

Primary data on water temperature, pH, Electrical Conductivity (EC), Total Dissolved Soild (TDS), Dissolved Oxygen (DO), Transparency (m), Nitrate (NO3), Nitrite (NO2) and Ammonia (NH3) were collected and analyzed as per standard method from 20 cultured ponds under HILIP in the five districts.
Data on water quality according to some important parameters were collected with instruments following the methods described hereunder.

Water Temperature: Temperature of water was measured by a Mercury thermometer in ^{0} Celsius. The thermometer gave temperature by direct reading.

pH: The pH of water bodies / ponds was observed in-situ with Hanna pH meter (Model HI 97107). Before observation the instrument was calibrated with pH buffer solution prepared by dissolving one pouch of solid supplied with the instrument in one beaker in 250 ml of deionized water. This solution gave a pH of 4.00 at 15-25 ^{0} and 4.01 in the range of temperature 25- 32^0 C. On calibration the instrument was used for observation. On completion of observation the instrument was checked with the buffer solution at 25^{0}C and found to be at pH 4.00.

Electrical Conductivity (EC): Electrical conductivity was measured with EZDO-COND5021 conductivity meter. Conductivity was measured in–situ at pond sites. Before use of the instrument the electrodewas rinsed with clean water and wiped dry. The electrode was immersed in calibration solution of 0.01N KCL. The probe containing the electrode was gently stirred in the calibration solution until the display stabilized. The reading was adjusted to 141 (1413 µS/cm) for conductivity.

The electrode was wiped dry before actual observation. On calibration the instrument was used directly to get the electric conductivity by gently stirring into the sample pond water held in a beaker.

Total Dissolved Solid (TDS): The same instrument was used after calibration. Before use of the instrument the electrodes was rinsed with clean water and wiped dry. The electrode was immersed in calibration solution of 0.01 N KCL. The probe containing the electrode was gently stirred in the calibration solution until the display stabilized. The reading was adjusted to 94 (940 ppm) for conductivity. The electrode was wiped dry before actual observation. On calibration the instrument was used directly to get the electric conductivity by gently stirring into the sample pond water held in a beaker. The readings were recorded by three observations and the mean was used for calculation of the TDS.

Dissolved Oxygen (DO): Dissolved Oxygen is affected by consumption by organism or chemicals and transportation of samples requires acidification and maintenance of low temperature that inhibit consumption by microbes. So, in-situ observation was undertaken with dissolved Oxygen instrument Model (DO 5509). The instrument was first calibrated at air oxygen content with a probe inserted at a slot electrically connected to main instrument. The instrument uses a 9 watt battery for observing readings. The instrument was calibrated at 20.9 mg content of oxygen in air with probe fixed with solvent protected by a membrane. The probe was then used for observation in the water. The temperature of pond water was taken previously.

Transparency of Pond water: This was measured with a Secchi Disk (30 cm dia) used to gauge the transparency of water by measuring the depth—known as the *Secchi depth* —at which the disk ceases to be visible from the surface. Water transparency, an indirect biological response, is measured by the Secchi depth (m). The acceptable level of water quality, measured by Secchi depth and chlorophyll a (Chl-a). Secchi depth of 30-40 cm is required.

Nitrate (NO_3): This was measured with a kit (Nice Brand). 10 ml of water sample was taken in a test tube and a pinch of Nitrate reagent (NA-1) was added and agitated for 5 minutes. It was allowed to stand for another five minutes. The supernatant liquid was decanted in another test tube. Three drops of Nitrate (NS-2) agent was added to the solution and mixed well. The solution was allowed stand for five minutes with occasional shaking. The final colour of solution reached is matched Nitrate colour chart and recorded the nitrate value.

Nitrite (NO_2): 5 ml of sample water was taken in a test tube and three drops of Nitrite reagent (NI-1) was added and mixed well. One minute time was allowed to elapse with occasional shaking. The final colour of solution reached is matched Nitrite colour chart and recorded the nitrite value.

Ammonia (NH_3): 5 ml of sample water was taken in a test tube and three drops of Ammonium reagent (NH-1) was added and mixed well. The colour that formed immediately was matched with Ammonium colour chart and recorded the Ammonium value.

The observations in the field were conducted by a couple of Agricultural graduates. The researchers were given one full day training on calibration and measurement. Some pictures of water quality data collection are shown in **photos 31 to 37**.

Photo 31. Picture of water quality parameters collection in Lakhai, Habiganj

Photo 32. Picture of recording water temperature with a thermometer at a pond in Nikli, Kishoreganj

Photo 33. Picture of water quality parameters collection at Nikli, Kishoreganj

Photo 34. Picture of measurement of Dissolved Oxygen in Sadar, Sunamganj

Photo 35. Picture of measurement of EC of water at Derai, Sunamganj

Photo 36. Picture of pH measurement with Hanna pH meter at Nasirnagar, B. Baria

Photo 37. Picture of measurement of EC of water at Madan, Netrokona

5.8.6.2 Water Quality Collected from the Project Area

Water Quality of five project districts were collected from 20 ponds at the rate of 4 ponds from each district. Ponds in each district were taken for two sample upazilas. Water quality parameters of pond standard by EQ 1997 and BCAS 1997. The test results are shown in Table 13.

Table 13: Water Quality Parameters of Ponds in five districts.

Parameters	Unit	Pond1	Pond 2	Pond 3	Pond 4	Standard
Sunamganj District						
Temperature	^{0}C	30	30	31.3	31.3	20.0 – 30.0
pH	No	7.8	7.2	6.8	7.1	6.5 – 8.5
Electrical conductivity	Micro Siemens	170	130	230	213	700
Dissolved Oxygen	Mg/Litre	5.86	6.07	6.6	6.7	4.5-8
Turbidity	Depth/Meter	0.35	0.21	0.35	0.33	30-40 cm
Total Dissolved Solid	Mg/Litre	113	87	153	142	1000
Nitrate content	Mg/Litre	1	1	0.4	1	10
Nitrite Content	Mg/Litre	0.1	0.2	0.3	0.2	<1
Ammonia	Mg/Litre	0.5	0.5	0.5	1	0.5 mg/L
Habiganj District						
Temperature	^{0}C	32.3	32	32.3	30	20.0 – 30.0
pH	No	7.5	8	7.5	7	6.5 – 8.5
Electrical conductivity	Micro Siemens	200	280	283	347	700
Dissolved Oxygen	Mg/Litre	5.5	5.8	6.2	5.67	4.5-8
Turbidity	Depth/Meter	0.3	0.28	0.25	0.2	30-40 cm
Total Dissolved Solid	Mg/Litre	133	187	189	231	1000
Nitrate content	Mg/Litre	0	0	0	1	10
Nitrite Content	Mg/Litre	0.17	0.2	0.1	0.17	<1
Ammonia	Mg/Litre	1	1	1	1	0.5 mg/L
Brahmanbaria District						
Temperature	^{0}C	32.3	32	31	33	20.0 – 30.0
pH	No	8.1	8.1	8.3	8.5	6.5 – 8.5
Electrical conductivity	Micro Siemens	58	58	93.5	275	700
Dissolved Oxygen	Mg/Litre	6.24	6.33	5.86	6.05	4.5-8
Turbidity	Depth/Meter	0.39	0.4	0.31	0.35	30-40 cm
Total Dissolved Solid	Mg/Litre	39	39	62	183	1000
Nitrate content	Mg/Litre	0	0	0	0	10
Nitrite Content	Mg/Litre	0.1	0.1	0.1	0.1	<1
Ammonia	Mg/Litre	0.5	0.5	0.5	0.5	0.5 mg/L
Kishoreganj District						
Temperature	^{0}C	28	29	29	28	20.0 – 30.0
pH	No	8.3	7	7.8	8	6.5 – 8.5
Electrical conductivity	Micro Siemens	390	220	213	74	700
Dissolved Oxygen	Mg/Litre	6.1	5.71	5.97	6.71	4.5-8
Turbidity	Depth/Meter	0.2	0.5	0.55	0.35	30-40 cm
Total Dissolved Solid	Mg/Litre	260	147	142	49	1000

Parameters	Unit	Pond1	Pond 2	Pond 3	Pond 4	Standard
Nitrate content	Mg/Litre	1	0	2	0.1	10
Nitrite Content	Mg/Litre	0.1	0	0.2	0	<1
Ammonia	Mg/Litre	1	1	0.1	0.5	0.5 mg/L
Netrokona District						
Temperature	^{0}C	29.7	28.7	56	31	20.0 – 30.0
pH	No	7.7	7.3	9.2	9.3	6.5 – 8.5
Electrical conductivity	Micro Siemens	310	183	560	250	700
Dissolved Oxygen	Mg/Litre	5.6	5.8	5.1	5.5	4.5-8
Turbidity	Depth/Meter	0.22	0.42	0.22	0.18	30-40 cm
Total Dissolved Solid	Mg/Litre	207	122	373	167	1000
Nitrate content	Mg/Litre	0.1	1	0.1	0.1	10
Nitrite Content	Mg/Litre	0	0	0	0	<1
Ammonia	Mg/Litre	0.75	0.75	0.75	1	0.5 mg/L

5.8.6.3 District wise Analysis of Water quality as determined through Field Test

Range Analyses of the tables depict the temperature during the period of observation from 09 Apr 2019 – 21 Apr 2019 varied from 28^0 -33^0 C. The pH varied from 6.8 – 9.3. High pH was observed in ponds, which were almost dry. Dissolved oxygen varied from 5.5 mg – 6.71mg /litre. The electrical conductivity varied from 74 -560 micro Siemens/cm. The total dissolved solid varied from 39–373 mg/litre. The nitrate content varied from 0 – 2 mg/litre while that of nitrite varied form 0 – 0.3 mg/litre. Ammonium content varied from 0.5 – 1 mg/ litre. In all cases, the contents were within allowable limit.

The turbidity observed depicted that the depth at which the colour on Secchi disc obliterated was around 0.3 meter depth. However, the Secchi depth varied from 0.18m – 0.55m but most being around 0.30m. The overall situation depicted in Table 14.

Table 14: Physiochemical Water Quality Parameters of Haors at Pond Sites of Project Area

Parameters	Unit	Sunamganj	Habiganj	Brahmanbaria	Kishoreganj	Netrokona	Standard by EQ standard of 1997/Allowable
Temperature	^{0}C	30-32.3	30-32.3	31-33	28-29	28.7-31	20.0 – 30.0
pH	No	6.8-7.8	7-8	8.1-8.5	7-8.3	7.3-9.3	6.5 – 8.5
Electrical conductivity	µ Siemens	130-230	200-347	0.58-275	74-390	183-560	700
Dissolved Oxygen	Mg/Litre	5.86 -6.7	5.5 -6.2	5.85-6.33	5.71- 6.71	5.1-5.8	4.5-8
Turbidity	Depth/Meter	0.21-0.35	0.2-0.3	0.31-0.4	0.2-0.55	0.18-0.42	30-40 cm
Total Dissolved Solid	Mg/Litre	87-153	133- 231	39-183	49-260	122-373	1000
Nitrate content	Mg/Litre	0.4- 1.0	0-1	0	0.1-2	0.1-1.0	10
Nitrite Content	Mg/Litre	0.1-0.3	0.1-0.2	0.1	0- 0.2	0	<1
Ammonia	Mg/Litre	0.5-1	1	0.5	0.1-1	0.75 -1.0	0.0125 mg/L (James 1985)

5.8.7 Soil Quality

Soil within the haor system can vary in texture, drainage type, fertility and other parameters. The soils of the area are grey silty clay loams and clay loam on the higher parts that dry out seasonally and grey clays in the wet basin. About 74% of the top soil texture of the haor region is clay to clay loam, 21% loam and the rest are silty loam, sandy loam and sand.

The project area occupied mainly by silt loam, silty clay loams, non-calcareous loam, clayey and permeable loamy soils (LZR, 2011, 2014, 2015). In Brahmanbaria, silt loam to silty clay loam soils predominate on highlands/ridges and silty clay to clay on low lands/basins. The soils are slightly acidic to strongly acidic in reaction. The soil pH varies from 5.0 to 6.5 and organic matter content is low to medium. In Habiganj, the top soil is occupied by non-calcareous loamy soils and some parts are clayey. In Ajmiriganj, organic matter contents are low in the high land, but moderate in the lower parts. In Baniachong and Lakhai, organic matter contents are moderate. The top soil pH level ranges from 3.9-6.4. The soil of Kishoreganj area occupied silty clay loams and clay loam on the higher parts/ridges and clays in the lower parts/basin. Organic matter contents of soil are low to medium. The top soil pH level ranges from 4.1-7.5. Netrokona area is occupied by loam to silty clay loam on the ridges and silty clay and clay in the basins. Organic matter contents of soil are low to medium. The top soil pH level ranges from 4.5-7.5. The top soil of Sunamganj is occupied by acidic, permeable loamy soils or non-calcareous loamy soils and some parts are clayey. Organic matter contents are low in the high land, but moderate in the lower parts. The top soil pH level ranges from 4.3-6.8.

Acid soil makes pond water acidic. This is unsuitable for the growth of most algae and other organisms. So, it is impossible for fish to grow healthy in such an adverse environment. The top soil pH varies from 3.9 to 7.5 in the project areas. Upazila wise variation of the top soil pH level in the study areas is shown in **Figure 21.**

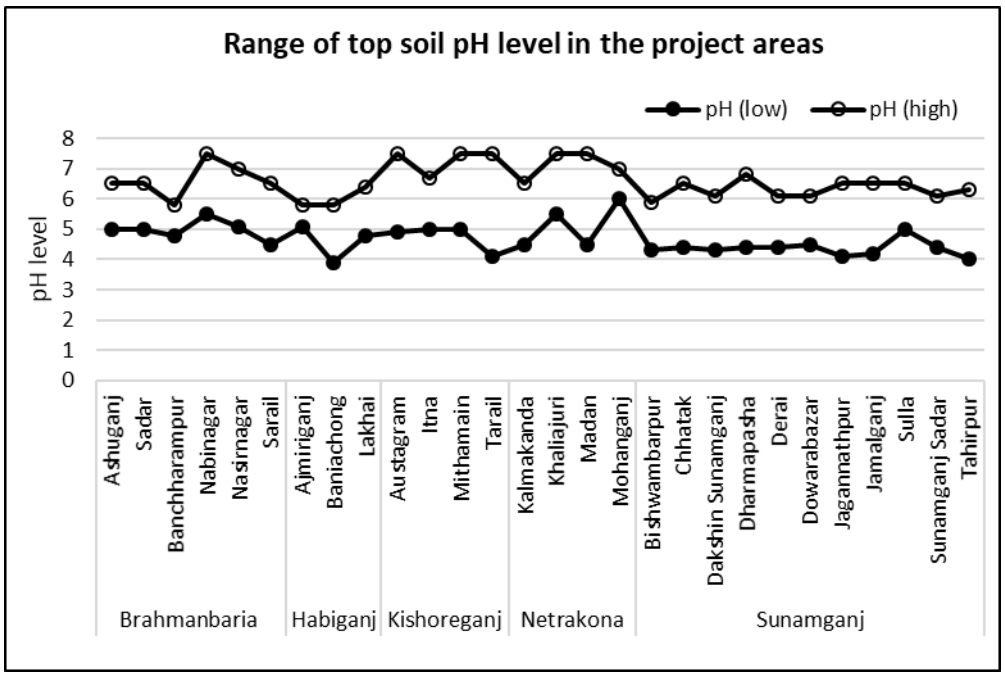


Figure 21: Range of top soil pH level in the project working areas.

5.9 Ecological Environment

Ecology is generally broad based as floral ecology and fauna ecology. Floral and faunal baseline situation has been studied by consulting relevant literature. These were checked in the field using group discussion with knowledgeable senior people in the project area.

Ecology is considered one of the important components for impact assessment as well as environmental auditing, because haor ecosystem is a unique and rich in biodiversity. It provides various tangible and intangible goods and services. Thus, auditing process for ecology has been designed with an assessment of the status of some key species and status of their habitats considering both pre and post project conditions. Some key ecological indicators have been identified based on literature review, review of project documents, secondary data analysis, i.e. In Depth Interviews (IDIs), Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) with knowledgeable senior people in the project areas. Selected ecological indicators are as below:

A. Flora: i) Aquatic flora, ii) Creepers iii) Herbs, iv) Shrubs and v) Trees

B. Fauna: i) Amphibians, ii) Mammals, iii) Reptiles, iv) Resident Birds and v) Fishes

In the last few decades, aquatic ecological degradation has become an alarming issue for haor region in Bangladesh. It casts impacts on natural fisheries resources, aquaculture productivity and food security of haor communities as well as biodiversity. To address the impact of scaling up pond aquaculture in haor districts, the HILIP-LGED study has gathered data on occurrence and diversity of flora and fauna parameters.

5.9.1 Flora

Flora identified have been classified under five categories viz. Aquatic flora, creepers, herbs, shrubs and terrestrial trees. The recorded terrestrial flora from the field area have mainly been collected through discussion with local people. The major habitat patterns of the study are homesteads, roadside and open land (very few).

The project area extending over five districts having mostly deeply flooded area and a small bit of high land have varying density of each type of flora and fauna. In the following section, we present the occurrence of each type of flora. The number of aquatic floral species in this part of country is significantly higher than other parts. Here we depict the range of occurrence showing maximal and minimal number of species in each area and the average number in the project area. Similarly, the trend of occurrence has been analyzed.

It is estimated that a total of 200 wetland plant species occurring in haor areas across the country. These are divided into five categories: Trees, Shrubs, Herbs, and Creepers for highland flora, and Aquatic flora. The aquatic flora have been again subdivided into three types: submerged plants, free-floating plants and rooted floating plants.

5.9.1.1 Aquatic Flora

The Haor Area is rich in aquatic flora. In all, 37 species were found in the project area. A maximum of 28 common species was founded at some of the sample places. The occurrence of common species was minimal at 24 in Habiganj District. This indicates that the number of aquatic floral species is more or less similar over the region. The number of rare species in a place varied from 9-11 while that for very rare species was 0- 4. The average number of common species over the region is 26 while the rare and very rare species are 10 and 1 respectively.

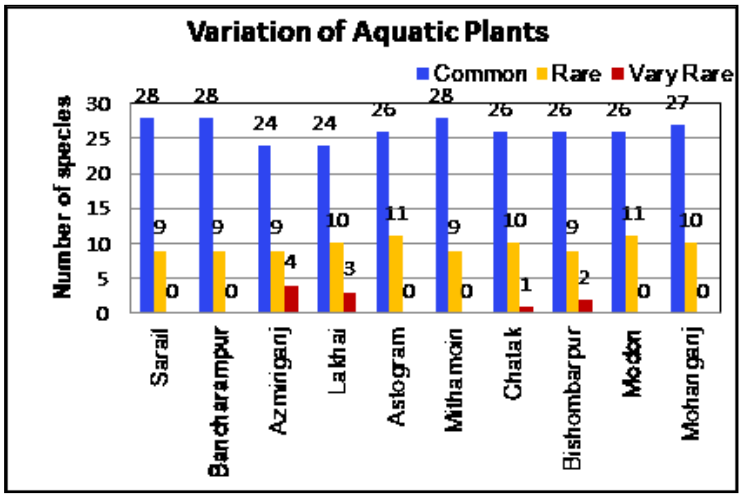


Figure 22: Status of Aquatic plant species in HILIP areas

The trend of occurrence of aquatic floral species over the region depicts that on average 8 species are decreasing in occurrence, 25 species remain unchanged while 1 specimen can hardly be found. On average, the number of increase of species is 2. The increase is mainly due to nurturing of Khudipana and topapana as fish food. At places, Kalmishak is increasing as it has human consumption value as a vegetable. Kachuripana, a menace, is increasing at places. The situation is depicted in **Figure 22**. Status of aquatic floral species is given in the **Annexure 6.**

Endangered and Threatened Aquatic Floral Species: Nol-Khagra has been reduced significantly. These uses to work as wave attenuators. As a result, village hamlets are now subject to more wave action. Jal padma (Lotus) previously nurtured in ponds for beauty and aesthetics is hardly cared for now and are found to have decreased in availability.

The trend of aquatic flora over the region depicts that on average 8 species are decreasing in occurrence, 25 species remain unchanged while 2 species is found increasing and 1 specimen can hardly be found. The summary is given in **Table 15**.

Table 15: Distribution of Occurrence and Trend of Occurrence of Aquatic Floral Species

Occurrence				Trend	
Species Status	Max. No. at a sample place	Min. No. at a sample place	Avg. No in the project area	Status	Number
				Increasing	2
Common	28	24	26	Unchanged	25
Rare	11	9	10	Decreasing	8
Very Rare	4	0	1	Hardly Available	1

5.9.1.2 Creepers Plants

At the project sites, 12 creeper species were identified through discussion and observation. A maximum of 8 common species was found at some of the sample places located mostly in Brahmanbaria and Kishoreganj districts.

The occurrence of common species was minimal at 3 at Biswambarpur of Sunamganj District. The number of rare species in a place varied from 3- 5 while that for very rare species was 0-4. The average number of common species over the region is 7 while the rare and very rare species are 4 and 2 respectively. The number of species is less in Habiganj and Sunamganj districts. The situation is depicted in **Figure 23.** Status of creepers plant is given in the **Annexure 7.**

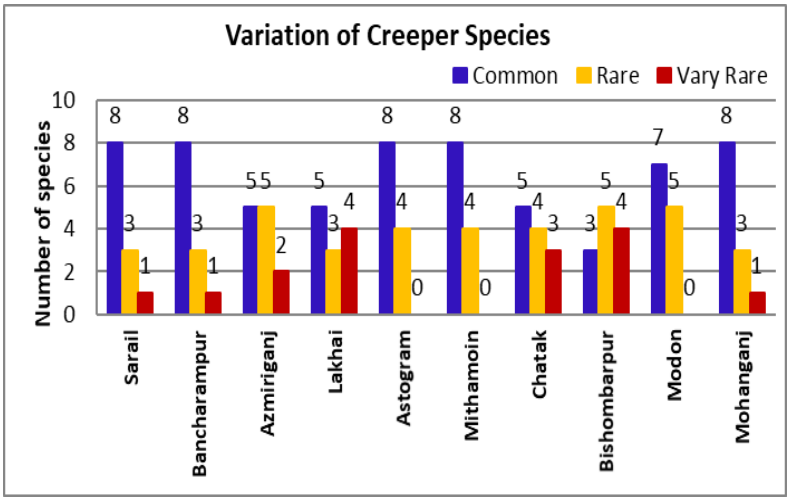


Figure 23: Status of creeper plant species in HILIP areas.

The trend of creeper species over the region depicts that on average 6 species are decreasing in occurrence, 4 species remain unchanged while 2 species can hardly be found. No species is found to be increasing in number at any of the sample places. The summary is given in **Table 16**.

Table 16: Distribution of Occurrence and Trend of Occurrence of Natural Creepers

Occurrence				Trend	
Species Status	Max. No. at a sample place	Min. No. at a sample place	Avg. No in the project area	Status	Number
				Increasing	0
Common	8	3	7	Unchanged	4
Rare	5	3	4	Decreasing	6
Very Rare	4	0	2	Hardly Available	2

5.9.1.3 Terrestrial Herbal Flora

Herbs are plants, which live for fruition. Such 32 plants were identified in the project area. A maximum of 31 common species was found at two sample places located in Brahmanbaria District. The occurrence of common species was minimal at 21 in Sunamganj District. The number of rare species in a place varied from 1- 8 while

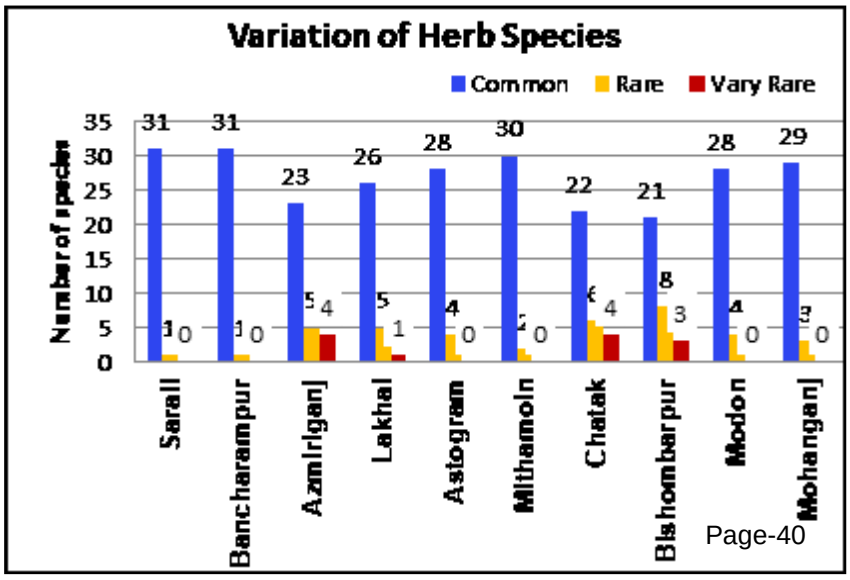


Figure 24: Status of Herbs species in HILIP areas.

that for very rare species was 0- 4. The average number of common species over the region is 27 while the rare and very rare species are 4 and 1 respectively. The number of species is less in Habiganj and Sunamganj districts. The situation is depicted in **Figure 24.** Status of Herb species is given in the **Annexure 8.**

The trend of herbal species over the region depicts that on average 21 species are decreasing in occurrence, 7 species remain unchanged while 2 species can hardly be found. Two species, mostly bananas and other herbs having agricultural value are increasing due to cultivation in Brahmanbaria District**.** The status of occurrence of species is given in **Table 17**.

Table 17: Distribution of Occurrence and Trend of Occurrence of Herbal Species

Occurrence				Trend	
Species Status	**Max. No. at a sample place**	**Min. No. at a sample place**	**Avg. No in the project area.**	**Status**	**Number**
				Increasing	2
Common	31	21	27	Unchanged	7
Rare	8	1	4	Decreasing	21
Very Rare	4	0	1	Hardly Available	2

5.9.1.4 Shrubs

In the Haor Area, 26 shrub species were identified through discussion and observation. A maximum of 20 common species were found at Madan and Mohonganj of Netrokona District.

The occurrence of common species was a minimum of 9 at Biswambarpur in Sunamganj District. The number of rare species in a place varied from 3- 10 while that for very rare species was 1- 9. The average number of common species over the region is 16 while the rare and very rare species are 6 and 4 respectively. The number of species is less in Habiganj and Sunamganj districts. The situation is shown in **Figure 25.** Status of Shrub species is given in the **Annexure 9.**

The trend of Shrub species over the region depict that on average the number of 16 species is decreasing in occurrence, 5 species remain unchanged while 4 species can hardly be found. No species are found to be increasing in number at any of the sample places. The overall situation is given in **Table 18**.

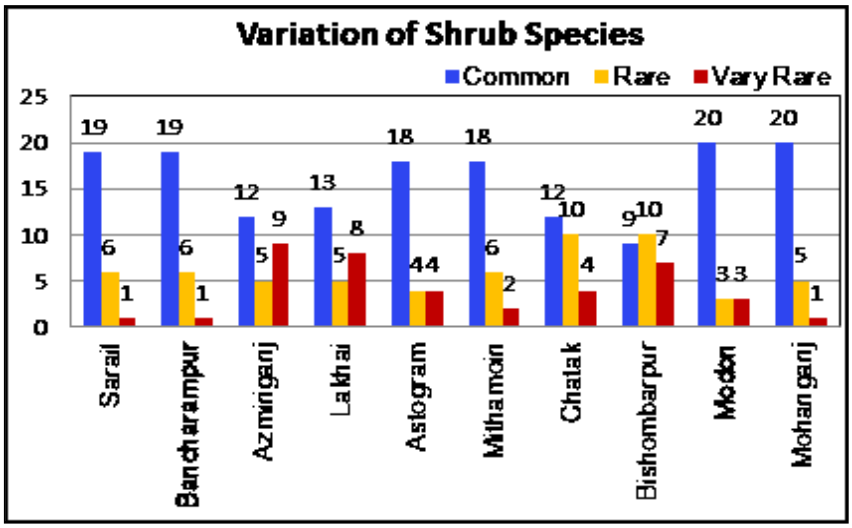


Figure 25: Status of Shrub species in HILIP areas

Table 18: Distribution of Occurrence and Trend of Occurrence of Natural Shrubs

Occurrence				Trend	
Species Status	**Max. No. at a sample place**	**Min. No. at a sample place**	**Avg. No in the project area.**	**Status**	**Number**
				Increasing	0
Common	20	9	16	Unchanged	5
Rare	10	3	6	Decreasing	16
Very Rare	9	1	4	Hardly Available	4

5.9.1.5 Terrestrial Trees

In Haor Area 69 terrestrial trees were recorded by discussion and observation. The maximum number of tree species commonly found at Sarail in Brahmanbaria District is 50 and larger number of species occurs mostly in Brahmanbaria and upper area of Netrokona districts. However, the occurrence of common tree species is minimum (30) at Biswambarpur of Sunamganj District, a deeply flooded area.

The species diversity is also less in Habiganj District. This indicates number of tree species in deep haor area is much less than the higher area, as expected. Over the project area the average numbers of common species are 41, rare species are 18 and very rare ones are 10. The situation over the area is depicted in **Figure 26.** Status of Tree species is given in the **Annexure 10.**The trend of occurrence of trees depicts that on average 42 species are decreasing, while 14 species remains unchanged. The average number of species that are hard to be found is 10. A small number of species (4) is increasing. These are mostly fruit trees or trees on road side planted under social forestry. The summary situation is given in **Table 19.**

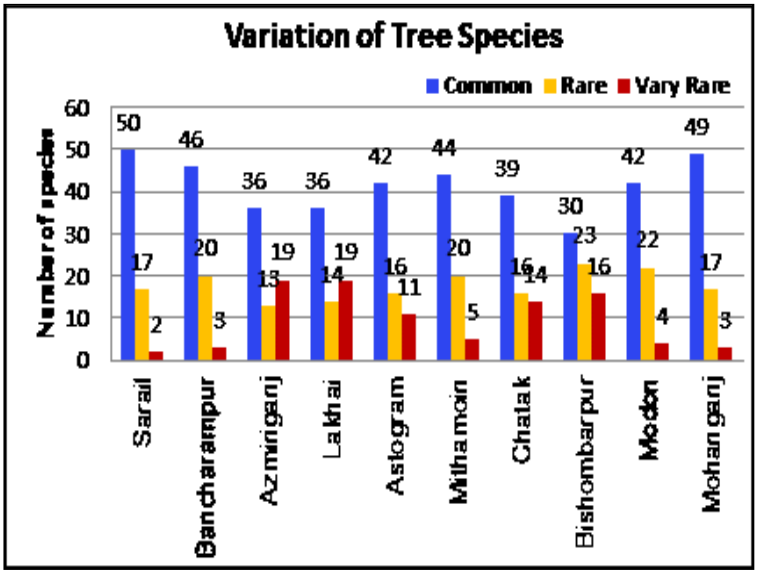


Figure 26: Status of Tree species in HILIP areas

Table 19: Distribution of Occurrence and Trend of Occurrence of Natural Trees

Occurrence				Trend	
Species Status	**Max. No. at a sample place**	**Min. No. at a sample place**	**Avg. No in the project area.**	**Status**	**Number**
				Increasing	4
Common	50	30	41	Unchanged	14
Rare	23	13	18	Decreasing	42
Very Rare	19	2	10	Hardly Available	10

5.9.2 Fauna

Fauna is all of the animal life present in a particular region or time. The haor fauna refers to the variety of life. Fauna identified have been classified under the five categories viz. Amphibians, Mammals, Reptiles, Birds and Fishes. The recorded fauna from the field area have mainly been obtained through discussion with local people under different categories.

Fauna assessment is the part of the environmental impact assessment for the infrastructure activities like ponds. A wide range of native fauna species utilizes terrestrial and aquatic vegetation as it provides shelter, nesting and roosting sites, it is a source of food and it may act as a corridor and enabling movement of fauna between areas of native vegetation. Besides, habitat disturbance can be detrimental to the long-term survival of a range of fauna species according to their rarity and the extent and nature of the disturbance. Therefore, potential fauna impacts should be minimized when considering scale up infrastructure activities.

5.9.2.1 Amphibians

In all, 11 amphibians are found in haor area. However, researchers have identified 28 species of amphibians, but most of these occur in the peripheral area hills and the forest habitat area. Common people can hardly differentiate between species having a very similar look and size. The number of amphibian species identified by IUCN in 2011 is eight (8). Local people also identified six (6) species of Amphibia in Kishoreganj and Netrokona Districts. The occurrence of common species was minimal at 3 at Chatak in Sunamganj and at Azmiriganj in Habiganj Districts. The number of rare species at a place varied from 1- 3 while that for very rare species was 1 -2. The average number of common species over the region is 4 while the rare and very rare species are 1 and 1 respectively. The number of species is less in Habiganj and Sunamganj districts. The variation of occurrence of Amphibia over the project area is shown in **Figure 27.** Status of Amphibian species is given in the **Annexure 11.**

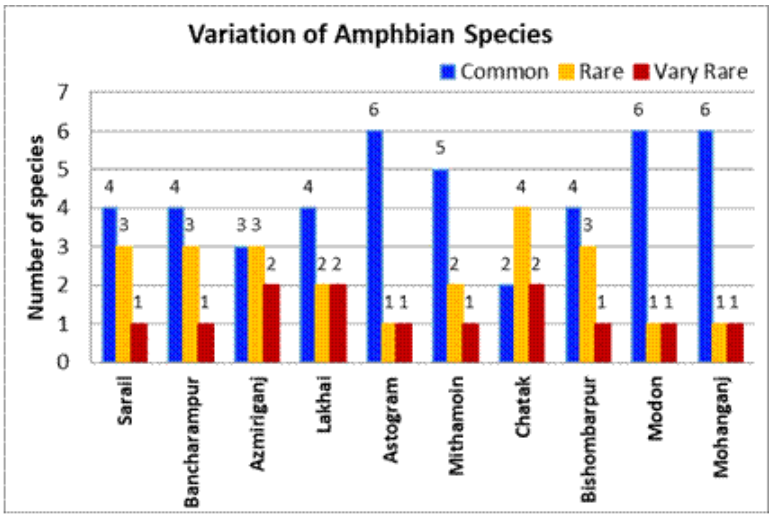


Figure 27: Status of Amphibian species in HILIP areas

The trend of occurrence of Amphibia over the region depicts that on average 3 species are decreasing in occurrence, 4 species remain unchanged while 1 specimen is hardly found**.** The increase in occurrence has not been reported anywhere**.** The overall occurrence and trend is given in **Table 20.**

Table 20: Distribution of Occurrence and Trend of Occurrence of Amphibians

Occurrence				Trend	
Species Status	**Max. No. at a sample place**	**Min. No. at a sample place**	**Avg. No in the project area**	**Status**	**Number**
				Increasing	0
Common	6	3	4	Unchanged	4
Rare	4	1	2	Decreasing	3
Very Rare	2	1	1	Hardly Available	1

5.9.2.2 Mammals

A NERP survey in 1993 found 34 mammals and IUCN study in 1997 found 19 species of mammals in Tanguar Haor alone. A study 2011 could find only 19 species of mammals in Tanguar Haor. Of these 19, seven mostly vermin, were found to be common (Ref: Biodiversity of Tanguar Haor Vol -3). The field survey could identify 25 species of mammals in the project area. A maximum of 16 common species were found at Madan in Netrokona District. The occurrence of common species was minimal at 9 in different places of the project area. The number of rare species at a place varied from 4- 9 while that for very rare species was 1 -10. The average number of common species over the region is 12 while the rare and very rare species are 7 and 6 respectively. The number of species is less in Habiganj and Sunamganj districts. . The variation of occurrence of mammals over the project area is shown in **Figure 28.** Status of Mammals is given in the **Annexure 12.**

The trend of occurrence of mammals over the region depicts that on average 11 species are decreasing in occurrence 5 species remain unchanged while 6 species are hardly be found. On average, the number of increase of species, mostly rats, is 3**.** The increase in occurrence has not been reported anywhere**.** The overall occurrence and trend is given in **Table 21**.

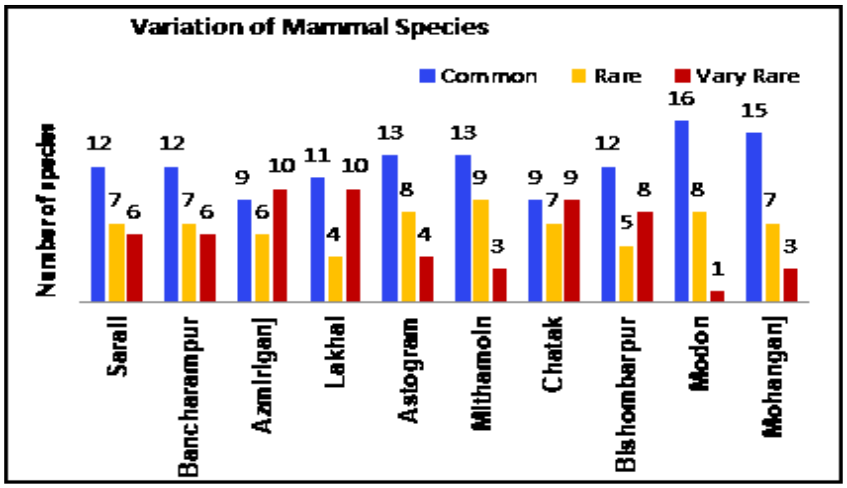


Figure 28: Status of Mammals in HILIP areas

Table 21: Distribution of Occurrence and Trend of Occurrence of Mammals

Occurrence				Trend	
Species Status	Max. No. at a sample place	Min. No. at a sample place	Avg. No in the project area.	Status	Number
				Increasing	3
Common	16	9	12	Unchanged	5
Rare	9	4	7	Decreasing	11
Very Rare	10	1	6	Hardly Available	6

5.9.2.3 Reptiles

In all 34 reptiles were identified in Tanguar Haor alone through a survey in 2011 by IUCN. Species identified by local people during present depict that a maximum of 18 common species were found at Austagram in Kishoreganj District and Madan and Mohonganj in Netrokona District. The occurrence of common species was minimal at

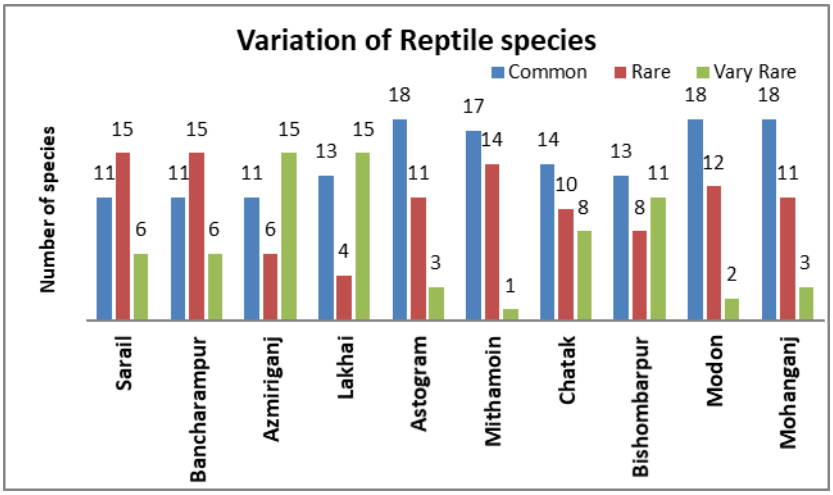


Figure 29: Status of Reptiles in HILIP areas

11 at Sarail, Bancharampur and Ajmiriganj. The number of rare species at a place varied from 4-15 while that for very rare species was 1 -15. The average number of common species over the region is 17 while the rare and very rare species are 8 and 7 respectively. The number of species is least in Habiganj and Sunamganj districts. The variation of occurrence of Reptiles over the project area is shown in **Figure 29**. Status of Reptile species is given in the **Annexure 13.**

The trend of occurrence of reptiles over the region depicts that on average 18 species are decreasing in occurrence, 7 species remain unchanged while 7 species are, hardly, found**.** The increase in occurrence has not been reported anywhere**.** The overall occurrence and trend is given in **Table 22.**

Table 22: Distribution of Occurrence and Trend of Occurrence of Reptiles

Occurrence				Trend	
Species Status	**Max. No. at a sample place**	**Min. No. at a sample place**	**Avg. No in the project area.**	**Status**	**Number**
				Increasing	0
Common	18	11	14	Unchanged	7
Rare	15	4	11	Decreasing	18
Very Rare	15	1	7	Hardly Available	7

5.9.2.4 Resident Birds

In all, 52 resident birds were identified through discussion with local people. A maximum number of 46 species were identified people at Bancharampur of Brahmanbaria District. The minimal number was found to be 32 at Chhatak, Bishwambarpur and Ajmiriganj. The number of rare species at a place varied from 6-15 while that for very rare species was 0 -9. The average number of common species over the region is 39 while the rare and very rare species are 10 and 3 respectively. The number of species is least at Lakhai in Habiganj District. The variation of occurrence of Birds over the project area is shown in **Figure 30.** Status of Bard species is given in the **Annexure 14.**

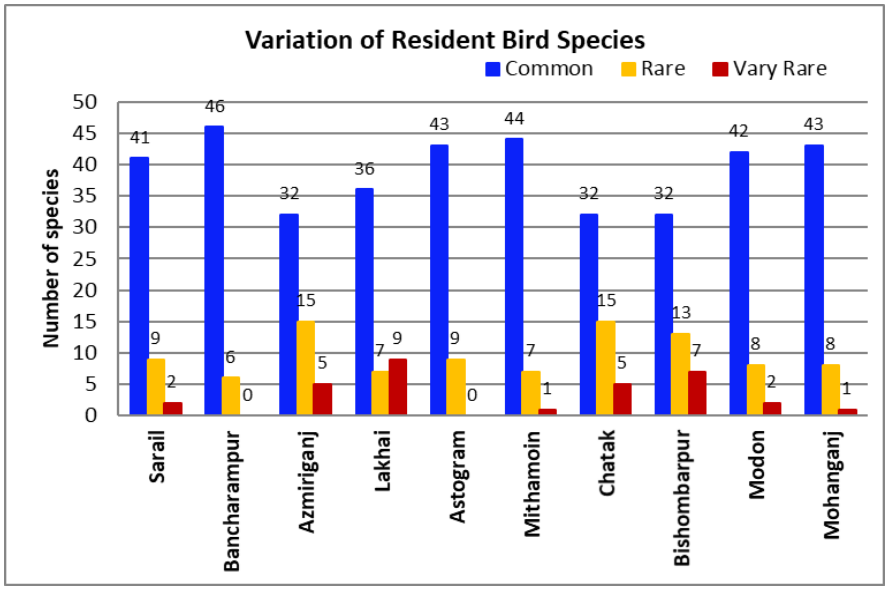


Figure 30: Status of Resident Bird Species in HILIP Area.

The trend of occurrence of resident birds over the region depicts that on average 33 species are decreasing in occurrence, 6 species remain unchanged while 4 species are hardly found**.** The increase in occurrence has not been reported anywhere**.** The overall occurrence and trend is given in **Table 23.**

Table23: Distribution of Occurrence and Trend of Occurrence of Resident Birds

Occurrence				Trend	
Species Status	Max. No. at a sample place	Min. No. at a sample place	Avg. No in the project area.	Status	Number
				Increasing	0
Common	46	32	39	Unchanged	6
Rare	15	6	9	Decreasing	33
Very Rare	9	0	3	Hardly Available	4

5.9.2.5 Fishes

Fisheries indicators have been selected through reviewing different literatures (study reports on haor areas of DoF, CEGIS, IUCN and CNRS and different articles on haor fisheries including red list of fishes -IUCN 2015) as well as surveying different institutions and using fisheries expert judgment.

5.9.2.6 Biodiversity Status of Fish Species

In all, 81 fish species were found in the project area through discussion with local people, pond owners and fishermen. Species identified by local people during present study depict that a maximum of 66common species were found at Mithamoin in Kishoreganj district. The occurrence of common species was minimal at 44 at Chhatak in Sunamganj district. The number of rare species at a place varied from 8- 24 while that for very rare species was 2-15. The average number of common species over the study area is 58 while the average number of rare and very rare species are 14 and 9 respectively. The number of available species is least at Chatak in Sunamganj district. The variation of occurrence of fishes over the project area is shown in **Figure 31.** Status of Shrub species is given in the **Annexure 15** and trends of fish species in the **Annexure 16.**

The trend of occurrence of fish over the region depicts that on average 40 species are decreasing in occurrence, 22 species remain unchanged while 11 species are not available or hardly found**.** The average increase in occurrence takes place to 9 species and which are mostly cultured species in perennial and seasonal ponds. The overall occurrence and trend is shown in **Figure 32** and **Table 24.**

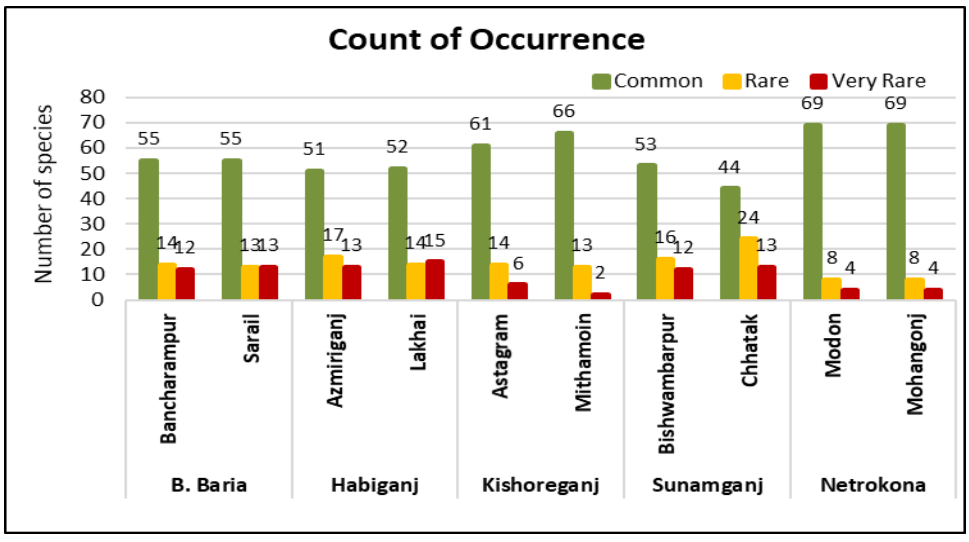


Figure 31: Status of Fish in HILIP Area

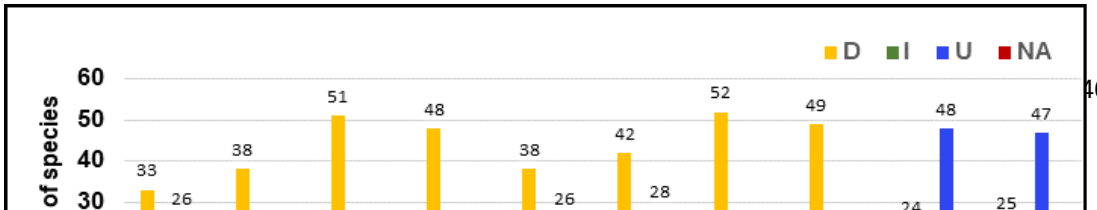


Figure 32: Rank of Fishes in the HILIP Sites

Table 24: Distribution of Occurrence and Trend of Occurrence of Fishes

Occurrence				Trend	
Species Status	**Max. No. at a sample place**	**Min. No. at a sample place**	**Avg. No in the project area.**	**Status**	**Number**
				Increasing	9
Common	68	51	60	Unchanged	22
Rare	24	9	16	Decreasing	40
Very Rare	7	2	5	Hardly Available	11

5.10 Climate

Bangladesh is one of the most vulnerable countries affected by climate change. The major disasters concerned here are the occurrences of flood, cyclone and storm surge, flash flood, drought, tornado, riverbank erosion and landslide. Climate included natural hazards are emerging as a cause of major concern, particularly in the haor areas of Bangladesh. The climate of haor areas is subtropical monsoonal. This includes temperature, rainfall and humidity situation. The situations are quite different in different seasons, especially in the wet and dry seasons. Fish and shellfish are potentially impacted by climate-driven changes in a suite of abiotic factors including the acidification of marine & freshwaters (Caldeira & Wickett, 2003; Weiss et al., 2018), deoxygenation (Altieri & Gedan, 2015) and altered precipitation and river flow rates in freshwater habitats (Ficke, Myrick, & Hansen, 2007; Markovic et al., 2014).

5.10.1 Temperature

Three weather stations maintained at Sylhet, Mymensingh and Comilla by Bangladesh Meteorological Department (BMD) lie in the peripheral area. Among these stations, Sylhet is closest to the study area. Data of the stations have been collected up to 2017. Annual average trend of maximum temperature at Sylhet over the periods 1988 – 2017 shows a dipping trend of .004 while the minimum temperature over the periods 1995 – 2017 shows a rising trend of 0.012.

The trend analyses of other two other peripheral stations depict that the average highest temperatures and lowest temperatures are increasing. **Figures 33, 34** and **35** show trends of change of highest and lowest temperatures over the period 1988 -2017 in Sylhet, Mymensingh and Comilla respectively.

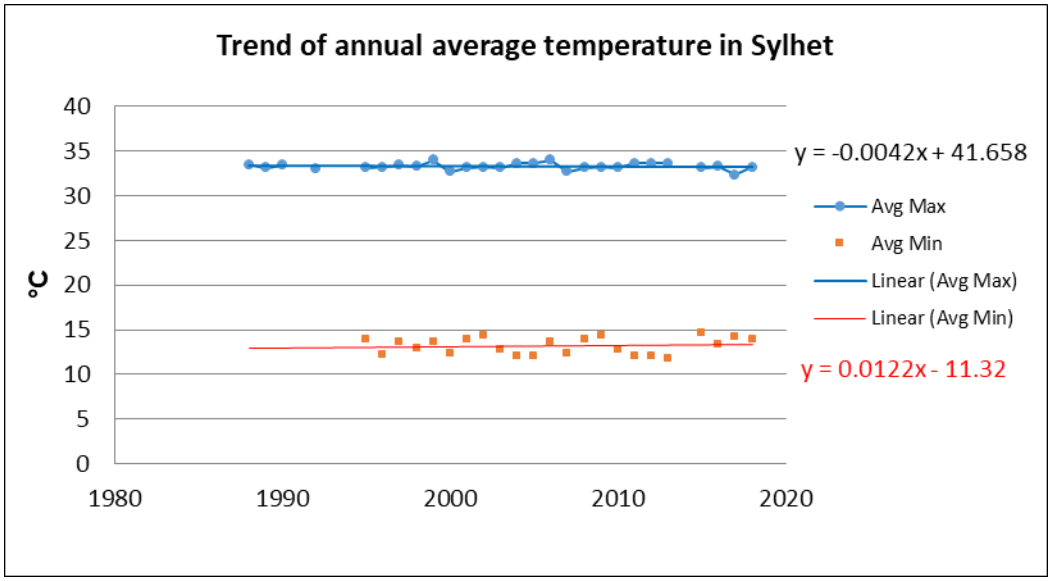


Figure 33: Trend curves for average maximum and minimum temperatures in Sylhet (Data source BMD).

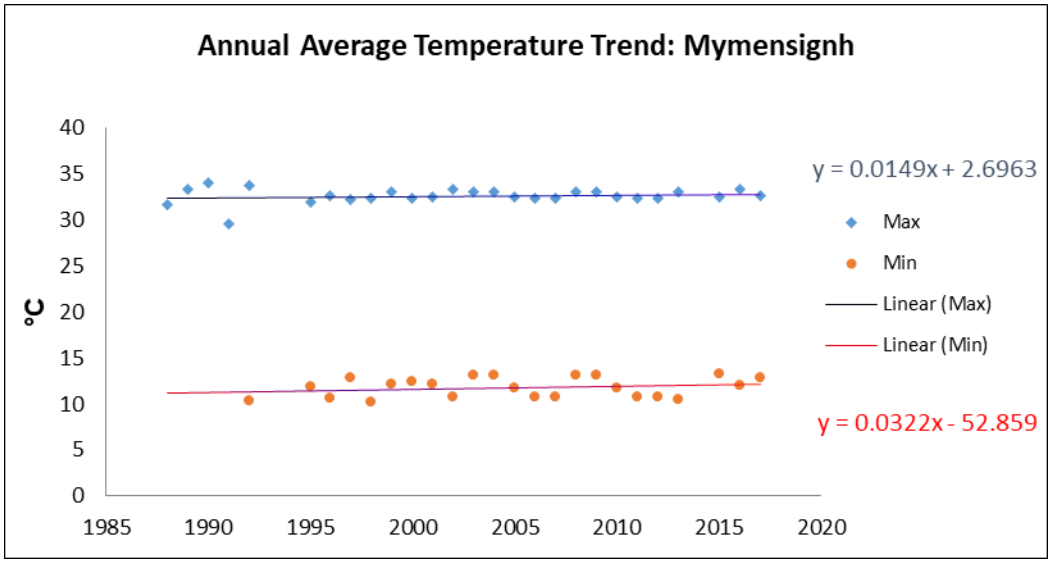


Figure 34: Trend curves for average maximum and minimum temperatures in Mymensingh (Data source BMD).

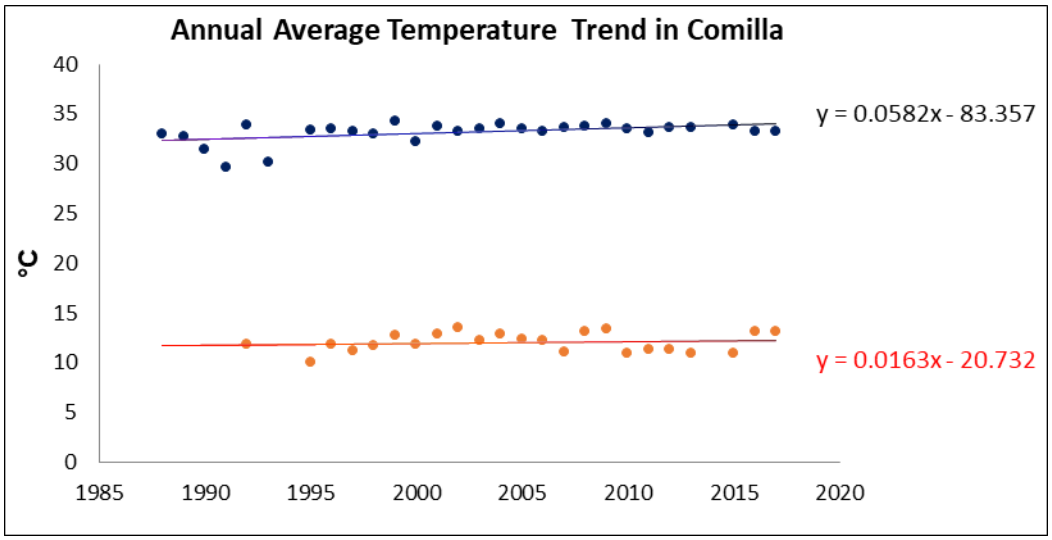


Figure 35: Trend curves for average maximum and minimum temperatures in Comilla (Data source BMD).

The rate of change is more in the South than in the North specifically in respect maximum temperatures. Trend of changes is given in **Table 25.**

Table 25: Trend of Change of Highest and Lowest Temperatures at Peripheral Stations.

Sl. No.	Name of Stations	Rate of Annual Change of Temperature	
		Average Maximum	Average Minimum
1	Sylhet	-0.004	0.012
2	Mymensingh	0.014	0.032
3	Comilla	0.058	0.016

5.10.2 Rainfall

Rainfall data are however available for a number of stations in the project area. The rainfall of five stations was investigated. Long-term data of three stations in the periphery of the Project has been collected for the period 1970 -2017. Relatively short-term data on stations at upazila level is available but quite often have blank data. These were collected and analysed. Finally, the long-term data of the three peripheral stations maintained by Bangladesh Meteorological Department (BMD) as well as Bangladesh Water Development Board have been analysed and presented herein. The rainfall patterns of Sylhet, Mymensingh and Comilla, the peripheral stations, depict that the trend of all high rain seasons are decreasing all throughout. However, the pre-monsoon rainfall at Sylhet is found to have increasing trend. The rainfall in dry seasons depicts that at Mymensingh and Comilla the trend is decreasing while that at Sylhet the trend is increasing. A set of graphs drawn for the Mymenshing, Sylhet and Comilla stations are shown in **Figure 36, 37** and **38** respectively.

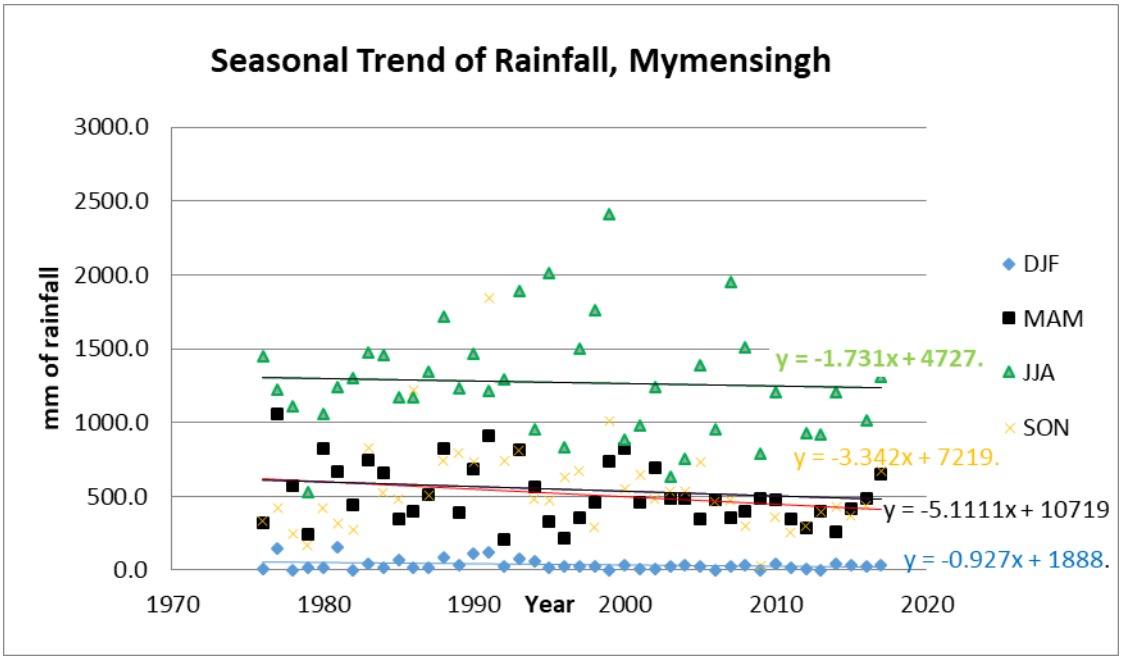


Figure 36: Seasonal trend of rainfall in Mymensingh district, Bangladesh (DJF- Dec, Jan, Feb; MAM – Mar, Apr, May; JJA – Jun, Jul, Aug; SON – Sep, Oct, Nov).

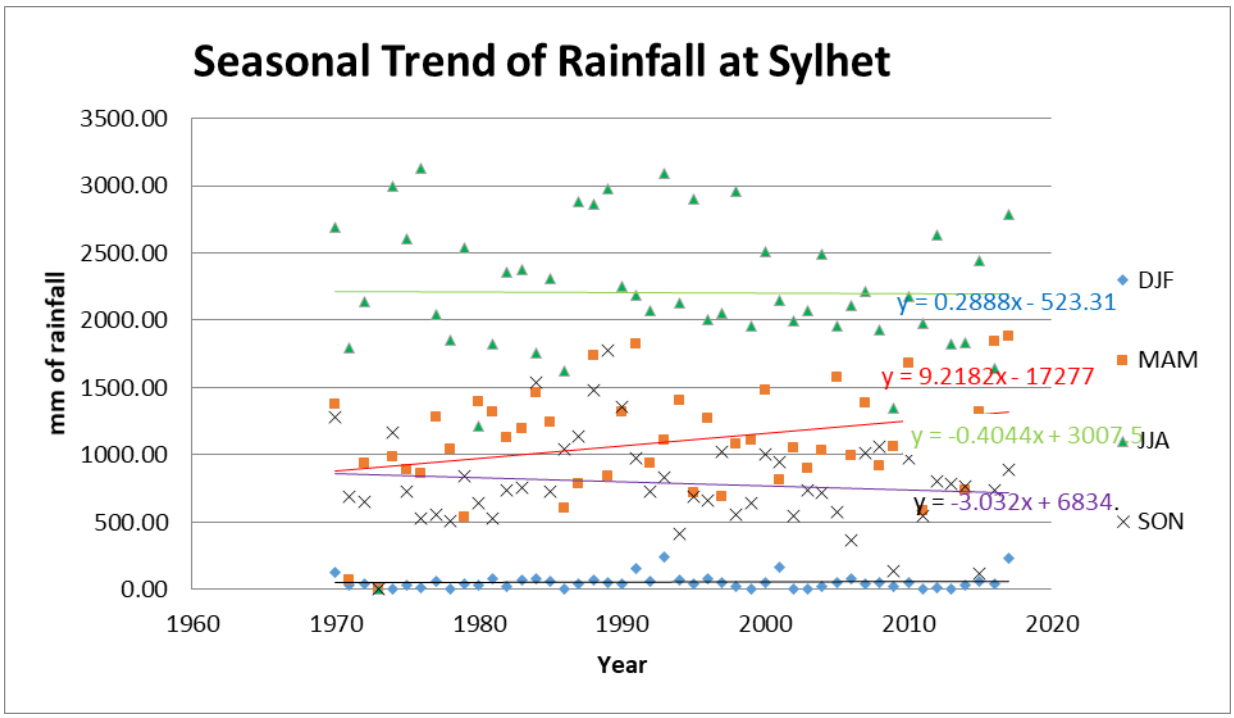


Figure 37: Seasonal trend of rainfall in Sylhet district, Bangladesh (DJF- Dec, Jan, Feb; MAM – Mar, Apr, May; JJA – Jun, Jul, Aug; SON – Sep, Oct, Nov).

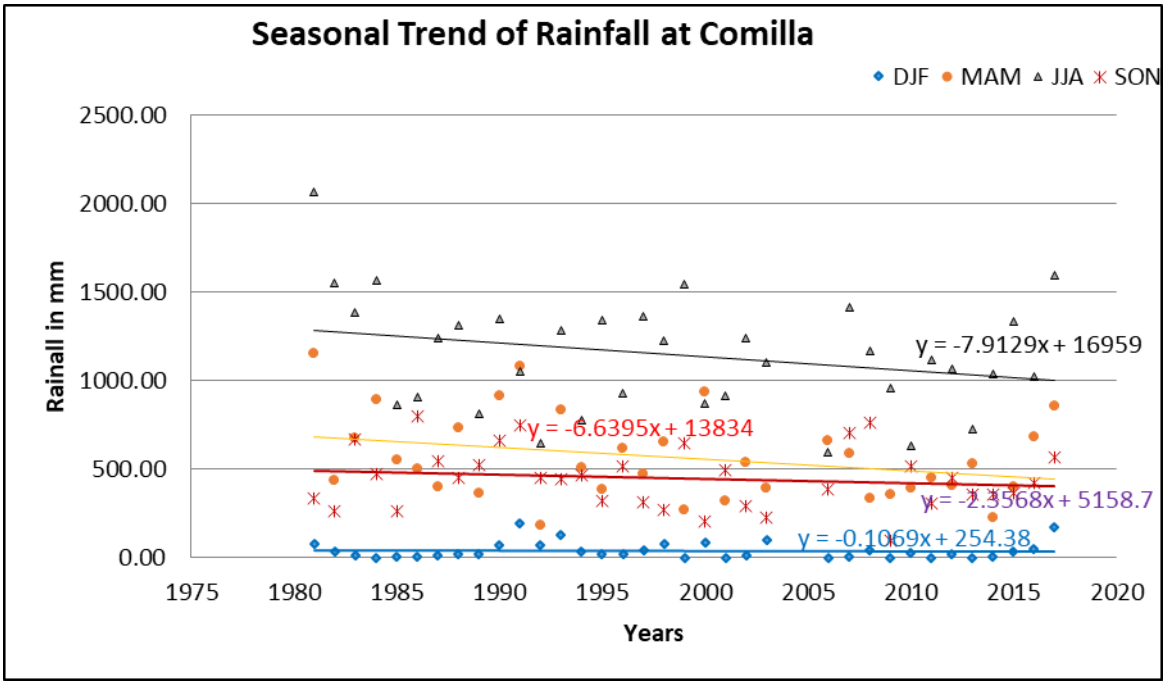


Figure 38:Seasonal rainfall trends in Comilla (DJF- Dec, Jan, Feb; MAM – Mar, Apr, May; JJA – Jun, Jul, Aug; SON – Sep, Oct, Nov).

It is depicted at all stations the total rainfall has a trend of reduced precipitation in all seasons. Only at Sylhet, there is slight rise in precipitation in the pre-monsoon. Trend of seasonal change are shown in **table 26.**

Table 26: Trend of seasonal change in rainfall in Mymenshing, Sylhet and Comilla

Season	Change in Rainfall at Stations mm/ yr		
	Mymensingh	Sylhet	Comilla
March- April -May	-5.111	+9.218	-0.106
June- July- August	-1.731	-0.404	- 6.639
September- October- November	-3.342	-3.032	- 7.912
December, January and February	-0.927	0.288	-2.356

5.10.3 Water Level Characteristics

Water levels of six WL stations in haor area maintained by BWDB were reviewed. It is found that data of Ajmiriganj and Markuli in Surma River system have significant gaps for a number of continuous years. Similarly, some data of Sukdevpur and Itna are also missing. So these have not been analysed. Mohanganj is in the upstream area of Baulai River and the low water level at Mohanganj is about 1 m above the lowest tide level and hence this station has also been excluded. The WLs of Surma River at Sunamganj and those of the Meghna River at Bhairab bazaar, the gate of Haor waters in the north have been analyzed **(Table 27).** Water level characteristics of Surma River in Sunamganj (HWL-High water level; LWL- Low water level) and Bhairab bazar are shown in the **Figure 39 and 40.**

Table 27: The trend of Water Level Increase or Decrease

Sl. No	Station Name	Slope of HWL	Slope of LWL	Trend
1	Sunamganj	0.008	0.000	Rising at hIgh water level and unchanged at Low Water levels
2	Bhairab Bazar	-0.003	0.012	Declining at High water level but increasing at Low water level.

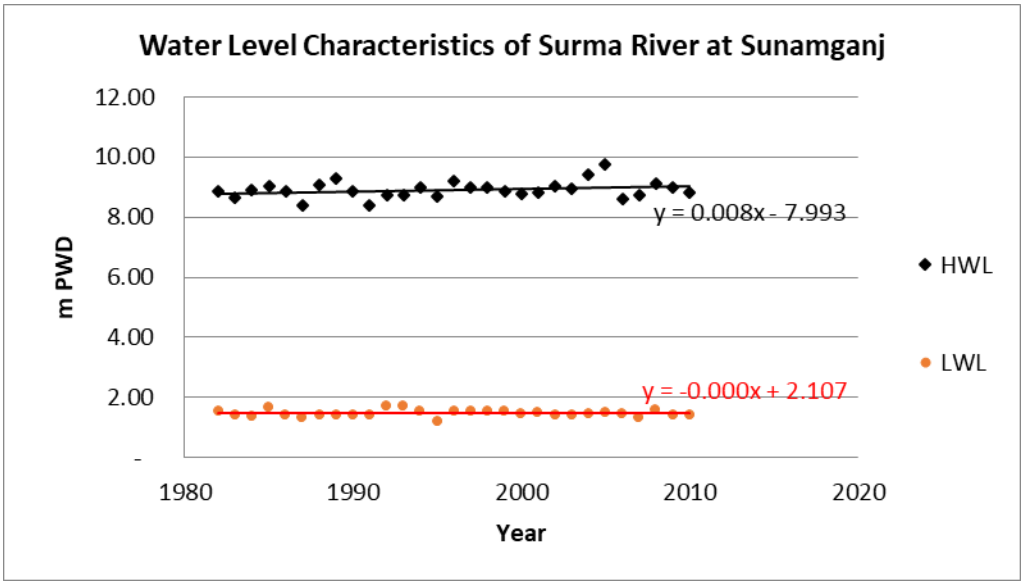


Figure 39: Water level characteristics of Surma River at Sunamganj

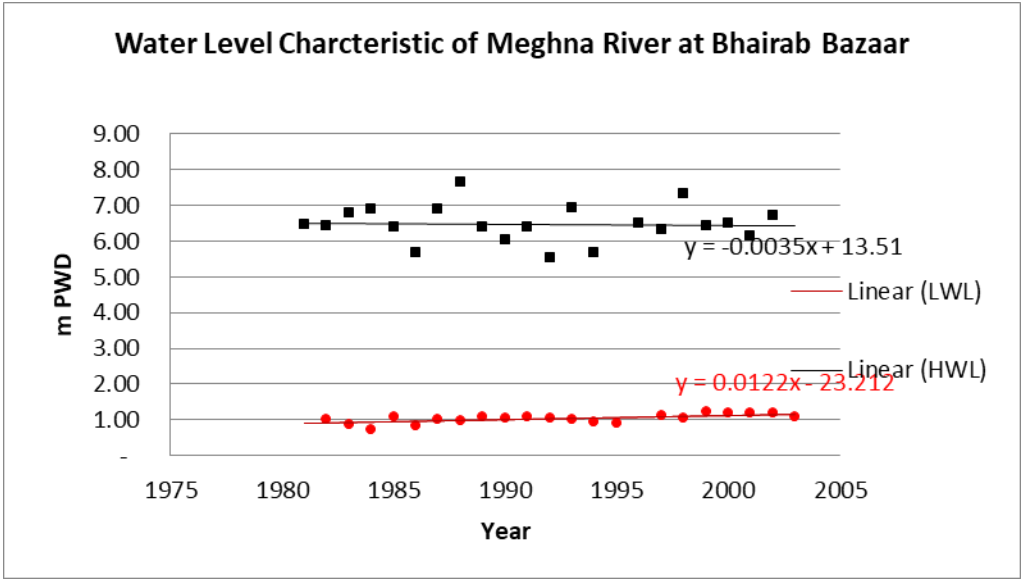


Figure 40: Water level characteristics of Meghna River at Bhairab Bazaar.

5.10.4 Groundwater in Haor areas

The haor areas have aquifers of semi-confined to confined types. In Sunamganj district, shallow alluvial aquifers are also available which is used for domestic water supplies with HTWs screened at 10-60 m below the land surface (Joarder et al 2008). The groundwater recharge in the haor areas is high due to high rainfall, and extensive, deep and extended period of flooding and the usable recharge is estimated to be about 3925 Mm^3 (about 735 mm) within the upazilas of the haors

(Mondal 2015). Current groundwater use for irrigation, domestic, commercial and industrial purposes is very low (about 10%) compared to the recharge (Mondal 2015).

5.10.5 Irrigation

Irrigation tools, i.e. Low Lift Pumps (LLP), Shallow Tube wells (STWs) and Deep Tube wells (DTWs) play a crucial role in accelerating food grain production (mainly rice and wheat) in Bangladesh (LZR, 2011, 2014, 2015). In the HILIP area, the main source of irrigation water is mainly are both surface and groundwater.

In Brahmanbaria, about 20-75% areas are under irrigation for Boro (HYV) cultivation, which is done by using both surface and ground water. In Ashuganj about 75% areas and in Banchharampur about 20% areas are under irrigation for Boro (HYV) cultivation. The scarcity of irrigation water in the dry season is common in this area. Scarcity of surface water for irrigation and higher cost of different agricultural machinery and equipment in the local markets are commonly felt problems. In the district, 52.8% of irrigated land is supplied with water from groundwater sources.

The source of irrigation water in Habiganj District (within project area) is surface water as well as ground water. However, ground water coverage is only 22.5%, 46% and 58.7% in Ajmriganj, Lakhai and Baniachang upazilas respectively. Ground water is mostly used by STWs. The major irrigation devices in this area are Shallow Tube wells (STW). In Rabi season, irrigation helps increasing agricultural production and crop diversification. In Rabi season most of the cultivated land of project area goes under irrigation.

In Kishoreganj, the sources of irrigation water are both surface water and groundwater. The major irrigation devices are LLP and STW. Moreover, other indigenous irrigation tools are used for supplying water to cultivated fields. In the district, ground water supplies water to 23.8% irrigated land. The use of ground water for irrigation in Mithamoin is zero while its use is maximal in Astagram being 51.7%.
Irrigation is considered as a basic input for producing cereals and many other crops in Netrokona. In Rabi season mechanized irrigation helps increasing crop diversification. The sources of water are both surface and groundwater. The major irrigation devices of Netrokona are LLP, STW, and DTW. In addition, other indigenous irrigation tools are used for lifting water. In the project area upazilas of the district ground water provides irrigation of 59.3% of irrigated land.

In Sunamganj, the main source of irrigation water is surface water, but in Chhatak and Dowara bazar upazilas ground water is the main source of irrigation water. The major irrigation devices are STW and LLP. In addition, other indigenous irrigation tools are used for lifting water. The total irrigation coverage is 19.2% by ground water and remaining area is covered by surface water. In Rabi season irrigation helps to increase agricultural production and crop diversification. *(Data extracted from Minor Irrigation Survey Report 2016-17, BADC).*

5.10.6 Crop

There are many haors (basin like structure) where water remains either stagnant or in flooded condition during the months of June to November and mainly Boro rice is grown in the Rabi season using irrigation. In terms of ecosystem, crop production practices, economic activities and over all

livelihoods of the farmers of haor areas are quite different from those of the other parts of the country. The cropping practices particularly Boro rice crop mainly depends on nature. Early flood, hailstorm and drought are the main constraints to grow modern boro rice. In most of the haor areas BRRI dhan 28 and 29 are the prominent Boro varieties. Almost 80% of total cultivated area of haor districts is covered by Boro rice, while only about 10% area is covered by T. Aman production (Huda, 2004). Among all the haor districts, the proportion of single cropped area is highest (44%) in Sunamganj and due to that the cropping intensity in that district stands at the lowest (143%). On the contrary, the proportion of triple cropped area is the highest (with lowest single cropped area) in Kishoreganj that led to have highest cropping intensity (215%), which is higher than the national average cropping intensity of 178% (HAS, 2007). In Sunamganj and Kishoreganj, 80 and 82% area, respectively, were covered by Boro-Fallow- Fallow pattern. Similarly, in Netrokona and Brahmanbaria, 78% and 72% of the total haor areas were covered by this pattern. In the haor areas under the five districts, some other crops such as vegetable, mustard, ground nut, wheat, chilli, jute, pulses, potato, onion, watermelon, spices, sweet guard etc. is grown (LZR, 2011, 2014, 2015). Different crops cultivated in Brahmanbaria area are Paddy (Boro, T. Aman, T. Aus), Jute, Vegetables, Pulses, Mustard, Muskalai, Mung bean, Potato, Onion, Lentil, Wheat, Maize, Chilli, Watermelon, Muskmelon, groundnut etc. In Habiganj**,** different crops (Paddy, Potato, Sweet Potato, Rabi crops, Vegetables, Wheat, Mustard and Jute) are cultivated. Crops cultivate in Kishoreganj are Paddy, Potato, Ground nut, jute, Sweet Potato, Mustard, Spices, Wheat, Chili, Pulses, Onion, Vegetable etc. Different crops cultivated in Netrokona are Paddy, Wheat, Black gram, Potato Jute, Mustard, Spices, Winter Vegetable, pulse, groundnut etc. In Sunamganj, different crops (Paddy, Watermelon, Groundnut, Wheat, Mustard, Jute, Cucumber, Sweet Gourd, Chili, and Vegetables etc) are cultivated.

5.11 Matrix Analysis for Identifying Mitigation Measures on Environmental Impacts

The social and ecological surveys have been conducted and data on physical parameter collected from secondary as well as primary sources. These have been analysed to identify exiting condition and identifying effects/impacts. Pond development is not a red category project and for such projects, IEE is sufficient. So, IEE has been carried out according to the EIA Guideline of Industries by DOE. They may have some effects on physical, biological and social environment. In order to assess the impacts data (positive or negative) as described in **Table 28** have been collected.

Table 28: Achievement in Quarter 3 the Environmental Components to Assess the Impacts

Sl. no.	Environmental components	Achievement in Quarter-1	Achievement in Quarter-2	Achievement in Quarter-3	Draft Reporting Stage
1	Impact on physical environment, if any	Data collection ongoing	Data collection in progress	Results partly presented and analytical results will be integrated	Analyses made and presented
2	Impact on Biodiversity, if any	Data collection ongoing	Data collection completed	Result summarized and partly presented	Analyses made and presented
3	Economic impacts on the local market in change in demand for local services,	Data collection ongoing	Data collection in progress	Pond fish culture base economic impact partly presented	Analyses made and presented
4	Agricultural and food demand	Data collection ongoing	Data collection in progress	Fish culture based demand will be analyzed	Analyses made and presented
5	Transports demand	Data collection ongoing	Data collection in progress	Fish culture based demand will be analyzed	Analyses made and presented
6	Income activities,	Data collection ongoing	Data collection in progress	Pond fish culture based income partly presented	Analyses made and presented
7	Impacts on employment	Data collection ongoing	Data collection in progress	Fish culture based results partly presented	Analyses made and presented
8	Impacts on health and hygiene	Data collection ongoing	Data collection in progress	Fish culture based impact will be analyzed	Analyses made and presented
9	Migratory life and impacts on cultural and archaeological sites	Data collection ongoing	Data collection in progress	Fish culture based impact will be analyzed	Analyses made and presented

The collected primary and secondary data have been used for describing the baseline condition and these have been used for assessing impacts and suggesting mitigation measures. A broad EMP will be prepared befitting the IEE document.

5.12 Reporting obligations

Several reports are to be submitted at different stages according to the schedules given in the ToR. These are given in **Table 29** with current status:

Table 29: Reporting obligations and achievements

Sl. no.	Reporting obligation	Achievement in Quarter-1	Achievement in Quarter-2	Achievement in Quarter-3	Reporting Stage
1	Inception Report	Completed & submitted	Completed& submitted	Completed& submitted	
2	Interim Report (Quarter 1)	Completed & submitted	Completed& submitted	Completed& submitted	
3	Interim Report (Quarter 2)	Will be completed	Completed & submitted	Completed & submitted	
4	Interim Report (Quarter 3)	Will be completed	Will be completed	Completed & submitted	
5	Action Research Report/Science paper	Outline drafted	Outline drafted	Draft completed & submitted	Completed & submitted
6	Draft Report (Final)	Outline drafted	Outline drafted	Completed and submitted	Completed & submitted
7	Final Report	Will be completed	Will be completed	Draft completed	Completed & submitted
8	Journal paper submission	Will be completed	Will be completed	Draft completed and submitted	Completed & submitted

6. ENVIRONMENTAL ASSESSMENT AND IMPACTS

6.1 General Considerations

An impact is a change in aspect of the environment. A potential impact is defined as the change of existing conditions of the physical, biological and human environments due to human activities related to a project in a particular area. The project activities undertaken includes excavation/ re-excavation of ponds, construction of pond dykes, preparation of ponds for release of fingerlings, Release of fingerlings, feeding, harvesting etc. The activities may be divided in three portions vise pre-implementation, implementation and maintenance and operation activities.

The activities may have significant impact on physical, biological and social environment. Physically the ponds, which may be perennial or seasonal lying in *haor* may in some cases by transformed into flood free ponds. The ecology may be affected. Socially, the more activities may be generated by pond culture and marketing of products i.e. fish.

6.1.1 Potential Impacts of Activities of Aquaculture Development

The development activities will involve activities at pre-construction stage that include pond selection and imparting training to pond fish culture participants. At construction stage clearance of jungles on dykes, excavation/re-excavation of ponds, increasing height of dykes, preparation of ponds like drying of pond adding lime to water improvement of access to rural roads. During operation phase will see release of fish fingerlings, feeding of fish, water quality monitoring etc. Impacts may take place on physical condition, agriculture, water resources, social condition etc. The probable impacts at different stages of activities are stated below.

6.1.1.1 Impacts on Water Resources

Preconstruction Phase: Identification of ponds for inclusion in project and data on area, depth, location, pond bottom, pond dyke will be collected by preliminary survey. The pond owners will be provided training on fish culture. Testing for identification acidic soil is to be done. This will have no detrimental effects.

Construction Phase: Excavation and re-excavation of ponds will not have significant effect. But, this may require emptying of the pond by pumping but the pond will be filled with water soon after the preparation stage. The pond if not culture may be used for domestic purpose but on culture there may be restrictions. People may have to use alternative water sources.

Post construction Phase: The ponds will cultured with fish that will require relapse of fish fry, fish feeding, monitoring fish health and water quality and ultimately fish harvesting. Water quality may be affected in small, especially, shallow ponds.

6.1.1.2 Impacts on Land Resources

Preconstruction Phase: Mostly existing ponds will be developed. In few cases, new pond may be excavated. The land will now by under fishery management. There will not any adverse impact on land resources but alternate use will be made.

Construction Phase: The ponds will be mostly re-excavated at their existing location Re-excavated earth will be deposited on dykes to strengthen it. So, land on the bank will not be affected. So, there will be no adverse affect on land.

Post-Construction Phase: The land of ponds will be used for aquaculture. Land quality will remain unaffected. In case acidic soil in pond bed the soil may be improved by addition of lime.

6.1.1.3 Impacts on Agricultural Resources

Pre-construction Phase: The identification may need visit to pond sites by project officials. But the visit will be carried out by a limited number of persons once or twice. Agricultural resources will not be affected.

Construction Phase: The activities will be limited in pond area and adjacent agricultural fields will not be affected. During this phase the existing cropping will continue as usual so adverse impact will not take place.

Post construction Phase: Cropping will not be affected as the utilization pond water will remain the same. However, as the capacity of ponds will be enhanced, so in case requirement water maybe available in small quantity to the benefit of agriculture.

6.1.1.4 Impacts on Fisheries Resources

Preconstruction Phase: Pre-construction activities will have no adverse effect on fisheries, as no interventions are limited in closed pond area. The selection will not affect migration or movement of fish. This will help avoiding culture of carnivorous fish and help intensification fish culture. Rather training in fish culture would have positive impact on fishery.

Construction Phase: The depth of the ponds will be increased in most cases. Pond drying and preparation will need pumping out of water. Thus, some indigenous fish living in the bottom of ponds may be affected. However, the culture will help increasing quantity of fish significantly. The

effects of pond preparation are temporary and ultimately helpful. The deposition of re-excavated earth on dykes will temporarily affect shrubs and herbs on the existing dykes. These are not endangered and re-grow after rains. Thus, floral ecology will not be adversely affected.

Post construction Phase: The excavated /re-excavated ponds will cultured for fish and technical support will be given. Fish will have to be fed and health monitored. Water quality is also to be monitored. Carnivorous species avoided. Exotic species culture and pathogens may be occurring. Use of chemicals and drugs may affect health. Aquaculture farm effluents may affect water sources. The perennial ponds will be more secure from being affected by flood/ flash flood. The seasonal ponds will be able to extend time of harvesting in the pre-monsoon. The result will be significant increase in fish output.

6.1.1.5 Impacts on Eco-system

Preconstruction Phase: Visit during identification will not affect the ecosystem and existing flora or fauna will not be disturbed.

Construction Phase: The re-excavation of ponds will require clearing of aquatic weeds that may exist. The weeds are common and not endangered. The flora on the dykes will be permanently affected by deposition of excavated earth. These would re-grow in the next rainy season. Higher dykes will provide better floral habitat. The holes and Burroughs in dykes will remain unaffected. Thus, ecosystem will be better supported.

Post construction Phase: The resuscitated ponds will provide better habitat for fish and other aquatic animals like shell fish, indigenous fish, turtles, etc. The dykes may be planted with creeper vegetables (country bean, bottle gourd, squash gourd and ridge gourd), agro plants and plants which are decreasing in abundance. Besides, banana, papaya, coconut, guava and lemon were grown on the dykes. Vegetables on dyke included snap bean, radish, brinjal, okra, pumpkin, tomato, poi, spinach, coriander and lal sag. Haor pond with the dyke based farming system can earn higher income. The trees may be resting places for birds resident as well as migratory. The discouragement of the culture of carnivorous fish will prevent harm to fishery resources.

6.1.1.6 Impacts on Socio-economy

Preconstruction Phase: The visit to pond sites by project people may seem to be strangers. However, this may be voided by prior information to visit. The training of the pond farmers will help capacity development of males and females on fish culture. It will create awareness on detrimental effects of culturing carnivorous fish. So, adverse social impact will not be felt.

Construction Phase: Employment opportunity will be a positive impact of re-excavation of ponds. The disposal of earth on dykes will follow environmental guidelines.

Post construction Phase: The ponds will be prepared for releasing of fingerling. This will create employment. Fish fingerlings on release will have to be nurtured and women may play significant role thus generating women employment and consequent empowerment. Fish will have to be fed and fish marketing will be needed. Here employment opportunities will be created. Fish will have to be harvested where fishermen will have earning opportunities. Fish on harvesting will have to be transported. Thus, employment in the form of transportation will take place. Fish intake at household level will increase leading to better nutrition. Thus, the social impact will be very significant.

6.2 Environmental Management Plan (EMP)

Fisheries are one of the most significant renewable resources that haor regions have for food security, livelihoods and economic growth. Haor people depend mostly on the exploitation of its natural resources largely fishes. It therefore makes sense that these natural resources are not just protected, but are exploited in a manner that fosters their regeneration, to address food and development demands by a growing population (White and Soto 2013).

Environmental management is essential to ensure that impacts identified are prevented and mitigated by the Environmental Management Plan (EMP). The requirements and implementation of aquaculture EMP varies from country to country, depending on the technology and systems applied (intensive vs. extensive, large-scale vs. small scale, fed vs. non-fed etc.). Maintaining a good pond fish culture environment is crucial for growing healthy fish, reducing diseases and deaths, achieving satisfactory production and improving culture efficiency. The EMP includes measures to address the potential impacts that will be implemented during the scale up of the haor ponds especially seasonal ponds. Pond fishery development is rapidly developing in haor areas, but these needs to be undertaken responsibly and sustainably to ensure strong social benefits with minimal impact to the environmental management planning for large-scale expansion, which have a potential for significant environmental impact, encourages responsible and sustainable pond fishery development. It also ensures that natural resources, including biodiversity will be also available to future generations (White and Soto 2013). Environmental Impact Assessment (EIA) is the most commonly utilized tools for evaluating environmental concerns, sustainability issues and developing mitigation measures for new development projects. EIA serves in i) identifying mitigation measures, which will minimize any possible environmental impacts, if any; ii) provide the framework for the follow up. Environmental monitoring and supervision shall be integrated into the haor pond fishery management.

Environmental Management Plan is not fully applied to the bulk of aquaculture in Bangladesh because most production is small-scale and in many cases is a traditional activity. However, it is important to recognize that many small-scale aquaculture activities could have significant impacts on the inundated water body and therefore some form of strategic environmental management plan is needed to cover such added effects. According to White and Soto (2013) properly implemented EIA seeks to:

- Concentrate on significant environmental impacts, taking into account the issues that matter;
- Adjust to the realities, issues and circumstances of the project proposals based on the best available information;
- Provide appropriate opportunities to inform and involve the interested and affected parties, and their inputs and concerns should be addressed explicitly;
- Be a clear, easily understood and open process with public consultation;
- Apply the “best doable” methodologies to address the impacts and issues being investigated;
- Identify measures for impact mitigation that work and can be implemented;
- Be carried out with rigour, fairness, objectivity and impartiality;

- Impose the minimum cost burden on proponents consistent with meeting process requirements and objectives;
- Provide the framework for assessment of impacts during operation and adjustments to minimize these when appropriate.

Environmental issues in haor pond fishery arise because pond fish culture relies heavily on environmental goods (e.g. water, feed ingredients, seed etc.) and services (e.g. water availability during dry season). Interactions between pond fishery and the environment are affected by various interrelated factors, including availability, amount and quality of resources utilized, type of species cultured, size of farm, farming systems design and management, and environmental characteristics at the location of the farm. Major issues are:

- Aquaculture in general is highly sensitive to adverse environmental changes (e.g., water quality, seed and feed quality), and can be seriously affected by aquatic pollution;
- Aquaculture inevitably interacts with stakeholders, not directly involved in aquaculture that rely on similar "common" resources such as water and public land and conflicts may arise where formal and informal institutional/legal/social structures are inadequate for conflict resolution and allocation of resources among competing groups.
- It is in the long-term interests of farmers working with aquaculture to work towards protection and enhancement of environmental quality. This issue raises interesting possibilities for aquaculture farmers to work in partnership with communities.

Hence, the expansion of Haor fish culture is not just about having more ponds. More intensive and effective systems of aquaculture production that promise higher yields and greater profit margins are increasingly being adopted (White and Soto 2013). EMP must take into account all the needs and potential impacts of an initiative. Table 30 summarizes the proposed EMP in light with management measures and responsible agencies of management.

Table 30: Environmental Management Plan

Activities	Environmental Impacts	Proposed Management Measures	Institutional Responsibilities
Pre-construction activities for identification of ponds for inclusion in the project	• No effect except short time presence of strangers to local people. • If acidic soil is found fish production may be affected	• Prior information to the community • Lime is to be added before release of fries. or pond changed	CBOs, LGED, DBHWD, DoF, DoE
Construction Phase			
Re-excavation/Excavation of ponds	• Difficult to maintained water quality in a smaller pond; • Fish in bottom clay may be affected	• Pond area should be about 3 decimal; • Water depth should be 1.2 to 1.8 meters deep; • The pond bottom should be made up of a layer of clay	LGED, Pond owner

Activities	Environmental Impacts	Proposed Management Measures	Institutional Responsibilities
		with good water retention; • Some fish from the bottom may be transferred to adjacent ponds	
Pumping of water for drying of pond	• Fish living in bottom clay layer may be affected	• Some fish from the bottom may be transferred to adjacent ponds	LGED, Pond owner
Deposition of excavated earth on dykes	• Flora and fauna on dykes may be affected • Sandy soil on dyke may be washed out	• Boroughs and holes of helpful creatures may be protected but those of vermin may be closed. • Endangered species if any is to be protected. • Proper turfing may avoid wash out and is to be made	LGED, Pond owner
Preparation of ponds before release of fries/fingerlings	• Fish in the bottom may be affected	• Some fish from the bottom may be transferred to adjacent ponds	LGED, Pond owner
Post Construction Phase			
Pond Preparation	Inherent soil acidity may turn the pond water acidic and metabolism of fish slows down in acidic water (below pH 6);	• After draining and sun drying the fishpond, sprinkle and adequate amount of lime on the edges before filling water. • If necessary, put lime directly into the pond and then measure the water pH. • The pond bottom should be made up of a layer of clay with good water retention; • Pond dyke should be strong enough to prevent dyke due to strong rain or tidal force	LGED, DBHWD, DoF, DoE, CBOs
Release of fish fry and fingerling	• Increased fish production. • Decline of the environment due to high production	• Market link to be developed. • Fingerling/Fry fish should be isolated for a few days to observe their condition. • Isolation/proper treatment of sick fish • Proper use of feed additives and drugs;	LGED, DOF,NGOs
Dykes of ponds is maintained	• Fish production may be affected by damage of dykes • In perennial ponds fish will be secure if dykes properly raised • More time will be	• Dykes are to properly shaped and planted with trees and turfed • Earth laying on dykes is take into consideration flood level • Harvesting should be done taking note meteorological	LGED, Pond Owner

Activities	Environmental Impacts	Proposed Management Measures	Institutional Responsibilities
	available for fish harvesting before onset of monsoon	information.	
Stocking of Fish species	• Aquaculture development impact to the environment; • Larger aquaculture projects have a potential for significant environmental impact • Overstocking may affect production; • Occurrence of pathogens may affect production • Environmental change due to aquaculture operations	• Fish Fingerling Stocking and Raising Programme • Selection of native species • Avoid over-stocking • Research on Fish Stock Improvement • Pen/Cage Fish Culture • Floodplain Aquaculture under CBOs • Technology to Fish Farmers Selection of high growth species • Stocking should be under expert guidance • Fish health is to be monitored • Ponds are to be checked every day • Exotic species escaping in the open water may affect local species	LGED, DoF, Pond Owner, NGO
Quality of fingerling	• Spawning season may be alter due to temperature variation; • Improper quarantine may cause large scale outbreak of fish disease	• Conserving Quality Brood Stock & Production of Fish Seeds • Fingerling/Fry fish should be isolated for a few days to observe their condition. • Beel Nursery Programme • Isolation/proper treatment of sick fish • Proper use of feed additives and drugs; • Ensure fingerling are free from disease; • Do not stock unknown exotic species unless approved by the government; • Fingerling/Fry fish should be isolated for a few days to observe their condition • Proper use of feed additives and drugs	LGED, DoF, Pond Owner, NGO
Use of chemicals and drugs.	• Water quality may be affected. • Health of fish may be affected	• Water quality (Water temperature, DO, pH, NH3, Nitrite, Nitrate, Transparency etc.) monitoring; • Monitoring of fish health	LGED, DoF, Pond Owner, NGO

Activities	Environmental Impacts	Proposed Management Measures	Institutional Responsibilities
Release of aquaculture effluents	• Water quality may be affected	• Water quality to be checked. • Environment standard of DOF followed.	LGED, DoF, Pond Owner, NGO
Planting of agro and other plants	• Ecological Habitat retained	• Suitable local trees are to be planted.	Pond owner, LGED, NGO
Supply of quality feed	• Market link may be affected	• Market link to be strengthened	LGED, DoF, NGO
feeding of fish in ponds	• Male and female employment generation	• Use feed ingredients produced in a recognized producer • Use feed with lower FCR;	Pond Owner, DoF, LGED
Transportation of feed / Quality feed supply chain	• Environmental degradation, • Contamination can occur due to inferiority feed, • Natural food deficiency, Decline normal growth, • Increased load on transportation	• Use feed ingredients produced in a recognized producer; • Use feed with lower FCR; • Increase load of transportation may be monitored	CBOs, LGED, DoF
Harvesting of fish	• Increased fish production • Nutrition improvement	• Supporting fish marketing	LGED, DOF, NGO
Marketing of fish	• Market link may be affected	• Market link to be strengthened	LGED, DoF, Pond Owner, NGO
Environmental Monitoring			
Monitoring of fish health	• Environmental degradation, biodiversity and the control of the outbreak of disease; • Intensification stress of fish and aquatic animals; • Daily check may prevent disease	• Water quality monitoring helps understand regarding fish diseases • Simple health check of the fish every day; • Proper disposal of dead fish and garbage; • Maintain healthy pond environment to reduce stress on fish; • Health check involving detection of pathogen Proper disposal of dead fish.	Pond owner, NGO, LGED, DoF
Market linkage	• Environmental degradation; • Decline of the environment due to economic growth; • Output price may be adversely affected	• Establishment of marketing information system • Establishment of Fish Landing Centers; • Integration of Fish farmers, processors, traders, intermediaries, day laborers and transporters. • Domestic market would be expanding in future; • Long term Master Plan for haor region help aquaculture will be	CBOs, LGED, DBHWD, DoF

Activities	Environmental Impacts	Proposed Management Measures	Institutional Responsibilities
		sustainable in term of investment; Environmental protection and resources management; • Market linkage is to be strengthened	
Water quality during aquaculture period	• Water quality impacts due to water pollutions; • Fish pond may be affected by muddy backflow during rain or entry of flash flood water	• Measure water quality parameters regularly (Water temperature, DO, pH, NH3, Nitrite, Nitrate, Transparency etc.) • Strictly implement approved Water pollution Control Plan • Aquaculture practices shall be well-maintained and shall meet national DoF standards. • Undertake regular cleaning of polluted materials. • Proper sanitary facilities and drainage in the community. • Water quality monitor shall be conducted periodically. • If water is visually turbid or muddy yellow in colour, observe the fish behaviour; change the pond water and apply fish feed sparingly; • Provide prior notification to the community on any fish diseases.	CBOs, LGED, BWDB, DBHWD, DoF, DoE
Supplementary works	• Environmental degradation; • Unusual vulnerabilities and poor water quality;	• Inspect fish pond regularly to observe fish behaviour • Disinfect and dry harvesting gear under sunlight regularly;	CBOs, LGED
Maintenance of pond management records	• Natural hazards and poor water quality;	• Keeping records of weather, feeding quantities, water temperature, dissolved oxygen level and fish activities etc. • A suitable management solution can be identified to enhance culture efficiency.	CBOs, LGED
Financial			
Financial management	• Deterioration of the environment due to economic growth	• Integration Bangladesh Krishi Bank and some other commercial banks for issuing credit support; • Training on Financial Management for fish farmers;	CBOs, LGED
Investors in the value	• Environmental	• Establishment of Fish Drying	CBOs, LGED,

Activities	Environmental Impacts	Proposed Management Measures	Institutional Responsibilities
chain	degradation,	and Fermentation Centre • Establishment of Cold Storage and Ice Plants; • Establishment of Fish Processing Industry;	DBHWD, DoF

6.3 Conclusion and Recommendations

Conclusion: The intervention has resulted in the improvement of yield from ponds and generated higher income and nutritious food for the fish farmers. Existing cultural practices could support experimentation and learning under future initiatives in the *haor* area. A good number of exotic species has been introduced in Bangladesh. Some introduced species (e.g., Tilapia) have established significant feral populations and the local communities considered them indigenous species. The study revealed that exotic species have provided socio-economic benefits for a vast number of poor and vulnerable people in the haor region. However, very limited studies have been done, so far, in order to bring these species into the culture. Fisheries are one of the most significant renewable resources that North-East region of Bangladesh have for food security, livelihoods and economic growth. The adoption process for fish culture in the study area is still in its beginning. Some farmers are still in a state of trial and ready to interrupt the activity as soon as problems occur. Besides, the pond aquaculture with dyke cropping can earn higher income.

Recommendations: The study has provided evidence that haor pond aquaculture approach aimed at improving the lot of the poor and vulnerable is effective in the study area. The study revealed the future initiative should carefully weigh both positive and negative impacts for each exotic species and need to develop a well planned research program to assess the impacts of exotic species in Bangladesh. The use of environmental management plan for pond fish culture, which has a potential for significant environmental impact, also ensures that natural resources including biodiversity will be also available to future generations. Pond fishery in the *haor* area mainly has an income-generating feature and less probability of being affected by climate change impacts on culture fishery. The approach should be extended beyond study areas and be adopted as a key strategy for development of haor fisheries resources in Bangladesh. Besides, Small and Medium Enterprise (SME) development in haor pond is of outmost importance for sustainable pond aquaculture

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List of Annexures

Annexure 1: Conducted IDIs by pond owners, FGDs and Flora & Fauna survey along with Unions, Upazilas, Districts and Divisions.

Division	District	Upazila	Union	No. of IDI conducted (pond)	No. of FGD conducted	No. of Session (Flora & Fauna)
Chittagong	Brahmanbaria	Bancharampur	Salimabad, Rupshuddhi	4	1	1 (Rupshuddhi-High)
		Nabinagar	Srirampur, Ibrahimpur	4	1	
		Ashuganj	Sharifpur, Durgapur	3	1	
		BrahmanbariaSadar	Masihata, Basudeb	4	1	
		Sarail	Chunta	3	1	1 (Panishwar-Low)
		Nasirnagar	Gokorno, NasirnagarSadar,	4	1	
Dhaka	Kishoreganj	Austagram	Austagram, East Austagram	3	1	1 (Austagram-High)
		Nikli	Gurue, Jarauitala	3	1	
		Mithamoin	Ghagra,Sadar	4	1	1 (Ghagra-Low)
		Itna	ItnaSadar, Chowganga	4	1	
Mymensingh	Netrokona	Khaliajuri	Mendipur, Nagar	3	1	
		Madan	Mogon,Gobindasri	3	1	1 (Mogon-Low)
		Mohanganj	Gaglajore, Soaiar	3	1	1 (Soaiar-High)
		Kolmakanda	Pogla	4	1	
Sylhet	Habiganj	Lakhai	Bolla, Bamui	2	1	1, (Bolla-High)
		Baniachong	Baraiuri, Khagapasha, Soundari	4	1	
		Azmiriganj	Shibpasha, Kakailsew	3	1	1 (Kakailsew-Low)
	Sunamganj	Sulla	Habibpur, Bahara	2	1	
		Dherai	Rajanagar, Karimpur	4	1	
		Jagannathpur	Chilaura-Haldipur, Raniganj, Jagannathpur	4	1	
		Chhatak	Bhatgaon, Jawa	2	1	1 (Bhatgaon-High)
		Dowarabazar	Dowara Bazar, Pandargao	2	1	
		SunamganjSadar	Mollah Para, LakhanSri	4	1	
		DakshinSunamganj	Joykalas, Shimulbak	4	1	
		Bishwambarpur	Fathapur, Salukabad	2	1	1 (Salukabad-Low)
		Tahirpur	Balijuri, DakshinBaradal	2	1	
		Jamalganj	Fenarbak, JamalganjSadar, Jamalganj	4	1	
		Dharmapasha	Dharmapasha, DharmapashaSadar, Madhyanagar	4	1	
=04	**=05**	**=28**	**=58**	**=92**	**=28**	**= 10**

Annexure 2: Key Tasks, Activities and Achievements during the study periods.

Key Tasks	Key Activities	Achievement in Quarter-1 and target to be achieved	Achievement in Quarter-2 and target to be achieved	Achievement in Quarter-3 and target to be achieved
Task – I: Development of an environmental baseline with indicators	i. Collection and Review of Maps, Review of Satellite Image and Environmental and Climate Change Reports ii. Collection of Secondary data iii. Reconnaissance visit in Project Areas iv. Collection of Qualitative data through FGDs, KIIs and physical observations v. Quality control of data vi. Data Management Plan vii. Qualitative Data entry (quantitative and qualitative) to the computer and compilation viii. Data table preparation for analysis	i. Some maps collected and reviewed, relevant Environmental and Climate Change reports collected, and satellite image will be collected. ii. Environmental related secondary data have been collected. iii. Reconnaissance visits conducted in the Project Area. iv. KIIs were conducted in two districts and target to be achieved in three districts. FGDs started at field level and ongoing along with physical observations. v. Data Quality will be maintained properly vi. Data Management Plan completed vii. Qualitative Data entry (quantitative and qualitative) will be conducted. viii. Data table preparation will be completed for analysis.	i. Necessary maps have been collected and satellite image will be collected. ii. Environmental related secondary data collected and analyzed. iii. Field visits conducted in the Project Area, and necessary visit will continue for gathering accurate information. iv. KIIs were conducted in one district and target to be achieved in two districts. FGDs completed at field level covering 28 upazilas with physical observations in all sampled sites. v. Data Quality maintained properly vi. Data entry managed according to plan. vii. Qualitative and quantitative data entry and table preparation is ongoing according to plan. viii. Data table preparation completed and analysis in progress.	i. Essential GIS maps collected. ii. Environmental related secondary data analyzed. iii. Field visits conducted in the Project Areas - Habiganj, andBrahmanbaria. iv. KIIs were conducted in two districts. FGDs completed at field level covering 28 upazilasand all information synthesized and drafted. v. Data quality ensured properly from data collection to data analysis process. vi. Data entry to analysis managed properly. vii. Data analysis and draft report completed according to plan. viii. Data table preparation and draft report completed.

Key Tasks	Key Activities	Achievement in Quarter-1 and target to be achieved	Achievement in Quarter-2 and target to be achieved	Achievement in Quarter-3 and target to be achieved
Task – II: Analysis of fish habitat and production	i. Collection of Data related with Fisheries (habitat & production, pond size , soil quality, species composition, gears) through FGDs with the stakeholders and discussion with Upazila Officers ii. Collection of primary & secondary data iii. Analysis fish biodiversity with available data	i. Data collection is ongoing through IDIs, FGDs and discussion with Upazila officers ii. Primary and secondary data collection is ongoing iii. Analysis will be conducted accordingly after completion of data collection.	i. IDI and FGDs data collection just completed and discussion with upazila level officers in progress. ii. Primary and secondary data collection nearly completed. iii. Data table preparations are in progress to conduct systematic analysis.	i. IDI, FGDs, KIIs data collected completed according to plan. ii. Primary data collection from field level completed and secondary data and information will be gathered, if needed. iii. Data table preparation completed and analytical results incorporated in the quarter-3 report.
Task – III: Identification, prioritization and validation of the Important Environmental Components (IECs)	i. Identification of Important Environmental Indicators ii. Review of Literature i.e. Project Documents, Reports and Other Related Documents iii. Collection of Review of Maps, Review of Satellite Image and Environmental and Climate Change Reports iv. Sample design of FGDs and KIIs v. First Quarterly Progress Reporting works vi. Data analysis based on IECs vii. Second Quarterly Progress Reporting works	i. Primarily identified important Environmental indicators; ii. Some important project reports, literatures and other related documents reviewed; iii. Some Maps collected and reviewed, relevant Environmental and Climate Change reports collected, and satellite imagery will be collected. iv. FGDs and KIIs sample design completed v. First interim report (quarter-1) completed vi. Data collection in progress	i. Key environmental indicators identified; ii. Relevant project reports, literatures and other related documents reviewed; iii. Relevant maps collected and reviewed, necessary environmental and Climate Change reports collected, however, satellite imagery will be collected; iv. FGDs and KIIs sample design completed; v. First and second interim reports (quarter-1& quarter 2) completed; vi. Data collection nearly completed and data entry in	i. Environmental indicators identified. ii. Relevant documents reviewed accordingly. iii. Necessary maps, reports, papers collected and reviewed accordingly. iv. FGDs and KIIs data collection completed according to design. v. First, Second and Third Interim reports (Q-1, Q-2 and Q-3) completed. vi. Data collection, entry, analysis almost completed and included in this report. vii. Completed. viii. Third Quarterly report completed and planned for final

Key Tasks	Key Activities	Achievement in Quarter-1 and target to be achieved	Achievement in Quarter-2 and target to be achieved	Achievement in Quarter-3 and target to be achieved
	viii. Third Quarterly Progress Reporting works	vii. Planned for the second quarterly report viii. Planned for the third quarterly report	progress. vii. Second quarterly report completed; viii. Planned for the third quarterly report	draft report.
Task – IV: Assessment of the key climate variables affecting pond fish culture	i. Identification of Important Environmental Indicators ii. Collection and Testing of Water Samples iii. Analysis of affects of scaling of pond fisheries iv. Assessment of climate change on fisheries	i. Important environmental indicator identified; ii. Water sample will be collected and tested accordingly; iii. Pond fisheries data will be analyzed to observe effects of scaling; iv. Climate change will be assessed on fisheries;	i. Important environmental indicator identified; ii. Water sample will be collected and tested accordingly; iii. Pond fisheries data will be analyzed to observe effects of scaling; iv. Climate change will be assessed on fisheries;	i. Data/information described according to environmental indicators. ii. Water sample data collection & testing is ongoing at field level from five districts, iii. Perennial and seasonal ponds data analyzed and results included in this report, iv. Impact of climate change partially described in this report.
Task – V: Identification of the exotic species in ponds and assessment of the potential impact of their presence on the local natural population species.	i. Sample design of FGDs and KIIs ii. Training of Field staff iii. Field testing and finalization of study instruments iv. Development of the field survey schedule	i. Data collection sample design formulated and implemented at the field level; ii. Training of field staff completed; iii. Field testing completed and finalized study instruments; iv. Field survey schedule completed and data collection ongoing at field level.	i. FGDs completed and implemented at the field level; Some KIIs will be completed. ii. Completed for field staff; iii. Completed and finalized all study instruments; iv. Data collection completed according to survey schedule at field level.	i. Completed. ii. Completed iii. Completed iv. Completed
Task – VI: Assessment of the physical, chemical,	i. Development of survey instruments ii. Assessment of	i. Development of survey instruments and data collection ongoing at the	i. Data collection completed at the field level according to survey instruments;	i. Completed ii. Completed iii. Completed accordingly

Key Tasks	Key Activities	Achievement in Quarter-1 and target to be achieved	Achievement in Quarter-2 and target to be achieved	Achievement in Quarter-3 and target to be achieved
biological, social and economic significance and implications of the predicted impacts.	Environmental (physical, chemical, biological and social impacts iii. Predict economic significance and impacts.	field level; ii. Data collection ongoing at the field level and assessment of environmental impact will be performed accordingly. iii. Economic significance will be predicted after data analysis.	ii. Data collection partly completed at the field level and assessment of environmental impact in progress. iii. Data table preparation in progress and economic significance will be predicted after data analysis.	
Task – VII: Suggesting measures to mitigate adverse environmental impacts and strengthen environmental friendly impasses	i. Matrix Analysis for identifying mitigation measures on environmental impacts ii. Develop participatory action plan	i. Analysis will be done after data collection; ii. Participatory action plan will be developed through incorporating the results of the study.	i. Field level data table preparation in progress and analysis will be done after data table completion; ii. Participatory action plan will be developed through incorporating the results of the study.	i. Analytical result described in environmental section. ii. People perception on environmental impact included in this report &participatory action plan will be drafted accordingly.
Task – VIII: Development of a detailed plan for environmental management of large scale expansion of pond fisheries	i. Participatory discussion meeting with stakeholders ii. Preparation of detailed Environmental Management Plan (EMP)	i. Will be conducted according to plan ii. Will be prepared accordingly	i. Partly completed and continue according to plan ii. Preparation in progress;	i. Almost completed and continue according to plan, ii. Draft outline prepared and different section included in this report,
Task – IX: Publishing the research finding taking the consent	i. Preparation of draft final report ii. Preparation of final report iii. Submission of final report	i. Draft outline prepared and enclosed in this report (Appendix 5); ii. Draft outline in preparation;	i. Draft outline prepared and enclosed in this report. ii. Draft outline in progress; iii. Will be submitted in due	i. Draft outline updated and enclosed in this report. ii. Draft outline in progress; iii. Will be submitted in due time;

Key Tasks	Key Activities	Achievement in Quarter-1 and target to be achieved	Achievement in Quarter-2 and target to be achieved	Achievement in Quarter-3 and target to be achieved
of Project Director, HILIP, and PMU.	iv. Preparation of Research paper and submission for publication	iii. Will be submitted in due time; iv. Draft outline prepared and enclosed in this report (Appendix 6).	time; iv. Draft outline prepared, updated and enclosed in this report.	iv. Draft outline updated and enclosed in this report.

Annexure 3: Secondary Documents Collected and Reviewed during study period.

Sl. no.	Name of documents	Collected & reviewed in Quarter-1	Collected & reviewed in Quarter-2	Collected & reviewed in Quarter-3
1	Development Project Proposal (DPP)	Key information collected from LGED	Collected in quarter 1	Collected in quarter 1
2	Relevant project reports and information available at HILIP, LGED	Collected some key documents from LGED web site	Collected in quarter 1	Collected in quarter 1
3	Progress reports	Collected some progress reports and some more progress report will be collected in Quarter 2.	Collected some progress reports	Collected in quarter 1 and 2, and some collected during this quarter
4	End report of Sunamganj Community Based Resource Management Project and Other concerned agencies	Collected some key documents of SCBRMP and other relevant projects	Key documents collected	Collected in quarter 1 and 2, and collected some annual reports during this quarter
5	List of Project Unions	Compiled from HILIP, and randomly selected for sampling	Field data collection almost completed according to sampling design	Completed in quarter 1 and data collection completed
6	Internet searching and other sources. The activity will continue up to compilation of reports.	Collected some key documents and more documents will be collected in Quarter-2.	Collected some more relevant documents	Collected in quarter 1 and 2.
7	SRDI (UpazilaNirdeshika) report on each of the upazilas	Collected for some upazilas and more reports will be collected to cover 28 upazilas.	Collected for some more upazilas	Collected in quarter 1 and 2.
8	BBS Report of each project district (Community Series to give information of socio-economics of	Collected for each project district	Collected in quarter 1	Collected in quarter 1

Sl. no.	Name of documents	Collected & reviewed in Quarter-1	Collected & reviewed in Quarter-2	Collected & reviewed in Quarter-3
	The district upazilas			
9	Land Zoning Report of 28 upazilas to give information of fisheries, land use, environment etc.	Collected for some upazilas and more reports will be collected to cover all 28 upazilas	Collected 28 Land Zoning Reports of 28 upazilas.	Collected in quarter 1 & 2
10	KalniKushiyara Project Feasibility study report to give idea on climate change effect	Communicated with the respective department: Will be collected soon.	Collected	Collected in quarter 2
11	CEGIS (undertaking a simultaneous study in the Haor area) map showing the location of ponds and other environmentally important issues.	Satellite based Google map collected and more maps will be collected according to needs. Besides, the study team will communicate with CEGIS for maps that are more accurate.	Some recent Google maps collected	Collected in quarter 2
12	Fisheries and relevant data already collected by HILIP	Some results based reports collected	Some recent reports collected	Some recent reports collected
13	Fisheries and *haor* related reports available at DBHWD, MACH, CBFM, FFP, IPAC, CREL, CBRMP, IUCN etc.	Some key reports of DBHWB, MACH, CBFM, FFP, IPAC, CREL, CBRMP and IUCN were collected	Collected some key documents e.g., FAO Fisheries & Aquaculture Technical paper 627, Rome 2018.	Collected in quarter 1 and 2
14	Science based publication available at WorldFish website and Research Gate.	Collected some key documents	Collected some more key documents	Collected some relevant publications, and these will be helpful for science paper
15	Temperature data for relevant stations from 1995 - 2012	Collected monthly maximum and minimum temperature data for three stations.	Data had processed annually for relevant three stations close to project areas.	Collected recent temperature data
16	Rainfall Data from 1982 – 2002 for relevant stations	More data are under the process of collection	Collected monthly rainfall data from Sunamganj and Kishoreganj	Collected recent rainfall data
17	Water level data from 1982 - 2002	More data are under the process of collection	Collected some data from the River Surma, Sunamganj	Collected recent water level data
18	Analysis of groundwater table variations in Sylhet region, Bangladesh (Zafor et al., 2017)		Collected some information regarding groundwater depth with the best-fitted model.	Collected recent information on groundwater levels
19	Groundwater resources in the hard to reach areas of Bangladesh: Constraints for drinking water supply and strategies for		Collected some information on Aquifers status, groundwater recharge and irrigation development in the haor areas	Gather information

Sl. no.	Name of documents	Collected & reviewed in Quarter-1	Collected & reviewed in Quarter-2	Collected & reviewed in Quarter-3
	sustainable use (Shahjahan, M. M. 2015)			
20	GIS Application in fish disease mapping and forecasting (Pranaya et al., 2019)		Collected some information on Geographic information system (GIS) for better understanding of fish health planning, environmental monitoring and forecasting.	Gather information
21	Fish in human health and nutrition (Bimal et al 2019)		Collected information on species wise different types of essential nutrition has to build a better health for *haor* community.	Describe about available species with essential nutrient's value
22	Impacts of climate change on fisheries and aquaculture (Manuel et al 2018)		Collected information on adaptation measures in the fisheries and aquaculture sectors to climate change and associated risks.	Collected guidelines for the management of pond fish culture Collected report on Local ecological knowledge on sustainable fish culture CC Impact on Hydrology, Bioclimatic conditions, and Terrestrial Ecosystems. Large scale fish production through carp polyculture

Annexure 4: Achievement of Important Environmental Components

Sl. no	IECs components	Achievement in Quarter-1	Achievement in Quarter-2	Achievement in Quarter-3
1	Water quality parameters e.g., Water temperature, DO, pH, Ammonium (NH4-N), Nitrate (No3-N), Carbon dioxide, Turbidity	Water quality parameters collection ongoing from both primary and secondary data	Water quality parameters collection in progress	Physiochemical water parameters were collected covering study sites from published journals (e.g., Temp, EC, DO, pH, TDS, BOD). Besides, additionalprimarydata on temperature, DO, pH, Turbidity, Nitrate from HILIP fish cultured ponds will be incorporate in the final draft report.
2	Fish habitat and production	Data collection ongoing from both primary (Survey) and secondary data	Data collection almost completed from both primary (households' survey) and secondary data sources. Primary data from 92 pond owner households in five districts and through 28 FGDs from 28 upazilas.	Primary data through IDIs from 92 pond owner households in five districts and 28 FGDs information from 28 upazilas incorporated in the Interim report 3.
3	Fish diseases	Data collection ongoing from both primary (Survey) and secondary data	Data collection in progress from both primary (households survey) and secondary data	Data gathers from IDIs, FGDs and KIIs accordingly
4	Fish species	Data collection ongoing from both primary (Survey) and secondary data	Data collection almost completed from both primary (household survey) and secondary data. Species diversity data were collected from 92 ponds owners during an In-Depth Interview (IDI) and individual pond base fish biodiversity were collected.	Majority of data gathers from primary survey (IDIs) and validated with recent reports (WorldFish study, IUCN report, DoF Statistical Year Books and publications).
5	Fish biodiversity	Data collection ongoing from both primary (Survey) and secondary data	Data collection almost completed from both primary (household survey) and secondary data. A total of 92households (pond owners) surveyed through In-Depth Interview (IDI) and individual pond base fish biodiversity was collected.	Majority of data gathers from primary survey (IDIs) and validated with recent reports (WorldFish study, IUCN red list, and Journal articles).
6	Irrigation	Data collection ongoing from both primary (Survey) and secondary data	Data collection in progress from primary (household survey), 28 FGDs and secondary data sources. Percentage (%) of areas under irrigation for Boro (HYB) by using both surface and ground water will be described.	Data gather through IDI, FGDs and KIIs. Besides, secondary data also collected from respective sources.
7	Water body	Partial information collected	Partial information collected and in progress	Data gather during quarter 1, 2, and 3 respectively.

Sl. no	IECs components	Achievement in Quarter-1	Achievement in Quarter-2	Achievement in Quarter-3
8	Ground water level	Data will be collected	Partial information collected from secondary sources and more date collection in progress	Data gather from secondary sources
9	Land form and land use	Data collection ongoing from both primary (Survey) and secondary data	Partial information collected and more data collection in progress	Data gather from secondary sources
10	Soil quality	Survey and information collection ongoing.	Data collection almost completed. A total of 92 ponds surveyed through In-Depth Interview (IDI) and individual pond species soil information was collected. Besides information from KII and secondary data on soil quality were also recorded.	Data gather through IDIs from 92 sites. Besides, inclusive data were collected from secondary sources.
11	Crop production	Will be collected from secondary data.	Different crops are cultivated in the project area and main dominating crops will be described. Data collection in progress from secondary data.	Data gather from secondary sources, particularly for Department of Agriculture Extension.

Annexure 5: The taxonomic group used in the catch analysis of the pond fishery & taxa contributed to each group (Native cultured fish, Exotic cultured fish & natural non-cultured fish) by % to the catches.

Group	Scientific name	Local name	Common name	Percentage composition of the total					
				Netrokona	Sunamganj	Kishoreganj	Habiganj	B.Baria	Overall %
Native cultured Fish	*Labeo rohita*	Rui	Roho labeo	15.5	7.88	12.95	9.67	11.56	10.82
	Chrrhinus cirrhosus	Mrigal	Mrigal carp	5.95	3.48	3.42	8.33	7.56	5.29
	Catla catla	Catla	Catla	5.31	0.91	2.67	3.33	5.81	3.23
	Amblypharyngodon mola	Mola	Indian carplet	1.53	2.88	0.48	2.78	0.21	1.66
	Labeo calbasu	Kaliboush	Orangefin labeo	-	-	0.62	-	0.71	0.27
	Mystus sp.	Tengra	Striped catfish	0.4	-	-	-	0.53	0.19
	Ompok pabda	Pabda	Pabdah catfish	1.06	-	-	-	-	0.15
Exotic cultured Fish	*Oreochromis mossambicus*	Tilapia	Mozambique tilapia	1.62	28.18	4.52	43.33	12.62	18.49
	Oreochromis niloticus	Mono-sex tilapia	Nile tilapia	40.41	4.09	40.57	-	12.83	16.59
	Hypophthalmichthys molitrix	Silver carp	Silver carp	9.68	7.88	10.47	6.11	14.26	9.9
	Cyprinuscarpio	Common carp	Common carp	4.02	13.64	4.74	2.22	6.07	7.94
	Barbonymus gonionotus	Thai sarputi	Thai sarputi	4.74	11.82	2.88	12.78	1.99	7.15
	Ctenopharyngodon idella	Grass carp	Grass carp	2.24	10.3	2.97	4.78	2.88	5.68
	Pangasianodon hypohthalmus	Thai pangus	Thai pangus	-	3.18	0.38	-	1.68	1.62
Natural non-cultured fish	*Puntius sp.*	Puti	Barb	2.88		2.72		4.28	1.86
	Channastriata/C. marulius	Shol/Gozar	Striped/ Great snakehead	0.87	2.27	1.82		1.37	1.56
	Heteropneustes fossilis	Shing	Stinging catfish	1.08		1.6			1.07
	Clariasbatrachus	Magur	Magur	0.47		1.2			0.37
	Channapunctata	Taki	Spotted snakehead	2.13		0.61			0.63
	Anabas testudineus	Koi	Climbing	0.08		0.67			0.59

Group	Scientific name	Local name	Common name	Percentage composition of the total					
				Netrokona	Sunamganj	Kishoreganj	Habiganj	B.Baria	Overall %
			perch						
	Mastacembelus sp.	Baim	Eel	-		-		0.11	0.03
	Wallago attu	Boal	Wallago	-		-		0.08	0.02
	Palaemon sp.	Prawn	Prawn	0.05		0.41			0.07
		Local small fish	Loach, small catfish, eel, garfish	-		0.46		-	0.07
		Others	small barb, catfish, flying barb,	-	2.88	3.85	6.67	10.02	4.72

Annexure 6: Status of Aquatic plant species in HILIP areas

		B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
Local Name	Scientific Name	Sarail		Bancharampu		Azmiriganj		Lakhai		Austagram		Mithamoin		Chhatak		Bishw ambarp		Modon		Mohonganj	
		O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Hycha	*Alternanthera philoxeroides*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Ghechu	*Aponogeton natans*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Kata Jhanji	*Ceratophyllum dumersum*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Kachu	*Colocasia esculenta*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Mutha	*Cyperus rotundus*	C	D	C	U	R	D	FC	D	FC	D	FC	D	FC	D	FC	D	R	D	R	U
Kochuri pana	*Eichhornia crassipes*	C	U	C	U	C	U	C	I	C	I	C	I	C	D	C	I	C	I	C	I
Pata Jhaji	*Hydrilla verticillata*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Kalmi shak	*Ipomoea aquatica*	C	U	C	U	C	U	C	U	C	U	C	U	C	D	C	I	C	U	C	U
Dholkolmi	*Ipomoea fistulosa*	C	U	C	U	C	U	C	U	C	I	C	U	C	U	C	U	C	I	C	I
Rasna/jhanji	*Lagarosiphon roxburghii*	C	D	C	D	Rv	NA	Rv	NA	C	U	C	D	Rv	NA	Rv	NA	C	D	C	D
Khodepana	*Lemna perpusilla*	C	I	C	I	C	U	C	D	C	I	C	U	FC	I	FC	I	C	I	C	I
Kesardam,	*Ludwigia adscendens*	C	D	C	D	Rv	NA	Rv	NA	C	D	C	D	R	u	R	U	C	D	C	D
Shapla Sada	*Nymphaea pubescens*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Topa pana.	*Pistia stratiotes*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Chechu/Chachr	*Scirpus articulatus*	C	D	C	D	Rv	NA	R	D	R	D	R	D	C	NA	C	NA	C	U	C	U
Pani Singara	*Trapa bisppinosa*	C	D	C	D	FC	D	C	U	C	D	FC	D	FC	I	FC	I	C	D	C	D
Baicha	*Vallisneria spiralis*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Helencha	*Alternanthera philoxeroides*	Fc	D	FC	D	R	D	R	U	FC	U	FC	U	R	D	FC	D	FC	U	FC	U
Mutra	*Clinogyne dichotoma*	FC	U	FC	U	FC	U	FC	U	R	U	R	U	FC	U	FC	U	R	U	FC	U
Jhaudham	*Najas minor*	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U
Jal Padma	*Nelumbo nucifera*	FC	D	FC	D	FC	I	R	D	FC	D	C	D	R	U	R	U	C	D	C	U
Sapla Nil.	*Nymphaea nouchali*	FC	D	FC	D	FC	D	FC	D	FC	D	FC	D	FC	D	FC	D	FC	D	FC	D
Chandmala	*Nymphoides hydrophylla*	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U
Panikola	*Ottelia corniculta*	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U
Panimarich	*Polygonum orientale*	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	C	U	C	U	FC	U	FC	U
Chhotokut	*Sagittariasagittifolia*	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U
Indurkani	*Salvinia cucullata*	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U
Guripana	*Wolffia arrhiza*	FC	I	FC	I	FC	U	FC	U	FC	U	FC	U	FC	U	FC	U	FC	I	FC	I
Kerali	*Criptocoryne ciliata*	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U
Phutki	*Hygroryza aristata*	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U
Shapla Beguni	*Nymphaea capensis*	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U
Shalook	*Nymphaea nouchali*	R	D	R	D	R	D	R	D	R	D	FC	D	R	D	R	D	R	D	R	D
Shapla lal	*Nymphaea rubra*	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U	R	U
Pachuli	*Nymphoides indicum*	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D
Nol Khagra	*Phragmites karka*	R	U	R	U	FC	D	FC	D	R	U	FC	U	C	D	FC	D	R	U	R	U
Singara	*Trapa maximowiczii*	R	D	R	D	Rv	U	Rv	U	R	U	R	D	R	NA	Rv	U	R	D	R	D
Benamul/Binna	*Vetiveria zizaniodes*	R	U	R	U	R	U	R	U	R	U	R	U	FC	U	R	U	R	U	R	U

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 7: Status of Creepers plant species in HILIP areas

		B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
Local Name	Scientific Name	Sarail		Bancharampu		Azmiriganj		Lakhai		Austagram		Mithamoin		Chhatak		Bishw ambarp		Modon		Mohonganj	
		O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Assamlata	*Eupatorium odoratum*	C	D	C	D	C	U	FC	U	C	U	FC	D	C	D	C	U	FC	U	FC	D
Swarnalata	*Cuscuta reflexa*	C	D	C	D	C	U	FC	U	C	U	C	D	FC	U	R	U	FC	D	FC	D
Telakucha	*Coccinea cordifolia*	C	D	C	D	C	U	FC	U	C	U	C	D	C	U	FC	U	C	D	C	D
Pipul	*Piper peepuloides*	C	D	C	D	FC	U	R	D	C	U	FC	D	FC	D	R	D	C	D	FC	U
Bet	*Calamus viminalis*	C	D	C	D	R	D	C	D	C	D	FC	D	FC	D	FC	D	C	D	C	D
Madhabi lata	*Quisqualis indica*	C	D	C	D	FC	U	FC	U	FC	U	FC	D	R	U	R	U	C	D	C	D
Mete Alu	*Dioscorea alata*	C	D	C	D	R	D	R	D	C	U	C	D	R	D	R	D	FC	U	C	U
Teet Karela	*Monordica charantia*	C	U	C	U	R	D	R	D	C	U	FC	U	R	D	R	D	R	U	C	U
Satamuli	*Asparagus recemosus*	R	D	R	D	R	D	Rv	NA	R	U	R	D	R	U	Rv	NA	R	U	R	U
Harjora	*Vitis quadrangularis*	R	D	R	D	R	U	Rv	NA	R	U	R	D	Rv	NA	Rv	NA	R	U	R	U
Gila lata	*Derris trifoliate*	R	D	R	D	Rv	NA	Rv	NA	R	U	R	D	Rv	NA	Rv	NA	R	D	R	D
Kuch	*Abrus precatomius*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	U	R	U	Rv	NA	Rv	NA	R	U	Rv	NA

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 8: Status of Herb species in HILIP areas

Local Name	Scientific Name	B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
		Sarail		Bancharampu		Azmiriganj		Lakhai		Austagram		Mithamoin		Chhatak		Bishw ambarp		Modon		Mohonganj	
		O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Hatishura	Heliotropium indicum	C	D	C	D	C	U	C	U	C	D	C	D	C	D	C	D	C	D	FC	U
Durba	Cynodon dactylon	C	D	C	D	C	U	C	D	C	U	C	D	C	D	C	D	C	U	C	U
Chorkanta	Chrysopogon aciculatus	FC	D	FC	D	C	D	C	D	R	D	C	D	C	D	C	D	C	D	C	U
Notey shak	Amaranthes viridis	C	U	C	U	FC	D	C	D	C	U	C	D	C	NA	C	D	C	U	C	D
Jangli kachu	Colocasia nymphaefolia	C	U	C	U	FC	D	C	D	C	U	C	D	C	D	C	D	C	D	C	U
Ghagra	Xanthium indicum	C	D	C	D	FC	D	C	D	C	D	C	D	C	D	C	U	C	D	FC	D
Kanta Notey	A. spinosus	C	D	C	D	FC	U	FC	U	C	U	C	D	C	NA	C	NA	C	D	C	U
Amrul Shak	Oxalis corniculata	C	U	C	U	FC	U	FC	u	C	U	C	D	C	D	C	U	C	D	C	D
Shialmutra	Vernolia patula	FC	D	FC	D	R	D	C	U	R	D	C	D	FC	D	C	D	R	D	FC	D
Man Kachu	Alocasia indica	C	I	C	I	C	U	FC	D	C	U	C	D	FC	D	C	D	C	U	C	D
Shetdrone	Leucas aspera	C	D	C	D	Rv	NA	FC	U	C	D	C	D	FC	NA	C	U	R	D	R	D
Bichi Kala	Musa sapientum	C	I	C	I	C	U	C	D	C	I	C	D	C	D	FC	D	C	U	C	D
Bangla Kala	Musa sp.	C	I	C	I	C	D	C	U	C	I	C	D	C	D	FC	D	C	U	C	I
Kash	Saccharum spontaneum	C	I	C	I	C	D	C	D	C	I	C	U	FC	U	FC	D	C	I	C	U
Lajw abati	Mimosa pudica	C	D	C	D	C	D	FC	D	C	D	C	D	FC	U	FC	D	C	D	C	D
Anaji Kala	Musa paradisiacal	C	I	C	I	C	D	FC	D	C	U	C	D	FC	D	FC	D	C	U	C	D
Bish Katali	Polygonum hydropiper	C	U	C	U	FC	D	FC	D	C	I	C	D	FC	D	FC	D	C	D	C	D
Ulu khar	Imperata cylindrica	FC	D	FC	D	FC	D	FC	D	R	U	C	D	FC	NA	FC	NA	R	D	R	U
Sabri Kala	Musa sp.	C	I	C	I	C	D	R	U	C	U	C	D	FC	U	FC	D	C	U	C	U
Ban Sharisha	Brassica Kaber	R	D	R	D	FC	D	R	D	C	U	C	D	FC	D	FC	D	FC	D	C	D
Bon Palong	Sonchus arvensis	FC	D	FC	D	FC	D	FC	D	FC	D	C	D	Rv	NA	FC	D	R	D	FC	D
Kalokeshi	Eclipta alba	FC	D	FC	D	Rv	NA	FC	U	R	D	R	D	FC	D	R	D	FC	D	FC	D
Ghrit Kumari	Aloe vera	FC	U	FC	U	R	D	R	D	C	D	FC	U	FC	D	R	D	FC	U	FC	D
Rajani gandha	Polyanthes tuberosa	C	D	C	D	C	U	FC	D	C	D	FC	U	R	D	R	D	C	D	C	U
Bon Dhonia	Eryngium foetidium	FC	D	FC	D	FC	D	FC	D	C	U	C	D	R	D	R	D	C	D	C	D
Teet Begun	Solanum nigram	C	U	C	U	R	D	FC	D	C	U	C	U	R	D	R	D	C	U	C	U
Shushni shak	Marsilea quadrifolia	C	D	C	D	R	D	FC	D	C	U	C	D	R	D	R	D	C	D	C	D
Dhutura	Datura metel	C	D	C	D	C	D	R	D	C	U	C	D	R	D	R	D	C	D	C	D
Phonimonsa	Opuntia dillenii	C	D	C	D	R	D	R	D	C	D	C	D	R	D	R	D	C	D	C	D
Bidyapata	Poligonum tementosum	FC	D	FC	D	Rv	NA	FC	NA	C	D	FC	D	Rv	NA	Rv	NA	FC	D	R	D
Kanshira	Commelina bengalensis	FC	D	FC	D	Rv	NA	FC	U	FC	D	R	D	Rv	NA	Rv	NA	C	D	FC	D
Sagar Kala	Musa sp.	C	I	C	I	FC	D	Rv	NA	C	I	C	U	Rv	NA	Rv	NA	C	U	C	D

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 9: Status of Shrub species in HILIP areas

		B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
		Sarail		Bancharampu		Azmiriganj		Lakhai		Austagram		Mithamoin		Chhatak		Bishwambar		Modon		Mohonganj	
Local Name	Scientific Name	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Mehedi	Justicia sp	C	D	C	D	C	U	C	U	FC	U	C	D	FC	U	C	D	C	D	C	D
Gandharaj	Gardenia jasminoides	C	D	C	D	C	U	FC	D	C	D	FC	U	R	D	R	D	C	D	C	D
Jaba	*Hibiscus rosa-sinensis*	C	D	C	D	C	U	C	D	FC	U	C	D	FC	U	FC	U	C	D	C	D
Lebu	*Citrus aurentifolia*	C	U	C	D	C	U	C	D	C	I	C	U	FC	I	FC	I	C	U	C	D
Tulshi	*Ocimum americanum*	C	D	C	D	C	U	C	D	C	U	Rv	NA	C	D	FC	U	C	U	C	U
Man kachu	Alocasia indica	C	D	C	D	C	U	C	D	C	U	C	D	FC	U	FC	U	C	U	C	U
Bashok	*Adhatoda vasica*	C	D	C	D	FC	D	FC	D	FC	D	C	D	R	U	R	D	C	D	C	D
Beli	*Jasminum sambac*	C	D	C	D	FC	D	R	D	FC	D	C	D	R	U	R	D	C	D	C	D
Bish Katali	Polygonum hydropiper	C	D	C	D	FC	D	FC	D	C	U	C	D	FC	U	FC	U	C	D	C	D
Akanda	*Calotropics procera*	C	D	C	D	R	D	FC	U	R	D	C	D	R	D	R	D	C	D	C	D
Ulot Kombol	*Abroma augusta*	C	D	C	D	R	D	FC	D	C	U	C	D	R	D	R	D	C	D	C	D
Kamini	Murraya panikulata	C	D	C	D	R	U	R	U	C	D	C	D	FC	U	Rv	NA	C	D	C	D
Rangan	*Ixora coccinea*	C	D	C	D	Rv	NA	Rv	NA	R	D	FC	D	FC	U	Rv	NA	C	D	FC	D
Jui	Jasminum auriculum	C	D	C	D	Rv	NA	Rv	NA	C	U	C	D	R	U	Rv	NA	Rv	NA	R	D
Titbegun	Solanum indicum	C	D	C	D	Rv	NA	Rv	NA	C	U	C	U	R	D	R	D	C	U	C	U
Bhat	*Clerodendrum viscosum*	FC	D	FC	D	FC	D	R	U	Rv	NA	R	D	C	D	FC	D	FC	D	C	D
Jagadumur	Ficus glomoreta	FC	D	FC	D	FC	U	FC	U	FC	U	R	D	FC	U	FC	U	R	D	C	D
Hargoza	Dillenia pentagyna	FC	D	FC	D	Rv	NA	Rv	NA	C	U	FC	D	Rv	NA	Rv	NA	C	D	C	D
Kanta Begun	Solanum surattense	FC	D	FC	D	Rv	NA	R	D	C	I	C	D	R	D	R	U	C	U	C	U
Sitki	Phyllanthus reticulates	R	D	R	D	FC	D	FC	U	FC	U	R	D	C	U	FC	D	R	D	R	D
Ashali	*Vitex glabrata*	R	D	R	D	R	D	R	D	R	D	FC	D	R	D	R	D	R	D	FC	D
Rang Chita	*Pedilanthes tithymatoides*	R	D	R	D	R	D	FC	D	FC	D	Rv	NA	R	D	R	D	FC	D	R	D
Kalkasunda	*Cassia sophera*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	R	U	Rv	NA	Rv	NA	C	D	FC	D
Venna	*Ricinus communis*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	FC	D	FC	D	R	U	Rv	NA	R	U
Ashshewra	Srebkus Aspera	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	R	D	Rv	NA	Rv	NA	Rv	NA	Rv	NA
Raktodrone	Leonarus sibiricus	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	R	D	Rv	NA	Rv	NA	FC	D	R	D

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 10: Status of Terrestrial Trees in HILIP areas

		B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
		Sarail		Bancharampur		Azmiriganj		Lakhai		Austagram		Mithamoin		Chhatak		Bishwambarpur		Modon		Mohonganj	
Local Name	Scientific Name	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Acacia	*Acasia nilotica*	C	I	C	I	C	D	C	I	R	D	C	I	FC	I	FC	I	C	U	C	U
Akashmoni	*Acacia moniliformis*	C	I	C	I	C	D	FC	U	C	D	C	I	FC	U	FC	U	C	U	C	U
Bel	*Aegle marmelos*	C	D	C	D	C	D	FC	D	C	D	C	D	FC	D	R	D	FC	D	C	D
Borroi	*Zizipus mauritiana*	C	D	C	D	C	U	C	D	C	D	C	U	C	I	C	I	C	U	C	U
Bot	*F. benghalensis*	C	D	C	D	C	D	C	D	C	U	FC	U	C	D	FC	D	C	U	C	U
Deshi Nim	*Melia azadirachta*	C	D	C	D	C	U	C	U	C	U	C	D	C	D	C	D	C	D	C	D
Eucalyptus	*Eucalyptus citriodor*	C	U	C	U	C	I	C	I	C	D	C	U	FC	I	FC	I	C	U	C	U
Hizal	*Barringtonia acutan*	C	D	C	D	C	U	C	U	C	I	C	D	FC	D	C	D	C	D	C	D
Jam	*Sugugium cumini*	C	U	C	U	C	D	C	D	C	D	C	U	FC	D	FC	I	C	D	C	U
Jambura	*Cytus grandis*	C	D	C	D	C	U	C	U	C	D	C	D	FC	U	FC	U	C	D	C	D
Kalo Karoi	*Albizia lebbek*	C	D	C	D	C	D	FC	D	C	I	C	D	R	D	C	D	C	D	C	U
Mahogani	*Swietenia mahogoni*	C	U	C	U	C	I	FC	D	C	U	C	D	C	U	C	U	C	D	C	D
Narikel	*Cocos nucifera*	C	U	C	U	C	U	C	I	C	U	C	D	FC	U	FC	U	FC	U	C	U
Peara	*Psidium guajava*	C	I	C	I	C	U	C	D	C	I	C	U	FC	I	FC	I	C	U	C	U
Raintree Koroi	*Samanea saman*	C	U	C	U	C	D	C	I	C	I	C	D	C	U	C	I	C	D	C	D
Tetul	*Tamarind indica*	C	D	C	D	F	D	R	D	C	U	C	D	C	D	R	D	C	D	C	D
Aam	*Mangifera indica*	C	U	C	U	FC	D	FC	D	C	U	C	D	C	U	C	I	C	U	C	U
Ata fal	*Annona squamosa*	C	D	C	D	FC	U	C	D	FC	D	C	D	FC	D	R	D	C	D	C	D
Bokul	*Nerium indicum*	C	D	C	D	FC	U	FC	U	FC	U	FC	U	R	D	R	D	FC	D	FC	D
Debdaru	*Poluanthia longifolia*	C	U	C	U	FC	U	FC	U	C	U	C	U	C	D	R	U	C	U	C	U
Dumur Khoska)	*Ficus hispida*	C	D	C	D	FC	D	FC	D	C	D	C	D	C	U	C	U	FC	U	C	D
Jamrul	*Sugugium samarang*	C	D	C	D	FC	D	FC	D	C	D	C	D	R	D	FC	D	FC	D	C	D
Kadam	*Anthocephalus chin*	C	D	C	D	FC	D	FC	D	C	D	C	D	C	D	C	D	C	D	FC	U
Kathal	*Artocarpus heterop*	C	U	C	D	FC	U	R	I	C	D	C	D	R	U	FC	U	FC	D	C	D
Shimul	*Bombax ceiba*	C	D	C	D	FC	D	C	D	C	D	C	D	FC	D	R	D	C	D	C	D
Supari	*Areca catechu*	C	U	C	U	FC	D	C	I	FC	U	FC	D	C	I	R	I	C	U	C	U
Babla	*Acacia nilotica*	C	D	C	D	R	U	Rv	NA	C	U	C	U	Rv	NA	Rv	NA	FC	D	C	D
Khejur	*Phoenix sylvestris*	C	D	C	D	R	D	R	D	R	D	R	D	C	D	R	D	R	D	FC	D
Lichu	*Lichi Chinensis*	C	D	C	D	R	U	R	U	R	U	R	U	FC	I	FC	I	R	U	FC	I
Najna/Sajna	*Moriginga sp.*	C	D	C	D	R	D	R	D	FC	U	FC	U	FC	D	FC	D	FC	U	FC	D
Sajna	*Moriginga olefera*	C	D	C	D	R	D	R	D	C	D	C	D	R	D	R	D	C	D	C	D
Tal	*Borassus flabellifer*	C	U	C	U	R	D	R	D	C	U	C	D	R	D	R	D	C	U	C	U
Karobi	*Zanthophyllum rhes*	C	D	C	D	Rv	NA	Rv	NA	C	D	R	D	Rv	NA	Rv	NA	R	D	FC	D
Shishoo	*Dalbergia sissoo*	C	D	C	U	Rv	NA	Rv	NA	R	D	R	D	FC	U	R	U	R	D	C	D
Jalpai	*Elaeocarpus robust*	C	D	FC	U	FC	D	FC	D	R	U	C	U	R	D	R	D	F C	D	FC	U
Jiga	*Lannea cormandelic*	C	D	FC	D	FC	U	R	D	FC	D	FC	D	FC	D	C	D	FC	D	R	D
Arjun	*Terminalia arjuna*	C	U	R	U	FC	D	FC	D	C	U	C	U	FC	R	R	D	C	D	C	D
Gamari	*Dmelina arborea*	C	D	R	D	FC	D	FC	D	R	U	R	D	Rv	NA	Rv	NA	R	D	R	U
Asshot	*Flemingia congesta*	C	D	R	D	Rv	NA	R	D	FC	U	FC	D	C	D	C	D	R	D	FC	D
Chalta	*Dillenia indica*	FC	D	C	D	FC	D	FC	D	C	U	C	D	R	D	FC	D	FC	D	C	U
Shil Karoi	*A. lucida*	FC	D	C	D	R	U	R	U	R	U	R	D	FC	D	R	D	R	D	FC	U
Chatim	*Alstonia scholaris*	FC	D	C	D	Rv	NA	Rv	NA	FC	D	FC	U	R	D	R	NA	FC	D	FC	D
Krishnachura	*Delonix regia*	FC	D	FC	D	C	U	FC	D	C	U	C	D	C	D	C	D	C	D	C	D
Sada Karoi	*A. procera*	FC	D	FC	D	C	U	C	U	C	I	FC	D	FC	D	C	D	C	D	C	D
Kad Bel	*Feronia limonia*	FC	U	FC	U	R	D	R	D	C	U	C	D	R	D	Rv	NA	FC	D	FC	U
Aash fal	*Nephelium longana*	FC	D	FC	D	Rv	NA	Rv	NA	R	D	R	U	Rv	NA	R	U	R	D	R	D
Kali Kadam	*Adina cordifolia*	FC	D	FC	D	Rv	NA	Rv	NA	C	U	FC	D	R	D	R	D	R	U	C	D
Tarla Bansh	*Bambusa longispicu*	FC	U	FC	D	Rv	NA	Rv	NA	Rv	NA	R	D	C	D	Rv	NA	R	D	R	D
Amloki	*Phyllanthus emblica*	FC	D	R	D	R	D	R	D	R	I	R	I	R	D	R	D	C	D	FC	D
Jhau	*Casuarina littomia*	FC	D	R	U	Rv	NA	Rv	NA	R	D	R	D	Rv	NA	Rv	NA	R	U	R	D
Barun	*Crataeva nurvala*	R	D	FC	D	FC	D	FC	D	FC	D	FC	D	C	D	C	D	FC	D	R	D
Raj Karoi	*A. richardiana*	R	D	R	D	C	D	C	U	C	U	FC	D	FC	U	FC	U	FC	D	C	D
Ghora Nim	*Melia sampervirens*	R	D	R	D	FC	D	FC	D	R	U	R	U	R	U	R	U	R	D	R	D
Pakur	*Ficus bejamina*	R	D	R	D	FC	D	C	D	FC	D	R	D	C	NA	Rv	NA	C	D	R	D
Barak Bansh	*B. balcooa*	R	U	R	U	R	D	FC	D	R	U	R	D	FC	D	FC	D	R	D	FC	U
Hartaki	*Terminalia chebula*	R	D	R	D	R	D	R	D	R	U	R	D	Rv	NA	Rv	NA	R	D	R	D
Ipil Ipil	*Leucaena latisiliqua*	R	D	R	D	R	D	FC	D	R	D	FC	D	Rv	NA	Rv	NA	R	D	Rv	NA
Segun	*Tectonia grandis*	R	U	R	U	R	U	R	U	R	U	R	U	FC	U	R	D	R	D	FC	U
Bahera	*T. belerica*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	R	D
Bajna	*Elaeis guineensis*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	R	D	Rv	NA	Rv	NA	R	D	R	D
Jaw a Bansh	*B. tulda*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	R	D	FC	D	FC	D	Rv	NA	R	D
Khoi Babla	*Acasia nilotica*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	U	R	U
Mandar	*Erythrina variegate*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	R	D	Rv	NA	R	D
Palm	*Trapa bispinosa*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	R	D	R	U	R	U	R	D	R	U
Shaw ra	*Carapa molocansis*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	FC	D	Rv	NA	Rv	NA	FC	D	C	D
Sonalu	*Oroxylum indicum*	R	D	R	D	Rv	NA	Rv	NA	R	U	R	D	R	NA	R	D	R	D	R	D
Shal	*Shorea rubusta*	R	U	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA
Goran	*Ceriops decandra*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA
Shara	*Streblus asper*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	Rv	NA	Rv	NA	R	D	R	D

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 11: Status of Amphibian species in HILIP areas

		B. Baria				Habiganj				Kishore				Sunamg				Netroko			
		Sarail		Bancharam		Azmiriganj		Lakhai		Austogra		Mithamoin		Chhatak		Bisho		Modon		Moh	
Local Name	Scientific Name	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Kuno Bang/A	*Bufo melanostictus*	C	U	C	U	C	D	C	D	C	U	C	U	FC	D	FC	U	C	U	C	U
Kotkoti Bang	*Euphlyctis cyanophlyctis*	C	D	C	D	R	D	FC	D	C	D	C	D	R	D	FC	U	C	U	C	U
Sona Bang	*Hoplobatrachus tigerinus*	C	U	C	U	C	D	FC	D	C	U	C	U	R	D	R	D	C	U	C	U
Cricket Frog	*Limnoectes limnocharis*	C	U	C	U	FC	U	C	U	C	U	C	U	R	U	FC	U	C	U	C	U
Gecho Bang	*Rana taipehensis*	R	U	R	U	Rv	N	Rv	N	Rv	N	Rv	N	Rv	N	Rv	N	C	U	C	U
Skipper Frog	*Euphlyctis canophlyctis*	R	D	R	D	Rv	N	Rv	N	C	D	R	D	Rv	N	R	D	C	D	C	D
Large tree fr	*Rhacophorus maximus*	R	U	R	U	R	U	R	U	R	U	R	U	FC	D	FC	D	R	U	R	U
Green Frog	*Euphlyctis Hexadactylus*	Rv	N	Rv	N	R	D	R	D	C	D	C	D	R	D	R	D	Rv	N	Rv	N

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, N=Not applicable

Annexure 12: Status of Mammals in HILIP areas

		B. Baria				Habiganj				Kishoregan				Sunamganj				Netrokona			
		Sarail		Bancharampu		Azmiriganj		Lakhai		Austogram		Mithamoin		Chhatak		Bishor		Modon		Mohar	
Local Name	Scientific Name	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Badami Kathb	*Callosciurus pygerythrus*	FC	D	FC	D	R	D	R	D	C	D	R	D	R	D	FC	D	C	D	FC	D
Beji	*Herpestes auropunctatus*	C	I	C	U	C	u	FC	D	C	U	C	U	C	U	C	D	C	U	C	U
Bara Indur	*Bandicota bengalensis*	C	I	C	I	C	D	FC	D	C	U	C	U	C	I	FC	I	C	U	C	U
Chamchika	*Megadernma lyra*	C	I	C	U	FC	D	FC	D	C	U	C	I	FC	D	R	D	C	U	C	U
Chika	*Suncus etruscus*	C	I	C	I	FC	D	C	U	C	I	C	I	FC	I	FC	I	C	U	C	U
Khek Shial	*Vulpes bengalensis*	C	I	C	I	Rv	NA	C	D	R	U	C	U	R	D	FC	D	FC	U	FC	D
Pati Shial	*Caris aureus*	C	I	C	U	R	D	C	D	FC	U	C	D	FC	D	FC	D	FC	U	C	U
Metho Indur	*Mus booduga*	C	I	C	i	C	D	R	I	C	I	C	U	C	I	FC	I	C	I	C	U
Nengti Indur	*Mus musculus*	C	I	C	i	FC	i	C	U	C	D	C	U	C	I	C	I	C	I	C	I
Bara Beji	*H. edwardsi*	FC	D	FC	D	R	D	FC	D	FC	D	FC	U	R	D	FC	D	C	U	C	D
Gecho Chika	*Tupaia glis*	FC	D	C	U	Rv	NA	Rv	NA	R	D	C	U	Rv	NA	R	U	R	D	R	D
Kola Badur	*Riusettus leschennautti*	FC	D	FC	D	C	U	FC	D	R	U	FC	D	R	D	R	D	R	D	R	D
Rangchita Bad	*Pipistrellus ceylonicus*	R	D	R	D	R	D	C	D	FC	D	R	D	R	D	FC	D	R	D	R	D
Flying fox	*Pteropus giganteus*	R	D	R	D	Rv	NA	Rv	NA	FC	D	R	D	Rv	NA	Rv	NA	FC	U	C	U
Ban Biral/Jung	*Felis chaus*	R	D	R	D	FC	D	Rv	NA	R	D	FC	D	FC	D	Rv	NA	C	D	FC	D
Mechho Biral	*Prionailurus viverrinus*	R	D	R	D	R	D	FC	D	R	U	R	U	R	D	R	D	C	U	R	D
Dora Kathbiral	*Funambulus palmarum*	R	D	R	D	FC	U	Rv	NA	FC	U	R	D	FC	D	R	D	R	D	R	NA
Khargosh	*Lepus nigricollis*	R	D	R	D	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA
Khatash	*Viverricula indica*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	Rv	NA	Rv	NA	FC	D	FC	D
Horse shoe ba	*Rhinolophus lepidus*	Rv	NA	Rv	NA	Rv	NA	R	D	FC	D	FC	D	Rv	NA	FC	D	R	U	R	U
Pata mukho ba	*Coelops frithii*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	FC	D	R	D	R	D
Bocha banur	*Pipistrellus coromandra*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	Rv	NA	Rv	NA	R	D	Rv	NA
Gandho Gokul	*Paradoxarus hermaphro*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	R	D	Rv	NA	Rv	NA	R	D	FC	D
Sajaru	Hystrix indica	Rv	NA	Rv	NA	Rv	NA	R	D	Rv	NA	Rv	NA	Rv	NA	Rv	NA	FC	D	Rv	NA
Shushuk/River	*Platanista gangetica*	Rv	NA	Rv	NA	R	D	Rv	NA	R	D	R	D	R	D	Rv	NA	FC	D	C	D

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 13: Status of Reptile species in HILIP areas

		B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
		Sarail		Bancharampur		Azmiriganj		Lakhai		Austogram		Mithamoin		Chhatak		Bishom		Modon		Mohang	
Local Name	**Scientific Name**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**	**O**	**T**
Gui shap	*Varanus nebulosus*	C	D	C	U	R	D	FC	D	C	U	C	U	C	D	R	D	C	U	C	U
Tiktiki	*Hemidactylus brookii*	C	D	C	D	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Striped grass skink	*Mabuya dissimilis*	FC	D	FC	D	FC	D	FC	D	FC	D	C	D	C	D	C	U	C	D	C	D
Tokkhak	*Gekko gecko*	R	D	R	D	FC	D	FC	D	C	D	C	D	C	U	C	D	C	D	C	D
Forest lizard	*Calotes jerdoni*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	C	U	FC	N	C	D	C	D
Dora shap	*Amphiesma stolata*	C	U	C	U	C	D	C	U	C	U	C	U	FC	U	FC	D	C	U	C	I
Dora shap	*Xenochrophis piscator*	C	U	C	U	FC	D	C	U	C	U	C	U	FC	D	FC	D	C	I	C	I
Original garden lizard	*Calotes versicolor*	C	D	C	D	R	D	FC	D	C	U	C	D	FC	U	R	D	C	U	C	U
Gui shap	*Varanus bengalensis*	C	U	C	U	FC	D	FC	D	C	U	C	U	FC	U	FC	D	FC	D	FC	D
Gokhra Shap	*Naja kaouthia*	FC	D	FC	D	FC	D	FC	D	R	D	R	D	FC	D	FC	U	R	D	R	D
Flying lizard	*Draco blaRvordii*	R	D	R	D	Rv	NA	Rv	NA	FC	D	C	D	FC	U	FC	D	R	D	Rv	D
Holdey Gui Shap	*Varanus flavescens*	Rv	NA	Rv	NA	R	U	R	U	C	D	C	D	FC	D	FC	D	C	D	C	D
Kal Keotey	*Bungarus caeruleus*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	R	D	FC	U	Rv	N	R	U	R	U
Black Pond Turtle	*Geoclemys hamiltonii*	Rv	NA	Rv	NA	FC	D	FC	D	R	D	FC	D	FC	U	C	D	FC	D	R	D
Darash	*Ptyas mucosus*	C	D	C	D	C	D	FC	D	C	D	C	D	R	U	FC	D	C	D	C	D
Common vine snake	*Ahaetulla nasuta*	FC	D	FC	D	C	D	C	D	FC	D	C	D	R	U	R	D	FC	D	FC	D
Dudhraj	*Elaphe Helena*	R	D	R	D	Rv	NA	Rv	NA	C	D	R	D	R	U	R	D	FC	D	FC	D
Gharmani Shap	*Lycodon aulicus*	R	D	R	D	R	U	R	U	R	D	R	D	R	D	R	D	Rv	N	Rv	N
Kalnagini	*Chrysopelea ornata*	R	D	R	D	Rv	NA	Rv	NA	C	D	R	D	R	D	Rv	N	R	D	R	D
Yellow Tortoise	*Indotestudo elongata*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	R	U	Rv	N	R	D	FC	D
Red-crowned Roofed Turtle.	*Batagur kachuga*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	R	U	Rv	N	R	D	R	D
Indian Roofed turtle	*Pangshura tecta*	R	D	R	D	Rv	NA	Rv	NA	FC	D	R	D	R	U	R	D	C	D	C	D
Three-striped Roof Turtle	*Batagur dhongoka*	Rv	NA	Rv	NA	Rv	NA	Rv	NA	Rv	NA	R	D	R	U	R	D	R	D	R	D
Brahminy River	*Hardella thurjii*	Rv	NA	Rv	NA	R	U	R	U	Rv	NA	R	D	R	U	R	D	FC	D	FC	D
Maitta Shap	*Atretium schistosum*	C	U	C	U	FC	D	FC	U	C	U	C	U	Rv	N	C	U	C	U	C	U
Diard's blindsnake	*Typhlops diardii*	R	D	R	D	Rv	NA	Rv	NA	R	D	FC	D	Rv	N	Rv	N	R	D	R	D
Ghargini Shap	*Lycodon aulicus,*	R	D	R	D	Rv	NA	Rv	NA	FC	D	FC	D	Rv	N	Rv	N	C	D	C	D
Raj Goghra	*Ophiophagus hannah*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	Rv	N	Rv	N	Rv	N	Rv	N
Russell's viper.	*Daboia russellii*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	Rv	N	Rv	N	R	D	R	D
Jalbora Shap	*Cerberus rynchops*	R	D	R	D	Rv	NA	Rv	NA	FC	D	C	D	Rv	N	Rv	N	R	D	R	D
Asian forest tortoise	*Manouria emys*	R	D	R	D	Rv	NA	Rv	NA	R	D	R	D	Rv	N	Rv	N	R	U	R	U
Venomous Pit v	*Trimeresurus albolabris*	Rv	NA	Rv	NA	R	D	R	D	Rv	NA	Rv	NA	Rv	N	Rv	N	R	D	R	D

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

Annexure 14: Status of Bird species in HILIP areas

		B. Baria				Habiganj				Kishoreganj				Sunamganj				Netrokona			
		Sarail		Bancharampur		Azmiriganj		Lakhai		Austogram		Mithamoin		Chhatak		Bishom		Modon		Mohang	
Local Name	Scientific Name	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T	O	T
Bhat Shalik	*Acridotheres tristis*	C	U	C	U	C	U	C	D	C	U	C	U	C	D	C	D	C	U	C	U
Bhutum Pencha	*B. bengalensis*	C	D	C	D	C	D	C	D	C	D	FC	D	FC	D	R	D	C	D	C	D
Bulbuli	*Pycnonotus cafer*	C	D	C	D	C	D	C	D	C	D	C	D	C	D	FC	D	C	U	C	U
Charui	*Passer domesticus*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Cheena Bok	*Ardeola bacchus*	C	D	C	D	C	U	C	U	C	D	C	D	FC	D	C	D	C	U	C	U
Chil	*Milvus migrans*	C	D	C	D	C	U	C	D	C	D	C	U	C	D	C	D	C	U	C	U
Dar Kak/Jungle crow	*Corvus macrorhynchos*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Dhushor Bok	*Ardea cinerea*	C	D	C	D	FC	D	C	D	C	D	C	D	R	D	FC	U	C	D	C	D
Doel	*Copsychus saularis*	C	D	C	D	C	D	C	D	C	U	C	D	C	D	C	D	C	U	C	U
Gobrey Shalik	*Sturnus contra*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Holdey Pakhi	*Oriolus xanthornus*	C	D	C	D	FC	D	C	D	C	D	FC	D	R	U	R	D	FC	D	FC	D
Kalo Shalik	*Aplonis panayensis*	C	U	C	U	FC	U	C	U	C	U	FC	U	R	U	FC	U	C	U	C	U
Kana Bok	*Ardeola gragii*	C	D	C	D	C	U	C	D	C	D	C	D	C	D	C	D	C	D	C	D
Kokil	*Eudynamys scolopacea*	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U	C	U
Maachranga	*Halcyon smyrnensis*	C	D	C	D	C	D	C	D	C	U	C	U	C	D	C	D	C	U	C	U
Pan Kauri	*Rynchops albicollis*	C	D	C	D	C	U	C	D	C	D	C	D	C	D	C	D	C	U	C	U
Pati Kak	*Carvus splendens*	C	D	C	D	C	U	C	D	C	U	C	U	C	U	C	U	C	U	C	U
Pencha/Owl	*Bubo nipalensis*	C	D	C	D	FC	D	C	D	C	U	C	U	FC	D	FC	D	C	U	C	U
Sada Bok	*Ardea insignis*	C	D	C	D	C	U	C	U	C	D	C	D	C	D	C	U	C	U	C	U
Tuntuni	*Orthotomus sutorius*	C	D	C	D	C	D	C	D	C	U	C	D	C	D	C	D	C	U	C	U
Ghughu (grey)	*Streptopelia senegalensis*	FC	D	C	D	FC	D	C	D	C	D	FC	D	FC	D	FC	D	C	D	C	D
Satbhai	*Pellorneum albiventre*	C	D	C	D	R	D	C	U	FC	D	R	D	FC	D	FC	D	FC	D	FC	D
Baj	*Aviceda jerdoni*	C	D	C	D	FC	D	FC	D	C	U	C	D	FC	D	FC	D	C	D	C	D
Chatak	*Cacomantis merulinus*	C	D	C	D	FC	D	FC	D	C	D	C	D	FC	D	FC	D	C	D	C	D
Choto Fingey	*D. aeneus*	C	U	C	U	FC	D	FC	D	C	D	C	D	FC	D	FC	D	C	D	C	D
Dahuk	*Amaurornis akool*	C	D	C	D	C	D	FC	D	C	D	C	D	FC	D	FC	D	C	D	C	D
Fingey	*Dicrurus macrocercus*	C	U	C	U	C	U	FC	U	C	U	C	U	C	U	C	U	C	U	C	U
Gangchil	*Gelochelidon nilotica*	C	D	C	D	C	D	FC	D	C	U	C	U	FC	D	FC	U	C	U	C	U
Jalali Kobutar	*Columba livia*	C	D	C	D	C	D	FC	D	C	I	C	I	C	D	FC	D	C	U	C	U
Kaththokra	*Dinopium benghalense*	C	D	C	D	R	D	FC	D	C	D	C	D	FC	D	FC	D	C	D	C	D
Shankho Chil	*Haliastar Indus*	C	D	C	D	FC	D	FC	D	C	U	C	D	FC	D	FC	D	C	U	C	U
Tia	*Psittacula krameri*	C	D	C	D	FC	D	FC	D	C	U	C	D	R	D	R	D	FC	U	C	U
Tota	*Psittacula alexandri*	C	D	C	D	R	D	FC	D	C	D	C	D	R	D	Rv	N	R	D	FC	D
Ghughu (Spotted)	*Spilopelia chinensis*	FC	U	C	U	FC	U	FC	U	C	D	FC	D	C	D	C	D	C	D	C	D
Manikjor	*Ciconia episcopus*	FC	D	FC	D	R	D	FC	D	C	D	FC	D	R	D	R	U	FC	D	FC	D
Shyama	*Copsychus malabaricus*	R	D	R	D	R	D	FC	D	C	D	R	D	Rv	N	Rv	N	R	D	R	D
Babui	*Ploceus philippinus*	C	D	C	D	R	D	R	D	C	D	C	D	FC	D	FC	D	C	D	C	D
Munia	*Lenchura striata*	C	D	C	D	R	U	R	U	C	D	C	D	R	U	R	U	C	D	C	D
Ratchara/Kanakua	*Caprimulgus macrurus*	FC	D	C	D	R	U	R	U	FC	D	FC	D	FC	U	R	U	FC	D	FC	D
Harial	*Treron sphenura*	R	D	FC	D	R	D	R	D	FC	D	R	D	R	U	R	U	R	D	R	D
Titir	*Francolinus pondicerianus*	C	D	R	N	R	N	R	N	R	N	C	D	Rv	N	R	D	Rv	N	Rv	N
Hot-titi	*Vanellus malabaricus*	R	D	C	D	R	U	R	U	R	D	R	D	R	U	R	U	R	D	R	D
Kura	*Gallicrex cinerea*	Rv	N	R	D	R	D	R	D	R	D	R	D	FC	D	FC	D	FC	D	FC	D
Kalim	*Porphyrio porphyrio*	C	D	C	D	Rv	N	Rv	N	C	U	FC	D	Rv	N	Rv	N	C	U	C	U
Chokhgelo Pakhi	*Hierococcyx varius*	FC	D	FC	D	FC	D	Rv	N	FC	N	FC	D	R	U	R	U	FC	D	FC	D
Harichacha	*Dendrocitta vagabunda*	R	D	R	D	Rv	N	Rv	N	FC	D	FC	D	Rv	N	Rv	N	R	D	R	D
Bharat Pakhi	*Alauda gulgula*	R	D	C	D	Rv	N	Rv	N	R	D	Rv	N	R	U	Rv	N	Rv	N	R	D
Hargila	*Leptoptilos dubius*	R	D	R	D	R	D	Rv	N	R	D	FC	D	R	D	Rv	N	R	D	R	D
Lejnachani	*Rhipidura aureola*	R	D	C	D	R	U	Rv	N	R	D	R	D	R	U	R	U	FC	D	FC	D
Modontak/Lesser Adjutant	*Leptoptilos javanicus*	R	D	R	D	Rv	N	Rv	N	R	D	R	D	Rv	N	Rv	N	R	D	R	D
Papiya	*Clamator jacobinus*	R	D	C	D	R	U	Rv	D	R	D	FC	D	R	D	R	D	FC	D	FC	D
Fatikjal/Common lora	*Aegithina tiphia*	Rv	N	FC	D	Rv	N	Rv	N	R	D	FC	D	R	D	R	D	R	D	R	D

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, Rv =Very Rare; T= Trend, I=Increasing, U=Unchanged, D=Decreasing, N=Not applicable

Annexure 15: Status of Fish species in HILIP areas

	B. Baria		Habiganj		Kishoreganj		Sunamganj		Netrokona	
	Sarail	Bancharan	Azmiriganj	Lakhai	Astagram	Mithamoin	Chhatak	Bishwamb	Modon	Mohangonj
Scientific Nme	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**	**O**
Labeo rohita	C	C	C	C	C	C	C	C	C	C
Catla catla	C	C	C	C	C	C	C	C	C	C
Cirrhinus mrigala	C	C	C	C	C	C	C	C	C	C
Oreochromis niloticus	C	C	C	C	C	C	C	C	C	C
Cyprinus caprio	C	C	C	C	C	C	C	C	C	C
Barbonymus gonionotus	FC	FC	C	C	C	C	C	C	C	C
Ctenopharyngodon idella	C	C	C	C	C	C	C	C	C	C
Hypophthhalmichthys nobilis	C	C	C	C	C	C	C	C	C	C
Pangasianodon hypohthalmus	FC	FC	C	C	C	FC	C	C	C	C
Ompok pabo	R	R	NF	NF	R	FC	FC	FC	FC	FC
Clarius gariepinus	FC	FC	R	NF	FC	NF	FC	NF	NF	NF
Aorichthys aor	FC	FC	FC	FC	FC	FC	FC	R	FC	FC
Plotosus canius	FC	FC	FC	FC	FC	FC	R	R	FC	FC
Ophisternon bengalense	FC	FC	FC	R	FC	FC	R	R	FC	FC
Anguila bergalensis	FC	FC	FC	C	FC	FC	R	FC	FC	FC
Bengala elanga	R	R	R	FC	R	R	R	NF	R	FC
Eutropiichthys vacha	FC	FC	R	R	FC	FC	FC	R	FC	FC
Glossogobius giuris	NF	FC	FC	FC	R	FC	FC	FC	FC	FC
Pseudeutropius atherinoides	FC	FC	C	C	FC	C	R	FC	FC	FC
Nandus nandus	FC	FC	FC	R	FC	C	FC	C	C	FC
Wallago attu	C	C	FC	FC	C	C	C	C	C	C
Ompok bimaculatus	FC	FC	NF	NF	FC	FC	FC	FC	FC	FC
Pseudambassis baculis	FC	FC	FC	C	FC	FC	FC	FC	FC	C
Gudusia chapra	FC	FC	C	C	FC	C	C	FC	C	C
Salmophasia bacaila	FC	FC	FC	FC	FC	FC	R	FC	FC	FC
Salmophasia aciNces	NF	FC	FC	FC	FC	FC	R	NF	FC	FC
Chela cachius	NF	NF	NF	NF	NF	R	NF	NF	R	R
Chitala chitala	FC	FC	R	R	R	FC	R	R	FC	FC
Psudambassis ranga	FC	FC	R	R	FC	FC	R	R	FC	FC
Trichogaster chuna	FC	FC	FC	FC	FC	FC	R	R	FC	FC
Rasbora daniconius	FC	FC	FC	FC	FC	FC	R	FC	FC	FC
Esomus danricus	FC	FC	FC	FC	FC	FC	R	FC	FC	FC
Osteobrama cotio	NF	NF	FC	NF	FC	R	NF	R	FC	R
Chana marulius	FC	FC	FC	FC	FC	C	FC	FC	FC	FC
Clupisoma garua	R	R	R	FC	R	R	FC	FC	FC	FC
Labeo gonius	R	R	R	R	C	C	FC	FC	C	C
Macrognathus pancalus	R	R	R	FC	FC	R	R	R	FC	FC
Sperate seenghala	FC	C	FC	FC	FC	FC	FC	FC	FC	FC
Bagarius yarrellii	NF	NF	R	R	R	NF	R	R	NF	NF
Xenentodon cancila	FC	FC	FC	FC	FC	FC	FC	C	FC	C
Badis badis	R	R	NF	NF	FC	R	NF	FC	R	R
Labeo calbusa	C	C	FC	FC	C	C	FC	C	C	C
Corica soborna	C	C	FC	C	C	C	FC	FC	C	C
Liza melinoptera	C	C	NF	NF	FC	FC	NF	NF	FC	FC
Colisa fasciatus	C	C	FC	FC	FC	FC	FC	C	FC	C
Rhinomugil corsula	NF	NF	NF	NF	R	FC	NF	NF	FC	FC
Anabas testudineus	C	C	C	C	C	C	C	C	C	C
Monopterus cuchia	R	R	FC	FC	FC	FC	R	FC	FC	FC
Clarias batrachus	C	C	C	FC	C	C	C	C	C	C
Amblypharyngodon mola	C	C	C	C	C	C	C	C	C	C
Mystus bleekeri	C	C	C	C	C	C	C	C	C	C
Setipina phasa	NF	NF	NF	NF	R	R	NF	NF	NF	NF
Notopterus notopterus	FC	FC	FC	R	R	FC	FC	FC	R	R
Chelonodon fluviatilis	FC	NF	FC	R	FC	FC	FC	NF	FC	FC
Pangasius pangasius	R	R	R	R	R	R	R	R	NF	NF
Puntius sophore	C	C	C	C	C	C	C	C	C	C
Rita rita	FC	FC	R	R	FC	FC	R	R	FC	FC
Mastacembelus armatus	C	C	C	C	FC	FC	C	FC	FC	FC
Silonia silondia	FC	FC	R	FC	FC	FC	NF	R	FC	FC
Chana striatus	C	C	C	FC	C	C	C	C	C	C
Heteropneustes fossilis	C	C	C	FC	C	C	C	C	C	C
Puntius sarana	C	C	C	C	C	C	C	FC	C	C
Chana punctatus	C	C	C	FC	C	C	C	C	C	C
Macrognathus aculeatus	FC	FC	C	C	C	C	C	C	C	C
Cirrhinus reba	NF	NF	NF	NF	NF	R	NF	NF	R	R
Chana orientalis	NF	NF	FC	FC	NF	R	R	FC	FC	FC
Puntis ticto	FC	FC	C	FC	FC	FC	FC	C	C	FC
Pseudambassis ranga	R	R	R	FC	R	FC	R	R	FC	FC
Tenualosa ilisha	FC	R	NF	R	FC	C	R	R	FC	FC
Mystus vittatus	C	C	C	C	FC	C	C	C	C	C
Ailia coila	FC	FC	FC	FC	FC	FC	NF	NF	FC	FC
Chanda nama	R	R	FC	FC	R	FC	FC	FC	FC	FC
Batasio batasio	R	R	R	FC	R	FC	R	FC	FC	FC
Ctenops nobilis	NF	NF	NF	NF	NF	R	NF	FC	R	R
Gagata gagata	R	R	R	FC	FC	FC	R	FC	FC	FC
Labeo bata	C	C	NF	NF	C	C	NF	NF	FC	FC
Lepidocephalichthys anandalei	FC	FC	R	R	C	FC	FC	FC	FC	FC
Lepidocephalichthys berdmorei	NF	NF	NF	NF	NF	FC	NF	FC	FC	FC
Lepidocephalichthys guntea	R	R	FC	R	FC	FC	R	C	C	FC
Tor tor	NF	NF	NF	NF	NF	R	NF	NF	R	R
Bagarius bagarius	NF	NF	R	NF	R	R	R	R	R	R

O=Occurrence, C= Common, FC=Fairly Common, R= Rare, NF (Rv)= Not Found now (Very Rare)

Annexure 16: Trends of Fish species in HILIP areas

	B. Baria		Habiganj		Kishoreganj		Sunamganj		Netrokona	
	Sarail	Bancharan	Azmiriganj	Lakhai	Astagram	Mithamoin	Chhatak	Bishwamb	Modon	Mohangonj
Scientific Nme	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**	**Trend (T)**
Labeo rohita	I	I	I	I	I	I	I	I	U	U
Catla catla	I	I	I	I	I	I	I	I	U	U
Cirrhinus mrigala	I	I	I	I	I	U	I	I	U	U
Oreochromis niloticus	U	U	I	I	U	I	I	I	D	D
Cyprinus caprio	I	I	I	I	U	U	I	I	U	U
Barbonymus gonionotus	U	U	I	I	I	U	I	I	U	U
Ctenopharyngodon idella	I	I	I	I	I	I	I	I	U	U
Hypophthhalmichthys nobilis	I	I	I	I	I	I	I	I	U	U
Pangasianodon hypohthalmus	U	I	I	I	U	U	I	I	U	U
Ompok pabo	D	D	NA	NA	D	D	D	D	D	D
Clarius gariepinus	U	U	D	NA	U	NA	D	NA	U	NA
Aorichthys aor	U	U	D	D	D	U	D	D	U	D
Plotosus canius	D	U	D	D	D	D	D	D	U	U
Ophisternon bengalense	U	U	D	D	D	U	D	D	I	I
Anguila bergalensis	D	U	D	U	D	U	D	D	U	U
Bengala elanga	D	D	D	D	D	D	D	NA	D	D
Eutropiichthys vacha	D	U	D	D	U	U	D	D	I	I
Glossogobius giuris	NA	D	D	D	D	D	U	U	U	U
Pseudeutropius atherinoides	D	U	D	U	D	D	D	D	U	U
Nandus nandus	U	D	D	D	D	U	D	D	U	U
Wallago attu	I	I	D	D	U	U	U	D	U	U
Ompok bimaculatus	D	D	NA	NA	D	D	D	D	D	D
Pseudambassis baculis	D	D	D	U	D	D	D	D	U	U
Gudusia chapra	D	D	D	D	D	D	D	D	U	U
Salmophasia bacaila	D	D	D	D	U	U	D	D	U	U
Salmophasia aciNces	D	D	D	D	D	U	D	NA	U	U
Chela cachius	NA	NA	NA	NA	NA	D	NA	NA	D	D
Chitala chitala	D	D	D	D	D	U	D	D	U	U
Psudambassis ranga	D	D	D	D	D	D	D	D	D	D
Trichogaster chuna	D	D	D	D	D	U	D	D	U	U
Rasbora daniconius	D	D	D	D	U	D	D	D	U	U
Esomus danricus	D	D	D	D	D	D	D	D	U	U
Osteobrama cotio	NA	NA	D	NA	D	D	NA	D	D	D
Chana marulius	D	D	D	D	U	U	D	D	U	U
Clupisoma garua	D	D	D	D	D	D	D	D	D	D
Labeo gonius	D	D	D	D	U	D	D	D	U	U
Macrognathus pancalus	D	D	D	D	D	D	D	D	U	U
Sperate seenghala	U	U	D	D	D	U	D	D	U	U
Bagarius yarrellii	NA	NA	D	D	D	NA	D	D	NA	NA
Xenentodon cancila	D	D	D	D	D	D	D	D	D	D
Badis badis	D	D	NA	NA	U	D	NA	D	D	U
Labeo calbusa	U	U	D	D	U	U	D	D	U	U
Corica soborna	U	U	D	U	U	U	U	I	U	U
Liza melinoptera	U	U	NA	NA	U	U	NA	NA	U	U
Colisa fasciatus	U	U	D	D	D	D	D	D	U	U
Rhinomugil corsula	NA	NA	NA	NA	D	D	NA	NA	D	D
Anabas testudineus	U	U	I	D	U	U	D	D	U	U
Monopterus cuchia	D	D	D	D	U	U	D	D	U	U
Clarias batrachus	U	U	D	D	I	U	D	D	U	U
Amblypharyngodon mola	D	U	I	D	U	D	U	U	U	U
Mystus bleekeri	D	U	D	U	I	U	U	U	I	I
Setipina phasa	NA	NA	NA	NA	D	D	NA	NA	NA	NA
Notopterus notopterus	D	D	D	D	D	D	D	D	D	D
Chelonodon fluviatilis	D	NA	D	D	D	NA	D	NA	NA	D
Pangasius pangasius	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Puntius sophore	U	U	U	D	U	U	U	U	U	U
Rita rita	D	D	D	D	D	D	D	D	U	D
Mastacembelus armatus	I	U	D	U	U	D	D	D	U	U
Silonia silondia	D	D	D	D	D	D	NA	D	D	U
Chana striatus	U	U	D	D	U	D	D	D	U	U
Heteropneustes fossilis	U	U	U	D	U	D	D	D	U	U
Puntius sarana	I	U	I	I	I	I	D	I	U	I
Chana punctatus	D	U	U	D	U	U	D	D	I	U
Macrognathus aculeatus	D	D	D	U	U	D	D	D	D	D
Cirrhinus reba	NA	NA	NA	NA	NA	D	NA	NA	D	D
Chana orientalis	NA	NA	D	D	NA	D	D	D	D	D
Puntis ticto	D	D	D	D	U	D	D	D	U	U
Pseudambassis ranga	NA	NA	D	D	D	D	D	D	D	D
Tenualosa ilisha	U	D	NA	D	U	U	D	NA	U	U
Mystus vittatus	U	U	NA	D	I	U	U	D	U	U
Ailia coila	D	D	D	D	D	D	NA	NA	D	D
Chanda nama	D	D	D	D	D	D	D	D	D	D
Batasio batasio	D	D	D	D	D	D	I	D	D	D
Ctenops nobilis	NA	NA	NA	NA	NA	D	NA	D	D	D
Gagata gagata	D	D	D	D	D	D	U	D	U	U
Labeo bata	U	U	NA	NA	U	U	NA	NA	I	I
Lepidocephalichthys anandalei	D	D	D	D	D	D	D	D	U	U
Lepidocephalichthys berdmorei	NA	NA	NA	NA	NA	D	NA	D	D	D
Lepidocephalichthys guntea	D	D	D	D	D	D	D	D	U	U
Tor tor	NA	NA	NA	NA	NA	D	NA	NA	D	D
Bagarius bagarius	NA	NA	D	NA	D	NA	D	D	D	D

T= Trend, I=Increasing, U=Unchanged, D=Decreasing, NA=Not applicable

List of Appendixes

Appendix 1a: Focus Group Discussion (FGD) Checklist (Bengali)

Government of the Peoples Republic of Bangladesh
Local Government Engineering Department
Haor Infrastructure and Livelihood Improvement Project (HILIP)
Level-3, RDEC Bhaban, LGED H/Q,
Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.

Action Research on Analysis of the environmental impacts of large scale expansion of pond fisheries and climate change affects under HILIP, LGED

ফোকাস গ্রুপ আলোচনা (FGD) চেকলিষ্টঃ

1.	FGD-এর স্থানঃ	
1.1	গ্রামের নামঃ	কোডঃ
1.2	ইউনিয়নের নামঃ	কোডঃ
1.3	উপজেলার নামঃ	কোডঃ
1.4	জেলার নামঃ	কোডঃ

এফজিডি-তে অংশগ্রহণকারীদের তালিকা

ক্রঃ নং	অংশগ্রহণকারীর নাম	বয়স	শিক্ষা	পেশা	মোবাইল নং	স্বাক্ষর
১.						
২.						
৩.						
৪.						
৫.						
৬.						
৭.						
৮.						
৯.						
১০.						
১১.						
১২.						

আলোচনা পরিচালনাকারীর নামঃ ---------- স্বাক্ষর ও তারিখঃ ----------

FGDচেকলিষ্ট

	প্রশ্ন	উত্তর
2.	আপনি বা আপনার পরিবারের কেউ হাওড়ের পুকুরে মাছ চাষে জড়িত? (নিজে=1, পারিবারের সদস্য=2, নিজে এবং পরিবারের সদস্য=3, কেউ নয়=4, জানি না=5)	1=---জন 2=---জন 3=---জন 4=---জন 5=---জন
3.	হাওড়ের পুকুরে মাছ চাষের প্রভাব সম্পর্কে আলোচনা করুন। (আয়, কর্মসংস্থান, জীবন যাত্রার মান, পরিবেশগত অবক্ষায়, মাছ জীববৈচিত্র ইত্যাদি)	
4.	হাওড়ের পুকুরে মাছ চাষ আগেও হতো কি? তখন এটা কি ধরণের ছিল?	
5.	আপনার পুকুরের ব্যবহার সম্পর্কে বলুন? (শুধু মাছ ধরা=1, মাছ চাষ=2, কৃষিতে সেচ=3, অন্যান্য=৪ উলেস্নখ করুন)	1=---জন 2=---জন 3=---জন 4=--- জন
6.	আপনার পুকুরের মাটির ধরণ সম্পর্কে বলুন (বেলে = 1, দোয়াশ= 2, এটেল = 3)	1=--- জন 2=--- জন 3=--- জন
7.	হাওড়ের পুকুরে মাছ চাষের প্রধান সমস্যাগুলো কি কি?	
8.	হাওড়ের পুকুরে মাছ চাষে HILIP-এলজিইডি'র অবদান কি কি ?	
9.	হাওড়ের পুকুরে মাছ চাষে HILIP-এলজিইডি'র অবদান কতটা গুরম্নত্বপূর্ণ?	
10.	হাওড় পুকুরে মাছ চাষ পদ্ধতি সম্পর্কে বলুন ?	
11.	হাওড় পুকুরে চাষকৃত মাছের জন্য খাদ্য সরবরাহ করেন কি? (১=হাঁ, ২ = না)	১. ----- % ২. ----- %
12.	আপনার কি মাছের রোগ সম্পর্কে অভিজ্ঞতা আছে? অভিজ্ঞতা থেকে থাকলে আপনি কিভাবে এটা মোকাবেলা করেন?	
13.	খাদ্য নিরাপত্তা ও অর্থনৈতিক উন্নতির জন্য হাওড়ে মাছ চাষের উন্নয়ন গুরম্নত্বপূর্ণ বলে আপনি মনে করেন?	

	প্রশ্ন	উত্তর
14.	হাওড়ের পুকুরে মাছ চাষের মাধ্যমে আপনার আয়, ভোগ (consumption) কোনটি হয়? নাকি দুটোই হয়।	
15.	কখন পুকুরের মাছ ধরা হয়? কি কি পদ্ধতি ব্যবহার হয়? কোন কোন জাল ব্যবহার হয়?	
16.	পুকুরে মাছের উৎপাদন, প্রজাতি এবং অনুপাত সম্পর্কে বলুন।	
17.	মাছ চাষের পুকুর নির্বাচনের বৈশিষ্টগুলি কি কি?	
18.	মাছের যে প্রজাতিগুলো চাষ করা হচ্ছে, স্থানীয় অহরণকৃত মাছের প্রজাতির উপর এর প্রভাব বর্ণনা করুন। স্থানীয় প্রজাতির মাছের ড়াতি না করে বহি:প্রজাতির মাছ চাষের জন্য আপনার পরামর্শ কি?	
19.	হাওড়ের পুকুরে মাছ চাষ সম্প্রসারণে আপনার মতামত উলেস্নখ করুন।	
20.	হাওড়ে মাছ চাষের ফলে বর্তমানে অর্থনৈতিক অবস্থার কোন পরিবর্তন হয়ে থাকলে আলোচনা করুন।	
21.	মাছের অভয়াশ্রম (মাছ নিরাপদে বসবাস যোগ্য স্থান) গড়ে তোলার বিষয়ে আপনার মতামত দিন।	
22.	আপনার এলাকার কৃষিকাজ সম্পর্কে আলোচনা করুন। আপনার এলাকায় কৃষিকাজে কি কি ধরণের সার এবং কি কি ধরণের কীটনাশক ব্যবহার হয়? মাছের উপর এদের প্রভাব বর্ণনা করুন।	
23.	আপনার এলাকার কৃষি জমিতে ঘাস/আগাছা দুর করতে কোন কীটনাশক ব্যবহার করেন কি? এবং কি ধরণের কীটনাশক ব্যবহার করেন?	
24.	শুকনো মৌসুমে পানির উচ্চতার পরিবর্তনের কোন প্রভাব দৃষ্টিগোচর হয়েছে? যদি পানির উচ্চতার পরিবর্তন হয়, তবে মৎস্য, কৃষি এবং পরিবেশের উপর এর প্রভাব বর্ণনা করুন।	

	প্রশ্ন	উত্তর
25.	আগাম বন্যা বা**Flash Flood** এর প্রকোপ কেমন? আপনার মতে এর কারণ কি?	
26.	আগাম বন্যা বা **Flash Flood** এর সময় যে পানি আসে তাতে কি কোন ক্যামিকেল বা বর্জ্য পদার্থ পা্ওয়া যায় বা কোথাও এগুলো পাওয়ার কথা শুনেছেন?	
27.	বন্যার সময় সমস্ত্ম অঞ্চল যখন এক হয়ে যায় তখন আপনাদের অঞ্চলের মাছ কি অন্য অঞ্চলে চলে যায় অথবা অন্য অঞ্চলের মাছ আপনাদের অঞ্চলে চলে আসে?	
28.	বন্যার সময় খাবার পানি কিভাবে যোগাড় হয়?	
29.	হাওড়ের পুকুরে মাছ চাষ সম্প্রসারণের মাধ্যমে এর সুফল স্থায়ীকরণের কি কি ড়োত্র আছে আলোচনা করম্নন।	
30.	মাছ চাষে পুকুরের আকার ও মাটির ধরণের সাথে মাছের জীববৈচিত্র (**Fish Biodiversity)** সম্পর্কে আপনার ধারণা আলোচনা করম্নন।	

(বিঃ দ্রঃ এফজিডি'র একটি বা দুটি ছবি নিন)

তথ্য সংগ্রহকারীর নামঃ ---------- স্বাড়ার ও তারিখঃ ----------

Appendix 1b: Focus Group Discussion (FGD) Checklist (English)

Government of the Peoples Republic of Bangladesh
Local Government Engineering Department
Haor Infrastructure and Livelihood Improvement Project (HILIP)
Level-3, RDEC Bhaban, LGED H/Q,
Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.

Action Research on Analysis of the environmental impacts of large scale expansion of pond fisheries and climate change affects under HILIP, LGED

Checklist for Focus Group Discussions (FGD)

31.	**Place of FGD:**	
31.1	**Village:**	**Code:**
31.2	**Union:**	**Code:**
31.3	**Upazila:**	**Code:**
31.4	**District:**	**Code:**

List of Participants in the FGD

Sl.No.	Name of the Participants	Age	Education	Occupation	Mobile No.	Signature
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						

Name of the FGD Moderator: ----------Signature and Date: ----------

FGD Checklist

Question	Response
32. Are you or any of your family members engaged in fish culture in Haor pond? (Self=1,Family Members=2, Self & Family Members=3, Nobody=4, Don't Know=5)	1=------persons 2=------persons 3=------persons 4=------persons 5=------persons
33. Discuss about impact of fish culture in Haor pond (on income, employment, standard of living, environmental degradation, fish biodiversity etc.).	
34. Whether fish culture in Haor pond existed earlier. If yes, what type then it was?	
35. Discuss about purposes for which pond is used (only capturing fish=1, fish culture=2, irrigation=3, others (specify)=4)	1=------ persons 2=------persons 3=------persons 4=------persons
6. What are the types of soil in your pond? (sandy=1,loam= 2, clay=3)	1=------ persons 2=------persons 3=------persons
7. What are the major problems of fish culture in the Haor pond?	
8. What are the contributions of HILIP-LGED on fish culture in Haor pond?	
9. To what extent contribution of HILIP-LGED is important for fish culture in Haor pond?	
10. Describe the methods of fish culture in Haor pond.	
11. Do you provide feed to the fish in the Haor pond? (yes=1, no=2)	1.--------% 2.--------%
12. Have you experienced problems of fish diseases? If yes, how did you tackle the problem? 13. Do you think it is important to develop fish culture in Haor pond for food security andeconomic development ?	
14. Through pond fish culture in Haor pond do you have only income or only consumption? Whetheryou have both?	
15. When fish is harvested in the pond? What are the methods of harvesting fish? What type of fishing gears are used?	

Question	Response
16. Discuss about the production of fish, species diversity and composition in the pond.	
17.What are the criteria for selection of pond for fish culture?	
18.Discuss the species cultured and its effect on local fish production. Suggestions forcultivation of exotic species without affecting the local fish species.	
19. Express your opinion on expansion of pond fisheries.	
20. Discuss if there is any improvement in your economic condition due to fish culture in the Haor pond.	
21. Give your opinion on developing fish sanctuary.	
22. Discuss about agricultural practices in your area. What type of fertilizers andinsecticides are used and what are their impacts on fish.	
23. Do you or others in your area use insecticides/weedicides to remove grass /weeds. If yes, mention types of insecticides.	
24. Is any effect of change in water level observed during dry season? If there ischange, what are the effects on fishery, agriculture and environment?	
25. What is the frequency of early flood/flash flood and what are the perceived causes?	
26. Did you find or heard anyone found chemical or waste materials coming with early flood /flash flood ?	
27. Have you observed immigration or migration of fish during flood?	
28. How drinking water is managed during adverse flooding condition.	
29. What are the scope of sustaining the benefits of pond fish culture through extension? Please discuss.	
30. Discuss about fish biodiversity with the pond size for fish culture and soil type.	

(Note: Please take one or two photographs of FGD)

Name of Data Collector:----------Signature with date:----------

Appendix 2a: Key Informant Interviews (KII) Checklist (Bengali)

Government of the Peoples Republic of Bangladesh
Local Government Engineering Department
Haor Infrastructure and Livelihood Improvement Project (HILIP)
Level-3, RDEC Bhaban, LGED H/Q,
Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.

Action Research on Analysis of the environmental impacts of large scale expansion of pond fisheries and climate change affects under HILIP, LGED.

*কি ইনফরমেন্ট ইন্টারভিউ **(KII)** চেকলিষ্ট-২: জেলা মৎস্য কর্মকর্তা*

(প্রকল্প ব্যবস্থাপনা ব্যক্তিবর্গ এবং প্রকল্প কর্তৃপড়োর নীতি নির্ধারণী পর্যায়ের কর্মকর্তাদের সাড়্গাৎকার গ্রহণের জন্য চেকলিস্ট)

প্রশ্ন		উত্তর	
1.	সাধারণ তথ্যাদিঃ		
1.1	নামঃ		
1.2	পদবীঃ		
1.3	মোবাইল নংঃ		
1.4	প্রতিষ্ঠানঃ		
1.5	জেলাঃ	নামঃ	কোডঃ
2.	আলোচ্য বিষয়াবলীঃ		
2.1	আপনি কি মনে করেন খাদ্য নিরাপত্তা, প্রয়োজনীয় নিউট্রিশন ও অর্থনৈতিক উন্নতির জন্য হাওড়ের পুকুরসমূহে মাছ চাষ সম্প্রসারন করা গুরম্নত্বপূর্ন ?		
2.2	হাওড় পুকুরে মাছ চাষে ব্যবহৃত বিভিন্ন পদ্ধতিগুলো সম্পর্কে আপনার মতামত বলুন।		
2.3	বিভিন্ন এজেন্সি কর্তৃক প্রদত্ত কার্যক্রম/প্রশিড়্গান হাওড়ের পুকুরে মাছ চাষের পদ্ধতিকে বদলে দিচ্ছে বলে মনে করেন কি?		
2.4	আপনি কি মনে করেন হাওড়ের মাছ চাষীদের মাছ চাষ অব্যাহত রাখার জন্য প্রয়োজনীয় কারিগরী জ্ঞান রয়েছে?		

2.5	বিভিন্নকার্যক্রম (ইন্টারভেনশন) প্রবর্তনের ফলে হাওড়ের মাছ চাষ কার্যক্রম কতটা স্থায়ীত্বশীল হবে ? বাইরের কোন সাহায্য ছাড়াই এটা কি অব্যাহত থাকবে ?
2.6	হাওড়ের পুকুরে মাছ চাষ কার্যক্রমের সাথে আপনার কি ধরনের সম্পৃক্ততা আছে ? তাদের কিছু ফলাফল কি আপনার নিজস্ব ইন্টারভেনশন বাস্ত্মবায়নে সাহায্য করেছে ?
2.7	মৎস্য বিষয়ক যে কার্যক্রমগুলো (ইন্টারভেনশন) হাওড় এলাকায় প্রবর্তন করা হয়েছে, তার প্রভাব হাওড়ের বাইরের এলাকায় পড়েছে কি?
2.8	হাওড় অঞ্চলের পুকুরে মাছ চাষ কার্যক্রম সম্পর্কে আপনার অভিমত বলুন।
2.9	আপনার মতে বাংলাদেশে হাওড়ের পুকুরসমূহে মাছ চাষ কার্যক্রম উন্নয়ন ও টেকসই করতে মূখ্য বিষয়গুলি (**Key elements**) কি কি ?
2.10	হাওড়ের পুকুরে মাছ চাষের জন্য কি ধরনের কারিগরী সহায়তা মাছ চাষীদের সরবরাহ করা প্রয়োজন ?
2.11	আপনার মতে হাওড়ের পুকুরে মাছ চাষের কার্যক্রমগুলি (ইন্টারভেনশন) পরিবেশের উপর কোন বিরম্নপ (নেগেটিভ) প্রভাব ফেলেছে ?
2.12	হাওড় পস্নাবিত হলে বা অন্য কোন কারনে হাওড় পুকুরের চাষকৃত মাছ উন্মুক্ত জলাশয়ে ছড়িয়ে পড়লে কি কি সমস্যাহয়? বা হতে পারে ?
2.13	হাওড়ের পুকুরগুলিতে কি কি প্রজাতির মাছ চাষ করা যেতে পারে ?

2.14 হাওড়ের পুকুরে মাছের কোন কোন প্রজাতিগুলো চাষ করার উদ্যোগ নেয়া উচিত নয় ?
2.15 হাওড়ের পুকুরের মাটির ধরণ সম্পর্কে অপনার মতামত দিন।
2.16 কোন ধরনের ষ্ট্রাকচারাল ইন্টারভেনশন হাওড়ের পুকুরে মাছ চাষে সাহায্য করতে পারে ? অপশনগুলি কি কি ?
2.17 শুকনো মৌসুমে হাওরে পানির উচ্চতা বাড়ার কোন প্রভাব পড়ে কি?
2.18 কোন নির্দিষ্ট প্রজাতির মাছের ডিম ছাড়ার ক্ষেত্রে জলবায়ু (তাপমাত্রা) পরিবর্তনের কি কি প্রভাব রয়েছে ?
2.19 হাওড়ের পুকুরে মাছ চাষে ইকোলজির উপর কোন বিরূপ প্রভাব আছে কি ? ইকোলজি সুরক্ষায় কি কি পদক্ষেপ নেয়া উচিত ?
2.20 হাওড়ের পুকুরে মাছ চাষ স্থানীয় প্রজাতির আহরণকৃত মাছ ও জীববৈচিত্রের উপর ইতিবাচক প্রভাব ফেলে কি ?
2.21 কৃষি জমিতে যে সকল কিটনাশক ব্যবহৃত হচ্ছে তার কোন প্রভাব হাওড়ের মাছের উপর পড়ে কি ? উলেস্নখযোগ্য কিছু প্রভাব বিষয়ে বলুন।
2.22 হাওড় এলাকার পুকুরে মাছ চাষীদের কাছে কারিগরী সহায়তা কিভাবে সম্প্রসারিত হওয়া উচিত ?
2.23 হাওড়ের পুকুর এবং সর্বোপরি হাওড়ে মাছ চাষের বিষয়ে কি কি গবেষনা হতে পারে ?

(বিঃ দ্রঃ একটি/দুটি ছবি নিন)

তথ্য সংগ্রহকারীর নামঃ ---------- স্বাক্ষার ও তারিখঃ ----------

Appendix 2b: Key Informant Interviews (KII) Checklist (English)

Government of the Peoples Republic of Bangladesh
Local Government Engineering Department
Haor Infrastructure and Livelihood Improvement Project (HILIP)
Level-3, RDEC Bhaban, LGED H/Q,
Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.

Action Research on Analysis of the environmental impacts of large scale expansion of pond fisheries and climate change affects under HILIP, LGED.

Checklist for Key Informant Interview (KII)

Question	Answer	
1. General information:		
1.1 Name:		
1.2 Designation:		
1.3 Mobile No:		
1.4 Department/Organization:		
1.5 District:	Name:	Code:
2. Discussion Points:		
2.1 Do you think that expansion of Haor pond culture is important for food security, nutrition and economicdevelopment?		
2.2 Give your opinion on different methods of fish culture in the Haor pond.		
2.3 Do you think training and other interventions by different agencies bringing any change to the methods of fish culture in the Haor pond?		
2.4 Do you think that the fish farmers of Haor area have necessary technical knowledge to continue Haor fish culture activities?		
2.5 How far Haor fish culture activities will be sustainable due to different interventions? Will it continuewithout any external help?		
2.6 State your form of involvement with the Haor pond fish culture. Did some of those results help in the realization of your own interventions?		
2.7 Do you think different interventions on fish culture in Haor have any impact outside the Haor areas?		

2.8 Express your opinion about pond fish culture in the Haor areas.
2.9 What are the key elements for improvement and sustainability of Haor pond fish culture?
2.10 What type of technical support may be provided to the fish farmers for pond fish culture in the Haor?
2.11 Do you think interventions carried out for pond fish culture in the Haor have caused any negative impact onthe environment?
2.12 What type of problems may be caused if cultured fish spread in the open water due to flood waterentrance?
2.13 What species of fish may be cultured in the Haor pond?
2.14 What species of fish should not be cultured in the Haor pond?
2.15 Give your opinion on soil type of Haor pond.
2.16 What type of structural interventions might help pond fish culture in Haor? What are the options?
2.17 Do you observe any effect of water level rise in Haor during lean period?
2.18 What are the effects of climate (temperature) change in spawning of any specific species of fish?
2.19 Is there any adverse impact of Haor pond fish culture on ecology? What steps should be taken for sustaining ecology?
2.20 Is there any positive impact of Haor pond fish culture on the local fish and biodiversity?
2.21 Is there any negative effect of pesticides used in the agricultural land on Haor fish? Mention some effects.
2.22 How should the technological support be extended to the pond fish farmers in Haor areas?
2.23 What type of research may be undertaken for fish culture in Haor ponds in particular and Haor areas in general?

(Note: Please take one or two photographs of KII)

Name of Data Collector:---------- **Signature with date:----------**

Appendix 3a: In-depth Interview Format (Bengali)

Government of the Peoples Republic of Bangladesh
Local Government Engineering Department
Haor Infrastructure and Livelihood Improvement Project (HILIP)
Level-3, RDEC Bhaban, LGED H/Q,
Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.

Action Research on Analysis of the environmental impacts of large scale expansion of pond fisheries and climate change affects under HILIP, LGED.

সাক্ষাৎকার অনুসূচি-১ঃ পুকুর মালিক

সম্মতি প্রদান করেছেন (√) ☐ →প্রশ্নমালায় যান

1. উত্তরদাতার তথ্যাদি

নাম: _____ বয়স: _____ লিঙ্গ: _____

মোবাইলনং: _____ মৌজা ও কোড _____ ইউনিয়নের নাম ও কোড: _____

উপজেলার নাম ও কোড: _____ জেলার নাম ও কোড: _____

সেকশন-এ: পুকুরমালিকের জনমিতিক ও আর্থ-সামাজিক তথ্যাদি

2. জনসংখ্যাতাত্ত্বিক বৈশিষ্ট্য

কোড	নাম (পরিবার প্রধান থেকে শুরূ করুন)	পরিবার প্রধানের সাথে সম্পর্ক	বয়স (পূর্ণ বছর)	লিঙ্গ (কোড)	শিক্ষাগত যোগ্যতা (কোড)	বৈবাহিক অবস্থা (কোড)	প্রধান পেশা (কোড)
	1	2	3	4	5	6	7
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

সম্পর্ক কোড:পরিবার প্রধান =1, স্বামী/স্ত্রী=2, ছেলে/মেয়ে=3,পিতা/মাতা=4, ভাই/বোন=5, ভাগনা/ভাগনী =6, ভাতিজা/ভাতিজী=7, বোনজামাই=8, ভাইয়ের বৌ=9, দাদা/দাদী= 10, নানা/নানী=11, ছেলের বৌ/মেয়েরজামাই=12, নাতি/নাতনী=13, কাজের লোক=14, অন্যান্য আত্মীয়=15

শিক্ষাগত যোগ্যতার কোড: (বয়স ৫ বছরের নিচে=1, নিরক্ষর=2, পড়তে ও লিখতে পারে=3, প্রাথমিক=4, জেএসসি=5, এসএসসি=6, এইচএসসি=7, স্নাতক=8, স্নাতকোত্তর=9, ডাক্তার/ইঞ্জিনিয়ার =10, লিঙ্গ কোড:পুরুষ =1, মহিলা =2,
বৈবাহিক অবস্থার কোড:অবিবাহিত=1, বিবাহিত =2, বিধবা=3, বিপত্নীক=4, বিবাহবিচ্ছিন্ন=5
পেশা কোড: (নির্ভরশীল=1, ছাত্র/ছাত্রী=2, কৃষি=3, কৃষি শ্রমিক =4, দিন মজুর=5, গৃহস্থালী কাজ=6, গৃহিনী=7,চাকুরী=8, পরিবহন শ্রমিক=9, ব্যবসাবড়/মাঝারি=10, কুটিরশিল্প=11, প্রবাসী=12, প্রাণীসম্পদ (গরম্ন/ছাগল/মহিস/ ভেড়া/)=13, হাঁস-মুরগী/পাখীপালন=14, জেলে=15, কামার=16, কুমার=17, দড়া শ্রমিক=18, মৎস্য চাষ=19, মৎস্য ব্যবসা=20, ক্ষুদ্র ব্যবসা=21, ডাক্তার=22, ইঞ্জিনিয়ার=23, অন্যান্য=24

3. মালিকানাধীন গৃহস্থালীয় সামগ্রী

গৃহস্থালীয় সামগ্রীর ধরন	কোড	সংখ্যা	মোট মূল্য (টাকা)
বৈদ্যুতিকপাখা	1		
সেলাই মেশিন	2		
টিভি	3		
মোবাইল ফোন	4		
ফ্রিজ	5		
আলমারী	6		
খাট	7		
সোফাসেট	8		
শোকেজ	9		
বাইসাইকেল	10		
মটরসাইকেল	11		
নছিমন	12		
মটরপাম্প	13		
গয়না	14		
অন্যান্য (উলেস্নখ করম্নন)	99		

4. ভূমিসম্পদের মালিকানা

জমির বিবরণ	কোড	(শতাংশ)	মূল্য (শতাংশ পতি)
বসতবাড়ী	1		
নিজেস্ব চাষের জমির পরিমান	2		
বন্ধক দেয়া জমির পরিমান	3		
বন্ধক নেয়া জমির পরিমান	4		
স্থায়ী পুকুর (একক মালিকানা)	5		
স্থায়ী পুকুর (যৌথ মালিকানা)	6		
মৌসুমী পুকুর (একক মালিকানা)	7		
মৌসুমী পুকুর (যৌথ মালিকানা)	8		
ফলের বাগান/ বাগিচা	9		

জমির বিবরণ	কোড	(শতাংশ)	মূল্য (শতাংশ পতি)
স্থায়ী পতিত জমি	10		
অন্যান্য (উলেস্নখ করস্নন)	99		

5. বসত বাড়ির মালিকানা

ঘরের বিবরণ	কোড	ধরণ কোড	ঘরের সংখ্যা	বাজার মূল্য (টাকা)
বসতঘর	1			
রান্নাঘর	2			
গোয়াল ঘর	3			
গুদাম ঘর	4			
ধরণ কোডঃ টিনসেড=1, আধাপাকা=2, পাকাবাড়ি=3, কাঁচা ঘর=4				

প্রশ্ন	উত্তর
6. আপনার খানায় বৈদ্যুতিক সংযোগ আছে কি? (হ্যাঁ=1, না=2)	
7. আপনার খাবার পানির উৎস কি ? (পুকুর =1, হস্ত্ম চালিত নলকূপ=2)	
8. পরিবারের শৌচাগার আছে কি? (হ্যাঁ=1, না=2)	
9. হ্যাঁ হলে কি ধরনের ? (স্যানিটারী=1, কাঁচা=2, অন্যান্য=3)	

10. মালিকানাধীন প্রাণিসম্পদ

প্রাণিসম্পদের ধরন	কোড	সংখ্যা	মোট মূল্য (টাকা)
গরস্ন	1		
মহিষ	2		
ছাগল / ভেড়া	3		
হাঁস/ মুরগি/কবুতর/পাখী	4		

11. মালিকানাধীন কৃষি যন্ত্রপাতি

পরিবহন ও যন্ত্রপাতির ধরন	কোড	সংখ্যা	মূল্য
পাওয়ার টিলার	1		
অগভীর পাম্প	2		
দেশী নৌকা	3		
যান্ত্রিক নৌকা	4		
মাছ ধরার সরঞ্জামাদী (জাল, বানা, ফাঁদ ইত্যাদি)	5		
অন্যান্য (উলেস্নখ করস্নন)	99		

সেকশন-বিঃ হাওড় পুকুর সংক্রান্ত তথ্যাদি

প্রশ্ন	উত্তর কোড
12. আপনার কয়টি পুকুর (স্থায়ী ও মৌসুমী) আছে?	

	প্রশ্ন	উত্তর কোড
13.	পুকুরের দৈর্ঘ্য, প্রস্থ, গভীরতা ও মাটির ধরণ সংক্রান্তঃ	স্থায়ী পুকুর দৈর্ঘ্য.....ফুট প্রস্থ.....ফুট গভীরতা.....ফুট পুকুরের মাটির ধরণঃ বেলে/ এটেল/ দোয়াশ মৌসুমী পুকুর দৈর্ঘ্য.....ফুট প্রস্থ.....ফুট গভীরতা.....ফুট পুকুরের মাটির ধরণঃ বেলে/ এটেল/ দোয়াশ
14.	কখন পুকুর খনন করা হয়? (জানুযায়ী=1, ফেব্রুয়ারী=2, মার্চ=3, এপ্রিল=4, মে=5, জুন=6, জুলাই=7, আগষ্ট=8, সেপ্টেম্বর=9,অক্টোবর=10, নভেম্বর=11, ডিসেম্বর=12)	
15.	পুকুর খননের উদ্দেশ্য কি কি?	১. ২. ৩.
16.	পুকুর খননে/তৈরীতে কার সহায়তা পেয়েছেন? (এলজিইডি = ১, এনজি্ও = ২, কারও নয় = ৩, অন্যান্য = ৪)	
17.	পুকুরে মাছ চাষে কার সহায়তা পেয়েছেন? (এলজিইডি = ১, মৎস্য বিভাগ = ২, এনজিও = ৩, অন্যান্য = ৪, কারও নয় = ৫,)	
18.	গ্রীষ্মের পরে সাধারণত কখন পুকুর পানিতে পস্নাবিত হয়/ডুবে যায়? (জানুযায়ী=1, ফেব্রুয়ারী=2, মার্চ=3, এপ্রিল=4, মে=5, জুন=6, জুলাই=7, আগষ্ট=8, সেপ্টেম্বর=9,অক্টোবর=10, নভেম্বর=11, ডিসেম্বর=12)	
19.	পুকুরে চাষকৃত মাছের যথেষ্ট বৃদ্ধি হয় কি?	১. বেশী বৃদ্ধি হয় ২. মাঝারী বৃদ্ধি হয় ৩. কম বৃদ্ধি হয় ৪. বৃদ্ধি হয় না
20.	মাছ ধরার পদ্ধতিগুলো কি কি? (হাতে সেচ=1, যান্ত্রিক সেচ=2, জাল দিয়ে মাছ ধরা (একবার)=3, জাল দিয়ে মাছ ধরা (বহুবার)=4)	
21.	মাছ ধরার জন্য কি কি জাল ব্যাবহার করেন	১. ------- ২. -------- ৩. ------- ৪. -------- ৫. ------- ৬. -------- ৭. ------- ৮. --------
22.	পুকুরের পানি অন্য কি কি উদ্দেশ্যে ব্যবহৃত হয়?	১. ২. ৩.
23.	পুকুরের নিষ্কাশিত পানি জমিতে সেচের কাজে ব্যবহৃত হয় কি? কিংবা পুকুরের তীরে চাষাবাদে ব্যবহৃত হয় কি? (হ্যাঁ=1, না=2)	
24.	উন্মুক্ত জলাশয়ের যে মাছগুলো পুকুরে জড়ো হয়েছে সেগুলো ধরার জন্য কি পুকুরের পানি নিষ্কাশন করা হয়? (হ্যাঁ=1, না=2)	

প্রশ্ন		উত্তর কোড
25.	পুকুর এবং তৎসংলগ্ন জলাশয়ের পানি ব্যবহার নিয়ে কোন দ্বন্ধ আছে কি? (হ্যাঁ=1, না=2)	
26.	ছোট মাছগুলো খাদ্য হিসাবে ব্যবহৃত হয় কিনা? (হ্যাঁ=1, না=2) যদি হ্যাঁ হয়, তবে উৎপাদনের কত ভাগ ব্যবহৃত হয়? (১০%=1, ৩০%=2, ৫০%=3, ১০০%=4)	
27.	কিভাবে মাছ সংরক্ষণকরা হয়?	১. ২. ৩.
28.	কিভাবে মাছ বাজারজাত করা হয়?	১. ২. ৩.
29.	মাছ থেকে শুটকি করা হয় কি? (হ্যাঁ=1, না=2)	
30.	পুকুর পানিতে পস্নাবিত হওয়ার পর উন্মুক্ত জলাশয়ের যে মাছগুলো পুকুরে জড়ো হয় সেগুলোধরে ফেলার পর বছরের অবশিষ্ট সময়ে মৌসুমী পুকুরে মাছ চাষ করেন কিনা? (হ্যাঁ=1, না=2)	
31.	উন্নত মাছচাষ প্রযুক্তির উপর কোন প্রশিক্ষণ পেয়েছেন কি ?(হ্যাঁ=1, না=2)	
32.	হ্যাঁ হলে কোথায়ঃ ----------, কারা দিয়েছেঃ ---------- ? কত দিন----(সংখ্যা)	
33.	মাছ চাষ উন্নয়নে আপনার পরামর্শ কি?	১. ২. ৩.

34. মাছ উৎপাদন সংক্রান্ত তথ্যাদি

মাছের নাম	কোড	মাছের অনুপাত (%)	পুকুর (শতাংশ)	উৎপাদন (কেজি/শতাংশ)	খরচ/ শতাংশ	মোট বাজার মূল্য

মাছের কোডঃ তেলাপিয়া=1, মনোসেক্স তেলাপিয়া =2, রুই=3, কাতলা=4, মৃগেল=5, কালবাউস = 6, সিলভারকার্প=7, গ্রাসকার্প = 8, কমনকার্প = 9, থাইসরপুটি=10, থাই পাঙ্গাস=11, থাই কৈ=12,মলা = 13,পাবদা =14 , টেংড়া =15, লাল তেলাপিয়া= 16,শিং=17, দেশী মাগুর=18, হাইব্রিড মাগুর=19, আফ্রিকান মাগুর=20, পিরহানা=21, দেশীপুটি = 22,টাকি=23, চিংড়ী=24, বাইম=25, দেশী কৈ=26, শোল/গজার = 27, বোয়াল=28, দেশী

মাছের নাম	কোড	মাছের অনুপাত (%)	পুকুর (শতাংশ)	উৎপাদন (কেজি/শতাংশ)	খরচ/ শতাংশ	মোট বাজার মূল্য
ছোটমাছ=29, অন্যান্য (উলেস্নখকরন্নন) =30,						

সেকশন-সি: আয়-ব্যয় সংক্রান্ত তথ্যাদি

35. পরিবারের সদস্যদের বার্ষিক আয়

আয়ের উৎস	কোড	মোট পরিমাণ (টাকা)
কৃষি	1	
প্রাণীসম্পদ (গরন্ন, ছাগল, ভেড়া, খরগোস, হাঁস, মুরগি, কবুতর, পাখি পালন)	2	
মৎস্য সম্পদ (জেলে, মৎস্য আহরণ, মৎস্য ব্যবসায়ী, শুটকি উৎপাদনকারী)	3	
মাছ চাষ	4	
নৌকার মাঝি	5	
ব্যবসা	6	
কৃষি শ্রম	7	
অকৃষি শ্রম	8	
কুটির শিল্প/ হস্ত্মশিল্প/ তাঁতি	9	
রিকসা / ভ্যানচালনা	10	
দড়া শ্রমিক (কাঠমিস্ত্রি/ রাজমিস্ত্রি/মেকানিক/কামারইত্যাদি)	11	
চাকুরী	12	
প্রবাসী	13	
ঋণ গ্রহণ	14	
অন্যান্য (উলেস্নখ করন্নন)	99	
সর্বমোট=		

36. খাত অনুসারে বার্ষিক ব্যয়

ব্যয়ের বিবরণ	কোড	মোট পরিমাণ (টাকা)
খাদ্য	1	
স্বাস্থ্য সেবা	2	
পোশাক	3	
বাসস্থান নির্মাণ/ বাসস্থান মেরামত	4	
শিড়া	5	
আসবাবপত্র	6	
কৃষিখাতে ব্যয়	7	
প্রাণীসম্পদ পালন	8	
মাছ চাষ	9	
ধর্মীয় উৎসব	10	

ব্যয়ের বিবরণ	কোড	মোট পরিমাণ (টাকা)
ঋণ পরিশোধ	11	
হস্তচালিত নলকূপ স্থাপন	12	
স্বাস্থ্য সম্মত পায়খানা স্থাপন	13	
যাতায়াত	14	
যোগাযোগ	15	
অন্যান্য (উলেস্নখ করন্নন)	99	
সর্বমোট=		

সেকশন-ডি: পরিবেশের উপর প্রভাব

37. হঠাৎ বন্যার আগাম খবর/তথ্য আপনারা জানতে পারেন কি ?
38. আগাম বন্যা বা হঠাৎ বন্যা (Flash flood) হলে আপনার পুকুরে এর কি প্রভাব পড়ে ?
39. মাছ চাষের পুকুরের সংখ্যা বৃদ্ধি হলে হাওরের পরিবেশের উপর কি কি প্রভার পড়বে?
40. বর্ষাকালে পুকুরে চাষকৃত মাছ অন্য জলাশয়ে চলে গেলে কি কি প্রভাব পড়বে?
41. কৃষি জমিতে বিভিন্ন কিটনাশক ব্যবহারে আপনার পুকুরে এর কি কোন প্রভাব পড়ে ?

সেকশন-ই: জেন্ডার প্রভাব

প্রশ্ন		উত্তর কোড
42.	মাছ চাষের জন্য পুকুর প্রস্তুতিতে মহিলাদের ভূমিকা কি ?	১. ২. ৩.
43.	পুকুরে চাষকৃত মাছের জন্য খাবার সরবরাহ ও পরিচর্যা করেন কি	১. হাঁ ২. না
44.	মাছের খাবার সরবরাহসহ পুকুর পরিচর্যায় মহিলাদের ভূমিকা কি ?	১. ২. ৩.
45.	মাছ উৎপাদন পরবর্তীতে (Post harvest) মহিলাদের ভূমিকা কি ?	১. ২. ৩.
46.	মাছ চাষে মহিলাদের কর্মসংস্থান বেড়েছে কিনা? (হ্যাঁ=1, না=2)	
47.	মাছ চাষে মহিলাদের আয় বেড়েছে কিনা? (হ্যাঁ=1, না=2)	

তথ্য সংগ্রহকারীর নামঃ ---------- তারিখঃ ----------

সুপারভাইজারের নামঃ ---------- তারিখঃ ----------

Appendix 3b: In-depth Interview Format (English)

Government of the Peoples Republic of Bangladesh
Local Government Engineering Department
Haor Infrastructure and Livelihood Improvement Project (HILIP)
Level-3, RDEC Bhaban, LGED H/Q,
Sher-e-Bangla Nagar, Agargaon, Dhaka-1207.

Action Research on Analysis of the environmental impacts of large scale expansion of pond fisheries and climate change affects under HILIP, LGED.

Interview Schedule-1: Pond Owner

Given consent **(√)** ☐ → Go to Questionnaire

1. Background of the Respondents

Name**:** _____ Age**:** _____ Sex**:** _____

Mobile No.**:** _____ Mouza & Code: _____ Union & Code**:** _____

Upazila & Code**:** _____ District & Code**:** _____

Section- A: Socio-Economic & Demographic Information of Pond Owner

2. Demographic Characteristics

Code	Name (Start from H.Hold Head)	Relationship with the Head	Age in Years (Round)	Sex (Code)	Educational Qualification (Code)	Marital Status (Code)	Main Occupation (Code)
	1	2	3	4	5	6	7
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
Relationship Code: H.Hold Head=1, husband/wife=2, son/daughter=3, father/mother=4, brother/sister=5, nephew =6, niece=7, sister's husband=8, brother's wife=9,grand							

father/grand mother=10, maternal grand father/ maternal grand mother=11, son's wife/daughter's husband=12, servant=14, other relatives=15
Education Code: Age below 5 years=1, illiterate=2, can read & write=3, primary=4, JSC=5, SSC=6, HSC=7, graduate=8, post graduate=9, doctor/engineer=10, **Sex Code:** Male=1, female=2,
Marital Status Code: Unmarried=1, married=2, widow=3, divorced=4, separated=5
Occupation Code: Dependent=1, student=2, agriculture=3, agriculture day labour=4, day labour=5, household work=6, house wife=7, service=8, transport labour=9, business=10, cottage industry=11, immigrant=12, livestock(cow, goat, buffalo, sheep)=13, poultry=14, Fisher man=15, blacksmith=16, potter=17, skilled labour=18, fish culture=19, fish trader= 21, small business=21, doctor=22, engineer=23, other=24

3. House Hold Assets

Types of Assets	Code	Number	Total Value (Taka)
Electric Fan	1		
Sewing Machine	2		
Television	3		
Mobile Phone	4		
Refrigerator	5		
Almirah	6		
Cot	7		
Sofa Set	8		
Showcase	9		
Bicycle	10		
Motor Cycle	11		
Nosimon	12		
Motor Pump	13		
Ornaments	14		
Others (specify)	99		

4. Land Ownership

Types of Ownership	Code	(Decimal)	Price (Per Decimal)
Homestead land	1		
Own cultivable land	2		
Leased out land	3		
Leased in land	4		
Permanent pond (individual)	5		
Permanent pond (joint)	6		
Seasonal pond (individual)	7		

Seasonal pond (joint)	8		
Fruit garden/orchard	9		
Permanent fallow land	10		
Others (specify)	99		

5. Types of Homestead

Description of Rooms	Code	Types Code	No. of Rooms	Market Price (Taka)
Living room	1			
Kitchen	2			
Cow shed	3			
Store room	4			
Types code: Tinshed=1, Semi Pucca=2, Pucca=3, Kancha=4				

Question	Answer
6. Do you have electricity in your house? (yes=1, No=2)	
7. What is the source of your drinking water? (Pond=1,Hand Tube well=2)	
8. Do you have latrine in your house hold? (Yes=1, No=2)	
9. If yes, what type of latrine? (Sanitary=1, Kancha=2, Others=3)	

10. Livestock Assets

Type of Livestock	Code	Number	Total Price (Taka)
Cow	1		
Buffalo	2		
Goat/Sheep	3		
Duck/Fowl/Pigeon/Bird	4		

11. Agricultural Equipment

Type of Transport & Equipment	Code	Number	Price
Power tiller	1		
Shallow pump	2		
Country boat	3		
Engine boat	4		
Fishing gears (net, bana, trap, etc.)	5		
Other (specify)	99		

Section- B:Information on Haor Pond

Question	Answer Code
12. How many ponds do you have (permanent & seasonal)?	
13. Length, width, depth of pond & type of soil related:	Permanent Pond Length----------feet Width----------feet Depth----------feet Pond's soil type : Sandy/clay/loam Seasonal Pond Length----------feet Width----------feet Depth----------feet Pond's soil type : Sandy/clay/loam
14. When pond is excavated? (Jan=1, Feb=2, Mar=3, Apr=4, May=5, Jun=6, Jul=7, Aug=8, Sept.=9, Oct.=10,Nov.=11, Dec.=12)	
15. What was the purpose of pond excavation?	1. 2. 3.
16. Whose assistance you have received in pond excavation/preparation?(LGED=1, NGO=2, None=3, Others=4)	
17. Whose assistance you have received in pond fishculture? (LGED=1, Fisheries department=2, NGO=3, Others =4, None =5)	
18. When pond is generally submerged after summer? (Jan=1, Feb=2, Mar=3, Apr=4, May=5, Jun=6, Jul=7, Aug=8, Sept.=9, Oct.=10,Nov.=11, Dec.=12)	
19. Is growth of fish in the pond sufficient?	1. Maximum growth 2. Optimum growth 3. Low growth 4. No growth
20. What are the methods of harvesting fish? (manually=1, mechanically=2, using gear (once), using gear (multiple time)	
21. Types of gear/net used for fishing	1.---------- 2.---------- 3.---------- 4.---------- 5.---------- 6.---------- 7.---------- 8.----------
22. For what other purposes pond water is used?	1. 2.

Question	Answer Code
	3.
23. Is pond water usedfor irrigating land? or used for farming in the bank of the pond? (yes=1, no=2)	
24. Do you drain out the pond water for catching fisheswhich gather in your pond from open water? (yes=1,no=2).	
25. Is there any conflict regarding use of pond and attached open water? (yes=1, no=2).	
26. Is small variety of fishes consumed in the family? (yes=1, no=2).If yes, what percentage of the production is consumed? (10%=1, 30%=2, 50%=3, 100%=4).	
27. How fish is preserved?	1. 2. 3.
28. How fish is marketed?	1. 2. 3.
29. Do you make dry fish? (yes=1, no=2).	
30. Do you cultivate/culture fish in your seasonal pond aftercatching fisheswhich gather in the pond from theopen water after flooding? (yes=1, no=2).	
31. Have you received any training on improved fish culture? (yes=1, no=2).	
32. If yes where?----------, From which agency?--------, Duration (days)----------.	
33. What is your suggestion on development of fish culture?	1. 2. 3.

34. Information on Fish Production

Name of Fish	Code	Proportion of Fish (%)	Pond (decimal)	Production (kg/decimal)	Cost/decimal	Total Market Price

Fish Code: Tilapia=1,Mono sex tilapia=2, Rui=3, Catla=4, Mrigal=5, Kaliboush=6, Silver carp=7, Grass carp=8, Common carp=9, Thai Sarputi=10, Thai pangas=11, Thai Koi=12, Mola=13, Pabda=14, Tengra=15, Lal tilapia=16, Shing=17, Magur (deshi)=18, Magur (hybrid)=19, Africal Magur=20, Pirhana=21, Puti (local)=22, Taki=23, Prawn=24, Baim=25, Koi (local)=26, Shol/Gager=27, Boal=28, Local small fish=29, Others (specify)=30

Section- C:Information on Income & Expenditure

35.Annual Income of the Family

Sources of Income	Code	Total Amount (Taka)
Agriculture	1	
Livestock Rearing (cow, goat, sheep, rabbit, duck, hen, pigeon, bird)	2	
Fisheries Related (fisherman, fish harvest, fish trader, dry fish producer)	3	
Fish Culture	4	
Boat driver	5	
Business	6	
Agricultural labor	7	
Non-Agricultural labor	8	
Cottage Craft/Handicraft/Weaving	9	
Rickshaw/Van Pulling	10	
Skilled Laborer (carpenter/mason/mechanic/blacksmith)	11	
Service	12	
Immigrant	13	
Credit	14	
Others (specify)	99	
Total=		

36. Annual Expenditure

Heads of Expenditure	**Code**	**Total Amount (Taka)**
Food	1	
Medical Service	2	
Clothing	3	
House Construction/Repair	4	
Education	5	
Furniture	6	
Agricultural Expenses	7	
Livestock Expenses	8	
Fish Culture	9	
Religious Festivals	10	
Loan Repayment	11	

Heads of Expenditure	Code	Total Amount (Taka)
Hand Tube well Installation	12	
Sanitary Latrine Installation	13	
Traveling	14	
Communication	15	
Others (specify)	99	
Total=		

Section- D: Impact on Environment

37. Do you receive early information on flash flood?

38. What impact you have observed in your pond due to flash flood?

39. What impacts you apprehend on the haor, if number of pond for fisheries increases?

40. If cultured fishes from the pond go to the other water areas what impacts are observed?

41. Do you observe any impact in your pond for using pesticides in the agricultural land?

Section- E: Impact on Gender

Question	Answer/ Code
42. What are the roles of women in preparation of pond for fish culture?	1. 2. 3.
43. Are they involved in feeding and caring fish in their pond?	Yes =1 No=2
44. If yes, describe their roles.	1. 2. 3.
45. What are their roles in post harvest fish production?	1. 2. 3.
46. Is there any increase in employment of women due to fish culture activities?	Yes=1 No=2
47. Is there any increase in income of women due to fish culture activities?	Yes=1 No=2

Name of the Data Collector:---------- Date:----------
Name of the Supervisor:---------- Date:----------

Appendix 4a: Trees Checklist in Project Area

Local Name	Scientific Name	Occurrence (O)	Trend (T)
Aam	*Mangifera indica*		
Aash fal	*Nephelium longana*		
Acacia	*Acasia nilotica*		
Akashmoni	*Acacia moniliformis*		
Amloki	*Phyllanthus emblica*		
Arjun	*Terminalia arjuna*		
Asshot	*Flemingia congesta*		
Ata fal	*Annona squamosa*		
Babla	*Acacia nilotica*		
Goran	*Ceriops decandra*		
Bahera	*T. belerica*		
Bajna	*Elaeis guineensis*		
Barak Bansh	*B. balcooa*		
Bel	*Aegle marmelos*		
Bokul	*Nerium indicum*		
Borroi	*Zizipus mauritiana*		
Bot	*F. benghalensis*		
Chalta	*Dillenia indica*		
Chatim	*Alstonia scholaris*		
Debdaru	*Poluanthia longifolia*		
Deshi Nim	*Melia azadirachta*		
Dumur Khoska)	*Ficus hispida*		
Eucalyptus	*Eucalyptus citriodora*		
Gamari	*Dmelina arborea*		
Ghora Nim	*Melia sampervirens*		
Hartaki	*Terminalia chebula*		
Ipil Ipil	*Leucaena latisiliqua*		
Jalpai	*Elaeocarpus robustus*		
Jam	*Sugugium cumini*		
Jambura	*Cytus grandis*		
Jamrul	*Sugugium samarangense*		
Jawa Bansh	*B. tulda*		
Jhau	*Casuarina littomia*		
Jiga	*Lannea cormandelica*		
Kadam	*Anthocephalus chinensis*		
Kali Kadam	*Adina cordifolia*		
Kalo Karoi	*Albizia lebbek*		
Karobi	*Zanthophyllum rhesta*		

Local Name	Scientific Name	Occurrence (O)	Trend (T)
Kathal	*Artocarpus heterophyllus*		
Kad Bel	*Feronia limonia*		
Khejur	*Phoenix sylvestris*		
Khoi Babla	*Acasia nilotica*		
Krishnachura	*Delonix regia*		
Hizal	*Barringtonia acutangula*		
Barun	*Crataeva nurvala*		
Lichu	*Lichi Chinensis*		
Mahogani	*Swietenia mahogoni*		
Mandar	*Erythrina variegate*		
Najna/Sajna	*Moriginga sp.*		
Narikel	*Cocos nucifera*		
Pakur	*Ficus bejamina*		
Tal	*Borassus flabellifer*		
Peara	*Psidium guajava*		
Raintree Koroi	*Samanea saman*		
Raj Karoi	*A. richardiana*		
Sada Karoi	*A. procera*		
Sajna	*Moriginga olefera*		
Segun	*Tectonia grandis*		
Shal	*Shorea rubusta*		
Shara	*Streblus asper*		
Shawra	*Carapa molocansis*		
Shil Karoi	*A. lucida*		
Shimul	*Bombax ceiba*		
Shishoo	*Dalbergia sissoo*		
Sonalu	*Oroxylum indicum*		
Supari	*Areca catechu*		
Palm	*Trapa bispinosa*		
Tarla Bansh	*Bambusa longispiculata*		
Tetul	*Tamarind indica*		
Others (name)			

Occurrence (O)	**Trend (T)**
1= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4=Very Rare (Not Found now)	NA=Not Applicable

4b: Shrubs Checklist in Project Area

Local Name	Scientific Name	Occurrence (O)	Trend (T)
Akanda	*Calotropics procera*		
Ashali	*Vitex glabrata*		
Mehedi	Justicia sp		
Bashok	*Adhatoda vasica*		
Beli	*Jasminum sambac*		
Bhat	*Clerodendrum viscosum*		
Jaba	*Hibiscus rosa-sinensis*		
Bish Katali	Polygonum hydropiper		
Kalkasunda	*Cassia sophera*		
Lebu	*Citrus aurentifolia*		
Rang Chita	*Pedilanthes tithymatoides*		
Rangan	*Ixora coccinea*		
Sitki	Phyllanthus reticulates		
Tulshi	*Ocimum americanum*		
Ulot Kombol	*Abroma augusta*		
Venna	*Ricinus communis*		
Ashshewra	Srebkus Aspera		
Hargoza	Dillenia pentagyna		
Jagadumur	Ficus glomoreta		
Jui	Jasminum auriculum		
Kamini	Murraya panikulata		
Kanta Begun	Solanum surattense		
Man kachu	Alocasia indica		
Raktodrone	Leonarus sibiricus		
Titbegun	Solanum indicum		
Others (name)			

Occurrence (O)	**Trend (T)**
1= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4= Very Rare (Not Found now)	NA=Not Applicable

4c: Creepers Checklist in Project Area

Local Name	Scientific Name	Occurrence (O)	Trend (T)
Assamlata	*Eupatorium odoratum*		
Bet	*Calamus viminalis*		
Gila lata	*Derris trifoliate*		
Harjora	*Vitis quadrangularis*		
Kuch	*Abrus precatomius*		
Madhabi lata	*Quisqualis indica*		
Pipul	*Piper peepuloides*		
Mete Alu	*Dioscorea alata*		
Satamuli	*Asparagus recemosus*		
Swarnalata	*Cuscuta reflexa*		
Telakucha	*Coccinea cordifolia*		
Teet Karela	*Monordica charantia*		
Others (name)			

Occurrence (O)	**Trend (T)**
I= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4= Very Rare (Not Found now)	NA=Not Applicable

4d: Herbs Checklist in Project Area

Local Name	Scientific Name	Occurrence (O)	Trend (T)
Amrul Shak	Oxalis corniculata		
Anaji Kala	Musa paradisiacal		
Ban Sharisha	Brassica Kaber		
Bangla Kala	Musa sp.		
Bichi Kala	Musa sapientum		
Bidyapata	Poligonum tementosum		
Bish Katali	Polygonum hydropiper		
Bon Dhonia	Eryngium foetidium		
Bon Palong	Sonchus arvensis		
Chorkanta	Chrysopogon aciculatus		
Dhutura	Datura metel		
Durba	Cynodon dactylon		
Gandharaj	Gardenia jasminoides		
Ghagra	Xanthium indicum		
Ghrit Kumari	Aloe vera		
Hatishura	Heliotropium indicum		
Kalokeshi	Eclipta alba		
Kanshira	Commelina bengalensis		
Kanta Notey	A. spinosus		
Kash	Saccharum spontaneum		
Lajwabati	Mimosa pudica		
Man Kachu	Alocasia indica		
Notey shak	Amaranthes viridis		
Jangli kachu	Colocasia nymphaefolia		
Phonimonsa	Opuntia dillenii		
Sabri Kala	Musa sp.		
Sagar Kala	Musa sp.		
Shetdrone	Leucas aspera		
Shialmutra	Vernolia patula		
Shushni shak	Marsilea quadrifolia		
Teet Begun	Solanum nigram		
Ulu khar	Imperata cylindrica		
Others (name)			

Occurrence (O)	**Trend (T)**
1= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4= Very Rare (Not Found now)	NA=Not Applicable

4e: Aquatic Plants Checklist in Project Area

Local Name	Scientific Name	Occurrence (O)	Trend (T)
Araguji	*Acanthus illicifolis*		
Choto pana	Echhornia crassipes		
Dhol Kolmi	*Ipomoea fistulosa*		
Helencha	*Alternanthera philoxeroides*		
Jal Padma	*Nelumbo nucifera*		
Jhanjhe	*Utricularia stellaris*		
Kachuripana	*Echhornia crassipes*		
Kalmi	*Ipomoea reptans*		
Keshardam	*Ludwigia adscendes*		
Khudi pana	*Lemna minor*		
Malancha	*Alternanthera sp.*		
Pani Singara	*Trapa bisppinosa*		
Shalook	*Nymphaea nouchali*		
Shapla	*Nymphaea nucifera*		
Chechu/Chachra	*Scirpus articulatus*		
Sheola	*Vallisnaria spiralis*		
Others (name)			

Occurrence (O)	**Trend (T)**
1= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4= Very Rare (Not Found now)	NA=Not Applicable

4f: Amphabians Checklist in Project Area

Local Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Kuno Bang/Asian common toad	কুনো ব্যাঙ	*Bufo melanostictus*		
Kotkoti Bang	কটকটি ব্যাঙ	*Euphlyctis cyanophlyctis*		
Sona Bang	সোনা ব্যাঙ	*Hoplobatrachus tigerinus*		
Green Frog	সবুজ ব্যাঙ	*Euphlyctis Hexadactylus*		
Gecho Bang	গেছো ব্যাঙ	*Rana taipehensis*		
Skipper Frog	স্কিপার ব্যাঙ	*Euphlyctis canophlyctis*		
Large tree frog	বড় ব্যাঙ	*Rhacophorus maximus*		
Jhi Jhi Bang	জি জি ব্যাঙ	*Limnoectes limnocharis*		

Occurrence (O)	**Trend (T)**
1= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4= Very Rare (Not Found now)	N=Not Applicable

4g: Mammals Checklist in Project Area

Local Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Badami Kathbirali	বাদামি কাঠবিড়ালি	*Callosciurus pygerythrus*		
Rangchita Badur	রংচিত্রা বাদুর	*Pipistrellus ceylonicus*		
Flying fox	ফায়িং ফক্স	*Pteropus giganteus*		
Horse shoe bat	হর্সসো বাদুর	*Rhinolophus lepidus*		
Pata mukho badur	পাটা মুখ বাদুর	*Coelops frithii*		
Bocha banur	বোচা বানর	*Pipistrellus coromandra*		
Ban Biral/Jungle Cat	বন বিড়াল	*Felis chaus*		
Mecho Biral	মেছো বিড়াল			
Bara Beji	বেড়া বেজি	*H. edwardsi*		
Beji	বেজি	*Herpestes auropunctatus*		
Bara Indur	বড় ইদুর	*Bandicota bengalensis*		
Chamchika	চামচিকা	*Megadernma lyra*		
Chika	চিকা	*Suncus etruscus*		
Dora Kathbirali	ডোরা কাঠবিড়ালী	*Funambulus palmarum*		
Gandho Gokul	গন্ধ গোকুল	*Paradoxarus hermaphroditus*		
Gecho Chika	গেছো চিকা	*Tupaia glis*		
Khargosh	খড়গোস	*Lepus nigricollis*		
Khatash	খাটাস	*Viverricula indica*		
Khek Shial	খেক শিয়াল	*Vulpes bengalensis*		
Pati Shial	পাতি শিয়াল	*Caris aureus*		
Kola Badur	কালো বিড়াল	*Riusettus leschennautti*		
Metho Indur	মেটো ইদুর	*Mus booduga*		
Nengti Indur	নেংটি ইদুর	*Mus musculus*		
Sajaru	দেশী সজারু	Hystrix indica		
Shushuk/River Dolphin	গঙ্গা নদী শুশুক	*Platanista gangetica*		
Others (name)				

Occurrence (O)
1= Common
2=Fairly Common
3= Rare
4= Very Rare (Not Found now)

Trend (T)
I= Increasing
D= Decreasing
U= Unchanged
NA=Not Applicable

4h: Birds Checklist in Project Area

Local Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Babui	বাবুই	*Ploceus philippinus*		
Baj	বাজ	*Aviceda jerdoni*		
Bharat Pakhi	ভারত পাখি	*Alauda gulgula*		
Bhat Shalik	ভাত শালিক	*Acridotheres tristis*		
Bhutum Pencha	ভুতুম পেচা	*B. bengalensis*		
Bulbuli	বুলবুলি	*Pycnonotus cafer*		
Charui	চড়ুই	*Passer domesticus*		
Chatak	চাতক	*Cacomantis merulinus*		
Cheena Bok	চিনা বক	*Ardeola bacchus*		
Chil	চিল	*Milvus migrans*		
Chikhgelo Pakhi	চোখগেলো পাখি	*Hierococcyx varius*		
Choto Fingey	ছোট ফিংগে	*D. aeneus*		
Dahuk	ডাউক	*Amaurornis akool*		
Dar Kak/Jungle crow	দাড়কাক	*Corvus macrorhynchos*		
Dhushor Bok	ধূসর বক	*Ardea cinerea*		
Doel	দোয়েল	*Copsychus saularis*		
Fatikjal/Common Iora	ফটিকজল	*Aegithina tiphia*		
Fingey	ফিংগে	*Dicrurus macrocercus*		
Gangchil	গাংচিল	*Gelochelidon nilotica*		
Ghughu (grey)	বাদামী ঘুঘু	*Streptopelia senegalensis*		
Ghughu (Spotted)	তিলা ঘুঘু	*Spilopelia chinensis*		
Gobrey Shalik	গোবরে শালিখ	*Sturnus contra*		
Hargila	হাড়গিলা	*Leptoptilos dubius*		
Harial	হাড়িয়াল	*Treron sphenura*		
Harichacha	হাড়িচাচা	*Dendrocitta vagabunda*		
Holdey Pakhi	হলদে পাখি	*Oriolus xanthornus*		
Hot-titi	হলদেগাল টিটি	*Vanellus malabaricus*		
Jalali Kobutar	জালালি কবুতর	*Columba livia*		
Kalim	কালিম	*Porphyrio porphyrio*		
Kalo Shalik	কালো শালিক	*Aplonis panayensis*		
Kana Bok	কানা বক	*Ardeola gragii*		
Kaththokra	কাঠঠোকরা	*Dinopium benghalense*		
Kokil	কোকিল	*Eudynamys scolopacea*		
Kura	কূড়া	*Gallicrex cinerea*		
Lejnachani	লেজনাচানী	*Rhipidura aureola*		
Maachranga	মাছরাঙ্গা	*Halcyon smyrnensis*		
Manikjor	মানিকজোর	*Ciconia episcopus*		

Local Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Modontak/Lesser Adjutant	মদনটাক	*Leptoptilos javanicus*		
Munia	মুনিয়া	*Lenchura striata*		
Pan Kauri	পান কৈরী	*Rynchops albicollis*		
Papiya	পাপিয়া	*Clamator jacobinus*		
Pati Kak	পাতিকাক	*Carvus splendens*		
Pencha/Owl	পেচা	*Bubo nipalensis*		
Ratchara/Kanakua	রাতচারা	*Caprimulgus macrurus*		
Sada Bok	সাদা বক	*Ardea insignis*		
Satbhai	সাতভাই	*Pellorneum albiventre*		
Shankho Chil	শঙ্খ চিল	*Haliastar Indus*		
Shyama	শ্যামা	*Copsychus malabaricus*		
Tia	টিয়া	*Psittacula krameri*		
Titir	তিতির	*Francolinus pondicerianus*		
Tota	তোতা	*Psittacula alexandri*		
Tuntuni	টুনটুনি	*Orthotomus sutorius*		
Others (name)				

Occurrence (O)
1= Common
2=Fairly Common
3= Rare
4= Very Rare (Not Found now)

Trend (T)
I= Increasing
D= Decreasing
U= Unchanged
N=Not Applicable

4i: Fishes Checklist in Project Area

Local Name	English Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Rui	Rohu	রুই	*Labeo rohita*		
Katla	Catla	কাতলা	*Catla catla*		
Mrigel	Mrigal	মৃগাল	*Cirrhinus mrigala*		
Tilapia	Tilapia	নাইলটিকা	Oreochromis niloticus		
Commonr Carp	Common Carp	কার্পিও	*Cyprinus caprio*		
Thai sarputi	Thai sarputi	থাই সরপুটি	*Barbonymus gonionotus*		
Grass Carp	Grass Carp	গ্রাস কার্প	*Ctenopharyngodon idella*		
Silver Carp	Silver Carp	সিলভার কার্প	*Hypophthhalmichthys nobilis*		
Thai pangas	Thai pangas	থাই পাঙ্গাস	*Pangasianodon hypohthalmus*		
Pabda	Pabo Catfish	মধু পাবদা	*Ompok pabo*		
African Magur	North African catfish	আফ্রিকান মাগুর	*Clarius gariepinus*		
Ayre/Aor	Longwhiskered Carfish	আইড়	*Aorichthys aor*		
Gang magur	Gray eel-catfish	গাং মাগুর	Plotosus canius		
Bamosh/Kunche	Bengal Mudeel/Pygmy Eel	বামস	*Ophisternon bengalense*		
Bamosh, Bao Baim	Indian Moltted Eel	বড় বাইম	*Anguila bergalensis*		
Along/Sephatia	Bengal Barb	ইলংগা	*Bengala elanga*		
Bacha	River catfish	বাচা	*Eutropiichthys vacha*		
Bele/Bailla	Tank Goby	বেলে	*Glossogobius giuris*		
Batashi	Indian Potasi	বাতাসী/পাতাসী	*Pseudeutropius atherinoides*		
Bheda	Mud Perch	মেনি	*Nandus nandus*		
Boal	Freshwater Shark	বোয়াল	*Wallago attu*		
Boali/Kani Pabda	Indian Buttercatfish	কানি পাবদা	*Ompok bimaculatus*		
Chanda	Himalayan Glassy Perchlet	চান্দা	*Pseudambassis baculis*		
Chapila	Indian River Shad	চাপিলা	*Gudusia chapra*		
Chela	Large razorbelly minnow	চেলা	*Salmophasia bacaila*		
Chela	Silver Razorbelly Minnow	চেলা	*Salmophasia acinaces*		
Chhep Chela	Silver Hatchet fish	হেটচেট মাছ	*Chela cachius*		

Local Name	English Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Chital	Humped Featherback	চিতল	*Chitala chitala*		
Chanda	Indian galssy fish	রাঙ্গাচান্দা	*Psudambassis ranga*		
Chuchra	Sunset Gourami	চুনা খইলশা	*Trichogaster chuna*		
Darkina	Slender Rasbora	দারকিনা	*Rasbora daniconius*		
Darkina	Flying barb	দারকিনা	*Esomus danricus*		
Dhela	Cotio	কেটি	*Osteobrama cotio*		
Gajar/Gajal	Giant Snakehead	গজার মাছ	*Channa marulius*		
Ghaura	Garua Bacha	গাওড়া	*Clupisoma garua*		
Gonia	Kuria Labeo	গনিয়া	*Labeo gonius*		
Guchibaim	Barred spiny eel	পাংকাল বাইম	*Macrognathus pancalus*		
Guizza/Guizza Ayer	Giant Rivercatfish	আইড়	*Sperate seenghala*		
Bagha air	giant devil catfish	দানব বাঘাআইড়	*Bagarius yarrellii*		
Kaikla	Freshwatr Garfish	কাকিলা	*Xenentodon cancila*		
Napit Koi	Dwarf Chameleonfish	নাপিত কই	*Badis badis*		
Kalibaus	Kalbasu	কালিবাউস	*Labeo calbusa*		
Kanchki	Ganga Riversprat	কাচকি	*Corica soborna*		
Bata	Giantscale Mullet	বাটা	*Liza melinoptera*		
Khailsha	Stripled Gourami	খলিশা	*Colisa fasciatus*		
Khorul Bata	Corsula Mullet	খরশোলা	*Rhinomugil corsula*		
Koi	Climbing Perch	কৈ	*Anabas testudineus*		
Cuchia	Gangetic Mudeel	কুচিয়া	*Monopterus cuchia*		
Magur	Magur	মাগুর	*Clarias batrachus*		
Mola	Indian Carplet	মলা	*Amblypharyngodon mola*		
Tengra/Golsha-tengra	Day's Mystus	টেংরা	*Mystus bleekeri*		
Phasa	Anchovy	ফাসা	*Setipinna phasa*		
Pholoi	Grey Featherback	কানলা	*Notopterus notopterus*		
Potka	Green Pufferfish		*Chelonodon fluviatilis*		
Pungas	Pungas	পাঙ্গাস	*Pangasius pangasius*		
Punti	Spotfin Barb	পুটি	*Puntius sophore*		
Rita	Rita	রিটা	*Rita rita*		
Shail Bain	Zig-zag-eel	বাইম	*Mastacembelus armatus*		
Shilong	Silondia	শিলং	*Silonia silondia*		

Local Name	English Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Shoal	Striped Snakehead	শোল মাছ	*Channa striatus*		
Singh	Stinging Catfish	শিং মাছ	*Heteropneustes fossilis*		
Swar Punti	Olive Barb	সরপুটি	*Puntius sarana*		
Taki	Spotted Snakehead	টাকি	*Channa punctatus*		
Tara Baim	Lesser Spiny eel	তারাবাইম	*Macrognathus aculeatus*		
Tatkini/Bata	Reba Carp	রায়েক	*Cirrhinus reba*		
Tel Taki	Asiatic Snakehead	গাছুয়া	*Channa orientalis*		
Tit Punti	Ticto barb	তিত পুটি	*Puntis ticto*		
Ranga Chanda	Indian Glassy Fish	লাল চান্দা	*Pseudambassis ranga*		
Ilish/Ilsha	Hilsa	ইলিশ	*Tenualosa ilisha*		
Tengra	Striped dwarf catfish	টেংরা	*Mystus vittatus*		
Kajuli	Gangetic ailia	কাজুলী	*Ailia coila*		
Lomba Chanda	Elongate glass perchlet	লম্বা চান্দা	*Chanda nama*		
Batashi tengra	Tista Batasio	বাতাসি টেংরা	*Batasio batasio*		
Naftani	Frail gourami	নাফতানি	*Ctenops nobilis*		
Gang tengra	Gangetic gagata	গাং টেংরা	*Gagata gagata*		
Bata	Bata	বাটা	*Labeo bata*		
Gutum	Annandale loach	গুতুম	*Lepidocephalichthys annandalei*		
Puiya	Burmese loach	পুইয়া	*Lepidocephalichthys berdmorei*		
Gutum	Guntea loach	গুতুম	*Lepidocephalichthys guntea*		
Tor Mohasheer	Tor barb	টর মহাশের	*Tor tor*		
Bagha air	Goonch	বাঘাআইড়	Bagarius bagarius		
Others (name)					

Occurrence (O)
1= Common
2=Fairly Common
3= Rare
4= Not Found now

Trend (T)
I= Increasing
D= Decreasing
U= Unchanged
NA=Not Applicable

4j: Reptiles Checklist in Project Area

Local Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Striped grass skink	স্ট্রিপ গ্রাস সাইন্ক/আচিল	*Mabuya dissimilis*		
Common vine snake	লাউডগা সাপ/ডারাস	*Ahaetulla nasuta*		
Indian Rat snake/darash	ডারাস	*Ptyas mucosus*		
Dudhraj, common trinket snake	দুধরাজ	*Elaphe Helena*		
Diard's blindsnake	ববখন্ত্ম সাপ	*Typhlops diardii*		
Dora shap/ Buff Striped keel back	দোড়া সাপ	*Amphiesma stolata*		
Gharmani Shap	ঘরমানি	*Lycodon aulicus*		
Indian Wolf Snake, Ghargini Shap	ঘরগিনি	*Lycodon aulicus,*		
Checkered Keelback , Dora shap	ডোরা সাপ	*Xenochrophis piscator*		
Gokhra Shap/monocellate Cobra	কেউটে সাপ	*Naja kaouthia*		
Raj Goghra, King cobra	রাজ গোখরা/শঙ্খচূড়	*Ophiophagus hannah*		
Venomous Pit vipers		*Trimeresurus albolabris*		
Russell's viper, Chandrabora	চন্দ্রবোড়া বা উলুবোড়া	*Daboia russellii*		
Kalnagini, ornate flying snake	কাল নাগিনী	*Chrysopelea ornata*		
Gui shap/Clouded monitor	গুই সাপ	*Varanus nebulosus*		
Holdey Gui Shap/yellow monitor	হলদে গুই সাপ	*Varanus flavescens*		
Jalbora Shap/water snake	জলবোরা সাপ	*Cerberus rynchops*		
Kal Keotey/ Indian Krait	শাখামুঠি	*Bungarus caeruleus*		
Maitta Shap/Split keelback	মাইট্টা সাপ	*Atretium schistosum*		
Original garden lizard	বাগানের গিরগিটি	*Calotes versicolor*		
Tiktiki/spotted house gecko	টিকটিকি	*Hemidactylus brookii*		
Tokkhak/Tokay gecko	তড়াক	*Gekko gecko*		
Flying lizard	উরন্ত্ম লিজার্ড	*Draco blanfordii*		
Forest lizard	ফরেস্ট লিজার্ড	*Calotes jerdoni*		

Local Name	Local Name	Scientific Name	Occurrence (O)	Trend (T)
Bengal monitor, Gui shap	গুইসাপ	*Varanus bengalensis*		
Yellow Tortoise/Elongated Tortoise	হলুদ পাহাড়ি কচ্ছপ	*Indotestudo elongata*		
Asian forest tortoise	এশীয় শিলা কচ্ছপ	*Manouria emys*		
Black Pond Turtle	কালা চিত্রা দীঘি কাইট্টা	*Geoclemys hamiltonii*		
Three-striped Roof Turtle	ত্রিরেখা ডিবা কাইট্টা	*Batagur dhongoka*		
Red-crowned Roofed Turtle	লাল-মুকুটি কড়ি কাইট্টা	*Batagur kachuga*		
Indian Roofed turtle	দেশি কড়ি কাইট্টা	*Pangshura tecta*		
Brahminy River Turtle	মুকুটি নদ-কাছিম	*Hardella thurjii*		

Occurrence (O)	**Trend (T)**
1= Common	I= Increasing
2=Fairly Common	D= Decreasing
3= Rare	U= Unchanged
4= Very Rare (Not Found now)	NA=Not Applicable

Scientific paper (Submitted to Journal):

Securing livelihoods through pond fisheries management in climate change scenario: Evidence from *haor* region of Bangladesh

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Authors' Contributions

This work was carried out as a collaborative research of all authors. All authors designed the study, performed the analysis, wrote the protocol and wrote the first draft of the manuscript. The authors managed the analysis of the study. All authors read and approved the final manuscript.

ABSTRACT

Aims: To identify the potential environmental impacts and influence of climate change on the pond fishery in *haor* region and impact of exotic species on the indigenous species through aquaculture.

Study Design: An investigation on the influence of the pond fishery approach to determine whether the approach is successful with respect to the climate change impacts in the *haor* area.

Place and Duration of Study: The study sites are located in five *haor* districts in Bangladesh for a period of one-year (May 2018 – April 2019) covering HILIP working area.

Methodology: The study includes collection and analyses of both quantitative and qualitative data. For quantitative study, 92 sample households in 58 unions of 28 upazilas (sub-districts) in five project districts were randomly selected. Fish catch data, including information on species composition, production and sale were collected from perennial and seasonal ponds. The qualitative primary data obtained through in-depth interviews, key informants interviews and focus group discussions have been used in this paper.

Results: Fish production was found to be better at perennial ponds, but not significantly more than that in the seasonal ponds. However, biodiversity was found to be better in seasonal ponds and greater than that in the perennial ponds. The findings clearly support the observation that pond fish culture is an attractive activity for *haor* people, especially those who are able to run both perennial and seasonal ponds and manage minimum feeding requirements, maintain those and market the outputs effectively. The present study fills gaps in existing knowledge of fish pond culture diffusion in *haor* region of Bangladesh.

Conclusions: Pond fishery appears to perform better so, aquaculture production would mitigate some lost capture fisheries in the *haor* area of Bangladesh. Existing cultural practices could support experimentation and learning under future initiatives in the *haor* area. Pond fishery in the *haor* area

mainly has an income-generating feature and less probability of being affected by climate change impacts. However, future initiatives should emphasize on culturing fish, which has the potential of balancing the *haor* ecosystem.

Keywords: *Haor*, Climate change, Perennial pond, Seasonal pond, Species composition

1. INTRODUCTION

The hydrology and topography of the Meghna Basin have led to the development of *haor* ecosystem in the upper Meghna Basin. *Haor*s are low-lying, marshy depressions that turn into a vast expanse of water during the monsoon [1]. Water of the *haor*s recedes as the monsoon rains taper down, providing fresh nutrient rich lands for seasonal cultivation including aquaculture. Bangladesh is a country of vast *haor* resources covering an area of about 1.99 million hectares (19,998 sq. km) with a human population of about 19.37 million [2]. Bangladesh is characterized by a tropical monsoon climate with significant variations in rainfall and temperature throughout the country. There are four main seasons in Bangladesh: i) the pre-monsoon during March through May, which has the highest temperatures and experiences the maximum intensity of cyclonic storms; ii) the monsoon from June through September, when the bulk of rainfall occurs; iii) the post-monsoon during October through November which, like the pre-monsoon season, is marked by tropical cyclones on the coast and iv) the cool and sunny dry season from December through February [1].

In 2016, global fish and shellfish production reached a record 171 million tons and employed around 200 million people either directly or indirectly [3]. The quantity of finfish and shellfish used for direct consumption from aquaculture has surpassed that from wild fisheries and this gap is expected to widen as aquaculture continues to expand [3].

In 2016-17, Bangladesh fish and shellfish production reached a record 4.13 million tons and more than 11% of the total population of Bangladesh is employed either directly or indirectly in the fishery [4](DoF 2017). This sector is contributing significantly to food security through providing safe and quality animal protein; almost 60% animal protein comes from fish. The *haor* fisheries of Bangladesh support the livelihoods of millions of poor people, but landings and species diversity are believed to be declining because of high rates of exploitation and habitat degradation [5].

Bangladesh is extremely vulnerable to climate change impacts because of its geographical location, high population density, high levels of poverty and reliance of many households on, particularly, fisheries and agriculture. These impacts fall more heavily on the poor fisher and farmer communities. This is due to high influence of monsoon, too much water in the monsoon and too little water in the dry season. These have significant impacts on fish stocks in the rivers and wetlands. Besides, water management puts more difficulties towards the coping with climate change, especially, where riverbank erosion is threatening the embankments in addition.

Bangladesh has always been vulnerable to climate changes and the climate of the country is strongly influenced by the monsoon. Accurate information about the climate change situation at the national or sub national level is limited in the *haor* areas. Bangladesh is expected to experience an increase in mean annual temperature over the next century. The Implications of these climate change scenarios are that about 18% of current lowly flooded areas will be susceptible to higher levels of flooding, while 12-16% new areas will be at risk to inundation. This will increase the risk of estuarine salinity as well as inland

water fisheries. Bangladesh' freshwater resources are at most risk from droughts and drainage congestion as well as lower dry season trans-boundary flows. Located on the floodplains of three major rivers, fed by an annual monsoon, Bangladesh is also under risk of more severe floods and cyclones. Backwater effect is pronounced in Bangladesh, particularly in the Meghna River Estuary, through which about 90% of the river water in the country discharges into the Bay of Bengal. It is important during the flood seasons. Acute situations are likely to occur all along the coastal area of Bangladesh, thus making the situation even worse. Simultaneously, increasing river morphological activities have resulted in erosion and loss of land at some locations and sedimentation at other places. Sedimentation and drainage congestion is hampering the withdrawal/flow out of the water from flooded areas, thus increasing the period of inundation.

Climate change (CC), particularly global warming, is having a demonstrable effect on the distribution and regional productivity of both terrestrial and aquatic organisms [6]. The projected effects of climate change on aquatic habitats and species, although fraught with uncertainty [7] are particularly relevant to society because of the importance of finfish and shellfish to food security, cultural heritage and/or the economics of dependent human communities [8], [9], [10], [11], [12].

In fact, Bangladesh has a couple of projects aiming at addressing climate change. However, none of those projects have any objective on fish stocks and the vulnerability of poor fisher's livelihoods, especially, those who heavily depend on fisheries and aquatic resources. Bangladesh *haor* pond aquaculture has ample scope of development to strengthen the national economy. HILIP-LGED has been involved in *haor* pond aquaculture not for the sake of aquaculture production increases alone; rather its goal has been to improve the socio-economic position and physical well-being of poor farmers involved in pond fishery. HILIP has been working within *haor* area by building the capacity of poor farmers with a view to improving the quality and quantity of their pond production.

In the recent years, small-scale floodplain aquaculture has become popular and is contributing, significantly, to country's total fish production. However, mass mortality of fishes in nature is not especially rare, but most often the phenomenon develops so unexpectedly that no biologist is on hand to trace its course or to identify the cause, except by inference [13].

The major challenges of this fast growing sector include –

- Depletion brood stock of potential species
- Scarcity of good quality fry and larvae
- Expansion of good aquaculture practices for ensuring food safety
- Climate change impacts on fisheries and aquaculture
- Gradual resource depletion of fishes in inland open water sector
- Increasing water logging, blocking migratory routes of many fish species

2. MATERIALS AND METHODS

2.1 Study Area

The study area comprises five *haor* districts namely Netrokona, Sunamganj, Habiganj, Kishoreganj and Brahmanbaria in the North-Eastern Bangladesh, wherein lies 165 unions under 28 upazilas (sub-districts).

The waters of these five districts are hydrologically connected and function as a unique ecosystem (Figure 1). The study has purposefully selected all five districts covering 28 upazilas (Table 1). Thereafter, a total of 92 *haor* ponds have been selected in 58 unions randomly. Two unions were randomly selected from each upazila and the ponds were distributed within the selected unions. The study employed data collection from June 2018 to April 2019. Status of *haor* ponds was examined in three ways. Firstly, the production from pond fishery was estimated by using data from household survey; secondly, by conducting Focus Group Discussions (FGDs) at upazila level with the help of a checklist and finally, by Key Informant Interviews (KIIs) at district level with the help of a KII checklist.

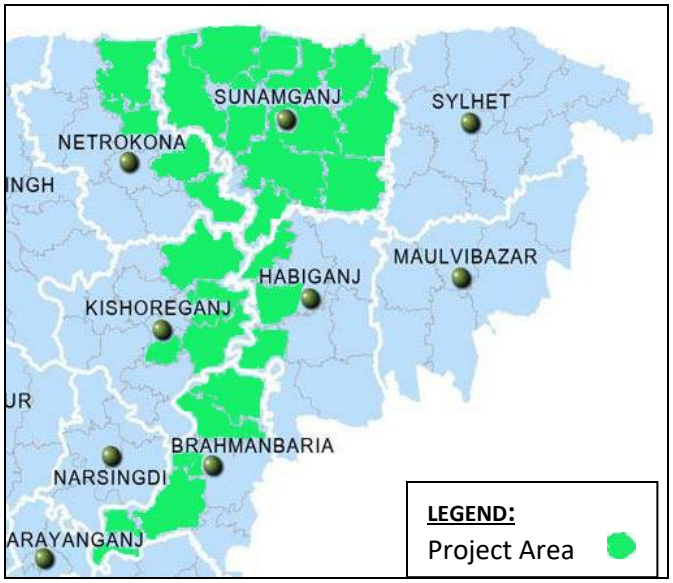

Fig. 1: Study Area Shown on Bangladesh Map

Table 1: List of Upazilas covered under HILIP.

Division	District	Name of Upazilas
Mymensingh	Netrokona	Khaliajuri, Kolmakanda, Madon, Mohanganj
Sylhet	Sunamganj	Sunamganj Sadar, DakshinSunamganj, Dherai, Bishwambarpur, Tahirpur, Jamalganj, Sulla, Dowarabazar, Dharmapasha, Chhatak, Jagannathpur
	Habiganj	Azmiriganj, Lakhai, Baniachong
Dhaka	Kishoreganj	Itna, Mithamoin, Astagram, Nikli
Chittagong	Brahmanbaria	Nasirnagar, Nabinagar, Sarail, Ashuganj, Brahmanbaria Sadar, Bancharampur

2.2 Data Collection

Source of data: Both primary and secondary data are used for the study. Primary data were collected through the survey using random sampling method (questionnaire, IDI - In Depth Interview) from four (4) upazilas in Netrokona, nine (9) upazilas in Sunamganj, four (4) upazilas in Kishoreganj, three (3)

upazilas in Habiganj and six (6) upazilas in Brahmanbaria. In addition, Focus Group Discussions (FGDs) were held in 28 upazilas and Key Informant Interviews (KIIs) held with policy planning and implementation personnel in five districts (DoF, HILIP and WorldFish). Besides, reviews of published articles, government websites and policy documents were conducted to gather information on the local issues and initiatives in the *haor* areas. Collected data have been stored using MS-Access and MS-Excel. Data and information have been analyzed using SPSS and other software.

Data collection method: Primary data from household respondents were collected using questionnaire interview and in Depth Interviews (IDIs), Focus Group Discussions (FGDs) and cross-check interviews with Key Informants. The interview schedule was developed in a logical sequence, so that local people and pond owners could answer, systematically. The questionnaire, interviews were conducted during the study period at the households in five districts to the randomly selected 13 pond owners in 7 unions of Netrokona, 34 pond owners in 25 unions of Sunamganj, 14 pond owners in 7 unions of Kishoreganj, 9 pond owners in 7 unions of Habiganj and 22 pond owners in 11 unions of Brahmanbaria. A total of 28 FGD sessions was conducted, where each group size of FGD was 10 to 16 participants. After collecting data through questionnaire, interviews (IDIs) and FDGs, cross-check interview were conducted with key informants at their offices.

2.3 Data Analysis

Mainly descriptive statistics were employed in analyzing the data. The collected data were verified to eliminate errors and inconsistencies. Any kind of inconsistency in the collected data was searched and avoided from the relevant data. The data were entered into the computer using MS Excel (Microsoft Excel) and analyzed using SPSS (Statistical Package for Social Science) by tabular and graphical method to attain the objectives of the study.

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristic of Pond Owners

The average sizes of the sampled households were 5.73, 5.57, 5.62, 6.89 and 5.38 in Brahmanbaria, Kishoreganj, Netrokona, Habiganj and Sunamganj districts respectively. The overall size of sampled households was 5.67, which was higher than the national average of 4.06 [14]. Population per household was found highest in Habiganj (6.89). However, national statistics reveal that household size is highest in Sunamganj, Habiganj and Brahmanbaria districts (5.29-5.86) and higher in Netrokona and Kishoreganj districts (4.85-5.28) [15]. Table 2 shows the demographic characteristic of sampled households, i.e. pond owners' household and distribution of males and females. The distribution shows that in these fish farming households there are 118 males for every 100 females.

Table 2: District wise distribution of household members according sex and family size

Demographic characteristics	B. Baria	Kishoregonj	Netrokona	Habiganj	Sunamganj	All districts
Total sampled household	22	14	13	9	34	N=92
Male	69	40	42	36	96	283
Female	57	38	31	26	87	239
Total population	126	78	73	62	183	522
Population per household	5.73	5.57	5.62	6.89	5.38	5.67

3.2 Main Occupation of Pond Owners

Respondents at households were asked to describe their main occupations and income from different sources prior to the IDIs. The main occupation was found to be fish culture and 64% of households were occupied with it. However, agriculture, business, fish trading, service, skilled labour sale, pottery, and fishing comprised occupation of about 34% households. Besides 2% households reveals dependents and students. **Figure 2** shows details status of main occupation of pond owner's.

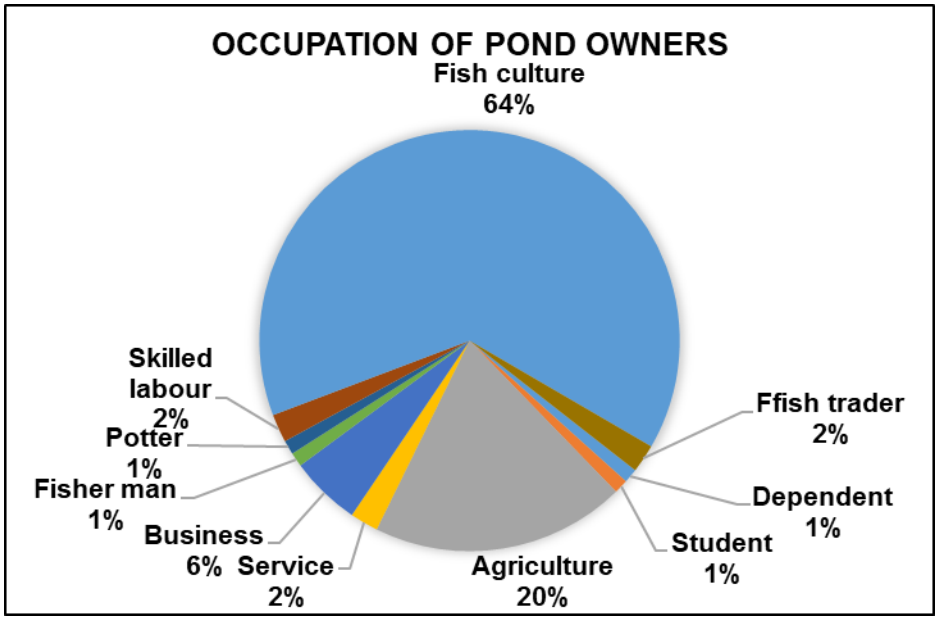

Figure 2: Main occupation of Pond owner's in HILIP sites

3.3 Status of Perennial and Seasonal Ponds

In *haor* areas, fish are cultivated in both perennial and seasonal ponds to meet the demand of present food supply of the area as well as of the country. The optimum production of fish per hectare in fishponds is vital for benefitting the farmers. Fish production in *haor* ponds (perennials and seasonal) remains vital in providing food, income and employment opportunities for millions of poor people. Recently, Bangladesh's aquaculture sector has developed rapidly; consequently, the production and system diversity continue to grow. Many people regard aquaculture as the most realistic way to secure the fish supply needs. Besides, production techniques are well established: inputs such as seed and feed are widely available.

Present study determines the average area (decimal) of both perennial and seasonal ponds and it reveals that the average area of perennial ponds in Brahmanbaria, Kishoreganj, Habiganj, Sunamganj and Netrokona districts are 79, 71, 42, 34.5 and 71 decimals respectively. Simultaneously, the average of

area of seasonal ponds are found to be 43.6, 80, 92, 54.1 and 42.4 decimals in Brahmanbaria, Kishoreganj, Habiganj, Sunamganj and Netrokona districts respectively. Maximum perennial pond area (decimal) was found in Brahmanbaria district and minimum pond area in Sunamganj district. Besides, maximum seasonal pond area was found in Habiganj district and minimum pond area in Netrokona district.

Typical fish production yields from perennial pond aquaculture are between 23.2 and 30.3 Kg/decimal compared to fish yields of 12.6 – 26.8 kg/decimal from seasonal pond aquaculture. *Haor* ponds yields are comprised of both exotic and indigenous fish species. Besides, a small percentage, (usually 8% in Perennial ponds and 15% in seasonal ponds) of the total catch weight is made up of indigenous *haor* fish species. Pond fish culture in seasonal ponds shows a maximal production in Kishoreganj district and minimal production in Brahmanbaria District. Fish culture in perennial ponds shows maximum production also in Kishoreganj district and minimal production in Netrokona district. Figure 3 shows the average production (Kg/decimal) of both perennial and seasonal ponds in the study areas.

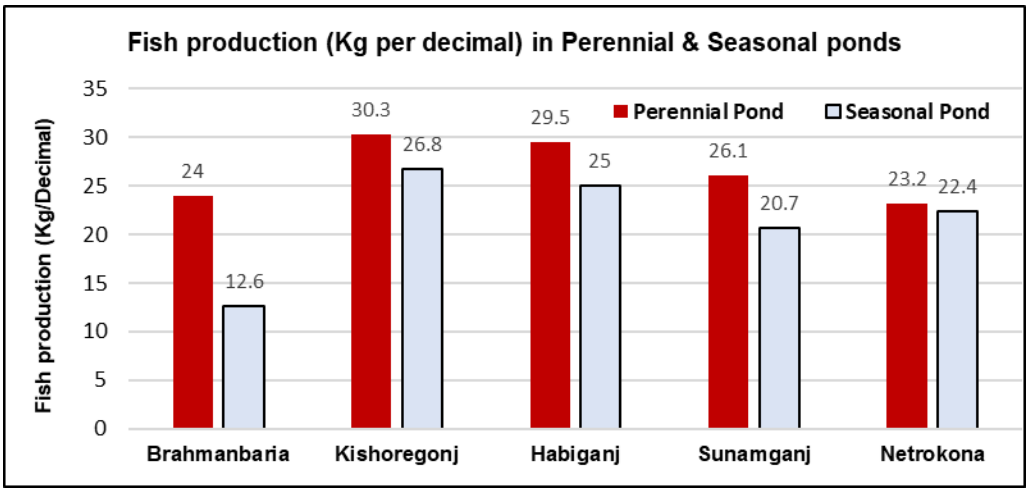

Figure 3: Average fish production (Kg/decimal) in Perennial and Seasonal ponds

3.3 Assessment of Impact of Pond Fish Culture

Local economies can gain significantly from both direct benefits of *haor* pond aquaculture activities, (i.e. increased production, profits, incomes, etc.) and indirect benefits of employment and service provision linkages created by the aquaculture activities. The average fish price (per Kg) from perennial pond aquaculture are between Tk. 97 and Tk. 123 per Kg compared to fish price (per Kg) of Tk. 106 – 172 per Kg from seasonal pond aquaculture. Using available information on cost and benefit the study reveals that pond fish farming provided an acceptable benefit in both perennial and seasonal ponds. The average benefit per decimal per year from perennial ponds varies between Tk. 1134 and Tk. 2113, and that from seasonal ponds varies between Tk. 1143 and Tk. 1664. Pond fish culture in perennial ponds shows least benefit in Netrokona District and highest benefit in Habiganj District. In contrast, pond fish

culture in seasonal ponds shows least benefit in Sunamganj District and most benefit in Habiganj District. Figure 4 shows a variety of benefits per decimal at different districts for both perennial and seasonal ponds.

Using cost benefit information for both perennial and seasonal ponds the study reveals that the maximum benefits from perennial and seasonal ponds were found to be Tk. 103,956 (US$ 1268) and Tk. 130,247 (US$ 1588) and, minimum benefits were found to be Tk. 40,377 (US$500) and Tk. 61,843 (US$ 754) respectively.

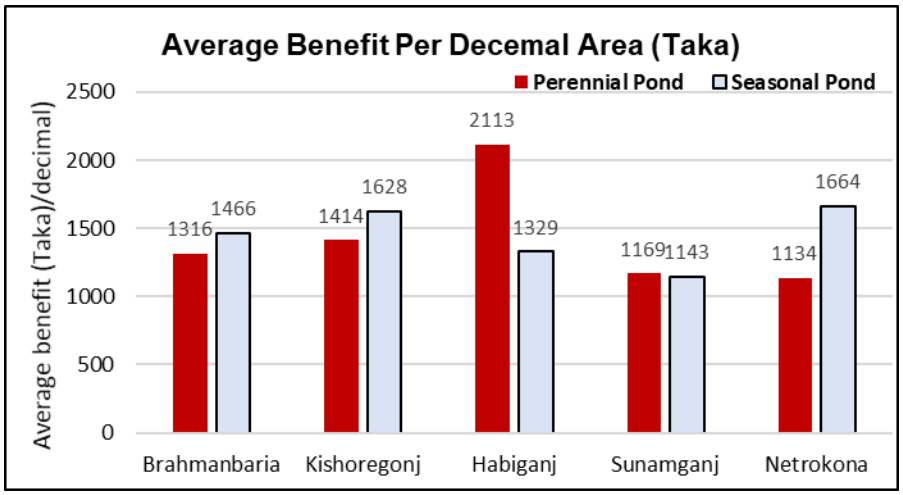

Figure 4: Average benefit (Taka) from fish culture at per decimal area

3.4 Assessment of Fish Culture: Impact of Exotic Species on Natural Fish Production

Haor pond aquaculture yields are mostly comprised of both indigenous and exotic fish species. The study area comprises exotic species, e.g., Tilapia, mono-sex Tilapia, Silver carp, Thai pangus, Common carp, Thai sarputi, Grass carp and most of these are available in culture fishery. Production in floodplains and *beels* has increased due to stocking with carp fingerlings, *Beel* nursery program and the strengthening of conservation measures. Besides, the production of *haor* pond fishery has gradually been increasing due to training provided through several projects, mostly HILIP and Climate Adaptation and Livelihoods Protection Project (CALIP) and stocking with carp fingerlings. Many inland aquaculture species used in Asia are exotic. Exotic fishes are those species of fish, which are not native and introduced from other countries to the local areas. Exotic animals are defined as “species occurring outside of its natural range”. Among the numerous reasons for the introduction of exotic aquatic animals into countries, aquaculture development is said to be a main motive [16].

Fish production yields from perennial ponds are comprised of 24% indigenous cultured fish, 68% exotic fish and 8% indigenous non-cultured fish. Fish production yields from seasonal ponds are comprised of 18% indigenous cultured fish, 67% exotic fish and 15% indigenous non-cultured fish**.** Overall fish production yields from both perennial and seasonal ponds are comprised of 22% native cultured fish,

67% exotic cultured fish and 11% indigenous non-cultured fish (Figure5).The predominance of 6-7exotic fish species are found in the *haor* ponds. Some of these species may pose a threat to indigenous biodiversity, through their escape and establishment of feral populations in adjacent *haor* water bodies.

Mola carplet (*Amblypharyngodon mola*) is a nutrient-rich small fish that provides essential nutrients, in particular, vitamin A, calcium, iron and zinc and used as food fish in Bangladesh. HILIP also introduced Mola carplet fish along with other natural indigenous species in *haor* ponds. Consequently, a good harvest of mola fish reveals successful HILIP intervention in both perennial and seasonal ponds. Overall, the mola comprised of about 1% and 2.88% in perennial and seasonal ponds respectively. However, in Sunamganj and Habiganj districts mola fish contributed 5.95% and 3.75% of production in seasonal and perennial ponds respectively. The mola culture has no adverse environmental impact and does not hamper existing fish. The mola fish culture has become popular among farmers in *haor* region in Bangladesh. This fish is available in the rivers, streams, beels and lakes and inundated fields throughout Bangladesh. However, there has been a decline in the areas of inland water and inundation that significantly reduced the vital habitat for its recruitment and stocking. The taxonomic group used in the catch analysis of the pond fishery and taxa contributed to each group (Native cultured fish, Exotic cultured fish and natural non-cultured fish) by % to the catches is given in Annexure 1.

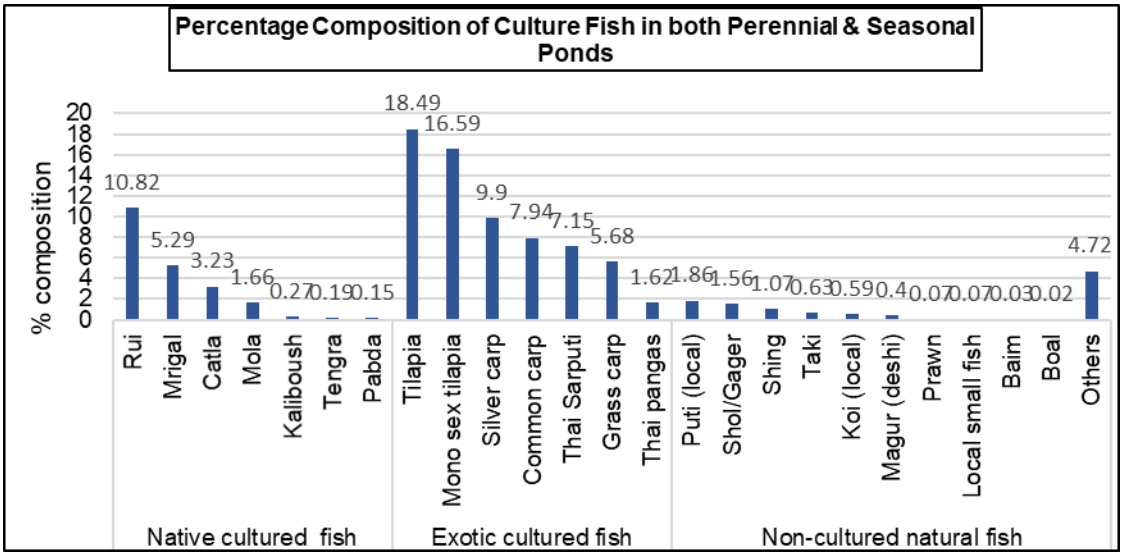

Figure 5: Overall Fish Production Yields from both Perennial and Seasonal Ponds

Empowerment of Women through Pond Fish Culture

Traditionally, Bangladeshi women have been involved in fish culture or fishing related activities, especially, it has been at the post-harvest stage of the production process. At the pond aquaculture level the skills and knowledge from training are still very much in evidence for men and much of the methodologies and protocols are being practiced [17]. However, *haor* pond aquaculture does create the situations for a diversification of their involvement, through the service provision opportunities, such as cleaning weeds, carrying soil up pond bank, pond cleaning, testing water quality (colour), applying fish

feed, fertilizer and lime and participating in the decision making process. In a perennial pond, women were observed having a more significant role in the process, either as pond culture operators or as household heads. In Depth Interviewed revealed that the *haor* pond culture has greatly enhanced their involvement in the pond culture leading to new economic opportunities.

Among various roles, feeding is vital for women and it has been revealed that 48% and 15% women are directly involved with feeding fish and mixing up feeds respectively. Besides, they are also involved with guarding, cleaning water hyacinth, examining water quality (colour) and looking after other related activities. During the dry season, post-harvest processing and management needs significant contribution of women in the *haor* area. Grading and drying are the most laborious but important economic post-harvest activities and it has been revealed that 76% and 11% women are directly involved with grading and fish drying respectively. Besides, they are also directly involved with cleaning the fish, maintaining accounts and helping during catching fish. The roles of women in overall pond fish culture and post-harvest management over the study area is shown in Figure 6.

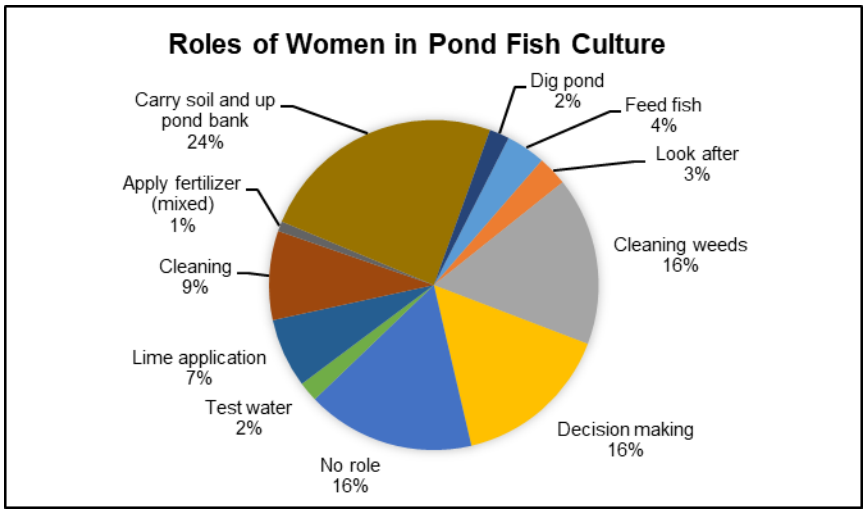

Figure 6: Overall Roles of Women in Pond Fish Culture

3.5 Environmental Impact

Impact of Flash Flood: *Haor* is a basin like structure where water remains either stagnant or in flash flooding condition during early monsoon. Flash flood damages Boro crop and pond aquaculture, so that the present study was conducted to know the impact of flash flood. Primary data were collected through IDIs from 92 pond owner households covering 28 upazilas. Most of the respondents were pond owners as well as farmers. Among the different categories of flood, flash flood damages the pond fishery most. Among the respondents, 23%, 28% and 20% revealed that it damaged, washed out fishes and destroyed banks of the pond respectively. Only 3% respondents revealed that ponds were submerged by flash flood. However, 26% respondents stated that no impact occurred on pond aquaculture due to flash flood. As flash flood often causes considerable, localized damage to pond fishery, particularly in the north, northeast part of the *haor* districts so, 26% respondents does not face

any impact on their perennial pond aquaculture. Flash flood is the common phenomena in the *haor* area and usually it damages pond fishery and create negative impacts on the local economy. Figure 7 shows the impact of flash flood on pond fish in the HILIP areas.

The *haor* area in Bangladesh is susceptible to flash flooding from water coming down hilly streams emerging out of Khasia- Jaintia Hills located in the Indian Territory. There are many *haor*s in Bangladesh, where remains either stagnant or in flash flooding condition during the months of June to November [18]. Flash floods occurring at intervals damage crops and flashes out fish in ponds into the *haor* area. Exotic species of fish cultured in ponds escape, quite often during a flash flood, to wide *haor* area, exposing the local species to be affected by these species.

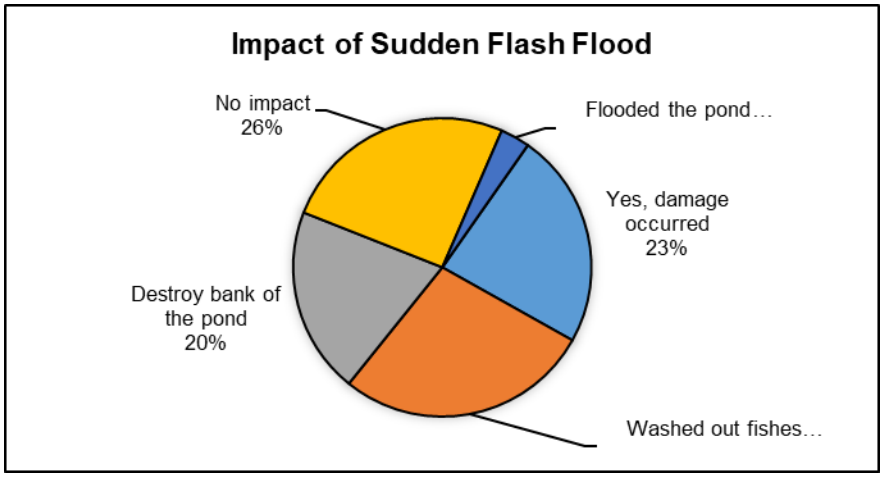

Figure 7: Communities' Perception on Sudden Flash Flood

3.5.1 Impact when Number of Fish Culture Ponds Increase

Haor area is very important for the production of fishes, especially open water fishes. However, recently pond aquaculture production, both perennial and seasonal has increased. Overall, 29% of the respondents, who make the major portion of pond fish culturist, said that no detrimental effect will occur, if pond fish culture is extended in the *haor* area. However, 22% respondents' reveals that this increased may affect local natural species of fishes and 21% respondents view that agricultural land will decrease if pond aquaculture increased in *haor* area. Besides 6% respondents, views that this might destroy the environmental balance and may cause of decrease water lily, which is very common in *haor* area in Bangladesh.

3.5.2 Impact when Cultured Fish Escape to *Haor* Water

According to the study, 67% of the respondents said that financial loss would occur when cultured fish escapes into *haor* water due to any environmental impact. However, 27% respondents reveal that no impact will occur. Besides, 8% respondents expressed that people will lose interest to fish culture. Figure 8 shows respondents' views regarding impacts if cultured fish escape to *haor* waters.

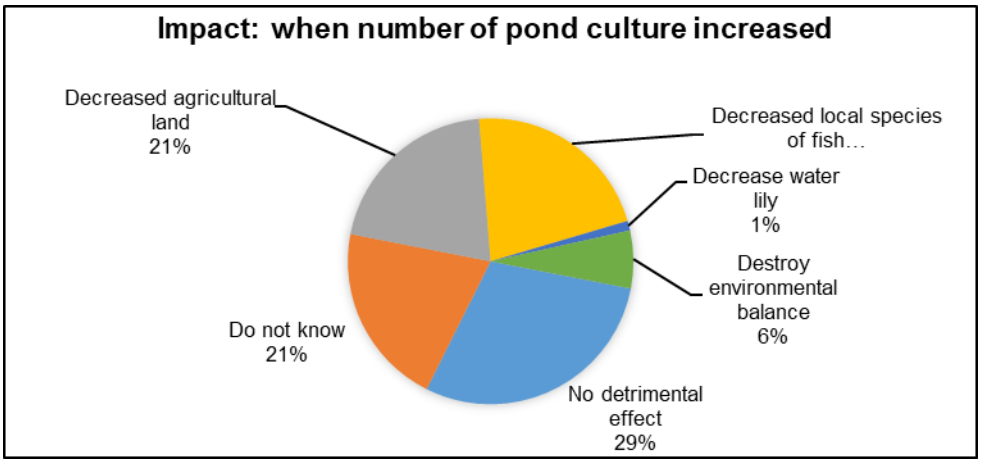

Figure 8: Communities' perception regarding impact of fish culture when number of pond increased

3.5.3 Impact on Pond Fish Culture – when Insecticide Applied in Agriculture

Aquaculture in general is highly sensitive to adverse environmental changes. According to the study, 45% respondents reveal that there will be no impact on pond aquaculture, if insecticides are applied to agricultural field. However, 22% respondents revealed that agricultural insecticide will reduce fish growth and about 22% respondents' viewed that fish disease will occur because of agricultural insecticide. Opinions on different types of impact that may occur due to application of insecticide in agricultural field revealed that 5%, 2% and 3% respondents thought that as a consequence, dead fish will float on water, water be polluted and infection in fish body will occur respectively. Only 1% respondents stated that eggs of local fish will be destroyed due to insecticide use in agriculture field.

3.5.4 Summary of Environmental Impact related KII Results

Summary of opinions of Key Informants on environmental impact includes the following:

i. Intensification of fish culture in both perennial and seasonal ponds is a lower area in *haor* districts will not create any adverse or conflicting impact on ecology;

ii. Pond culture interventions did not produce as of now any negative effects on the environment;

iii. Water level rise in lean season (winter) due to sea level rise is not clearly perceptible as yet in the *haor* region, so question of adverse effects does not arise;

iv. Climate change, especially temperature has adverse effect on spawning of fish species. Due to siltation in the *haor* area water depth is reducing chronologically and water temperature is perceived to be rising nowadays, especially in the lower haor area; high temperature has adverse effect on spawning of fish. On the other hand, optimum temperature (20 – 39°C) enhances spawning of fish and the maximum temperature hardly exceeds the upper limit and

v. African magur (*Clarias gariepinus*), Piranha (*Pygocentrus nattereri*) and other exotic carnivorous species should not be attempted to be cultured in the *haor* ponds. Besides, Roho labeo (*Labeo rohita*), Catla (*Catla catla*), Mrigel carp (*Cirrhinus cirrhosus*), Orange fin labeo (*Labeo calbasu*),

Tilapia (*O. mossambicus*), Striped catfish (*Mystus tengara*) and Pabda catfish (*Ompok pabda*) are the popular environmental friendly fish species that can be cultured in *haor* ponds.

3.5.5. Summary of Key Findings of the FGDs

Summary of key findings of the FGDs are presented below:

6. Due to fish culture in the *haor* pond, the income of local fish farmers has increased, employment has been generated for both male and female members of the households, nutrition intake has increased, some fish-centered business have been generated etc.;
7. Financial support for digging and raising the dikes of the pond should be arranged and aquaculture training should be imparted;
8. Fish sanctuaries are to be established and this measure is the best for preventing extinction of different varieties of local fish and increase production in general and
9. Frequency of the early flood/flash flood was has increased in the *Haor* area and the perceived causes include onrush of water from the Indian hills, excessive rainfall and disruption of link with the local rivers.

4. CONCLUSIONS

The study has provided evidence that *haor* pond aquaculture approach aimed at improving the lot of the poor and vulnerable is effective in the study area. The intervention has resulted in the improvement of yield from ponds and generated higher income and nutritious food for the fish farmers. Existing cultural practices could support experimentation and learning under future initiatives in the *haor* area. Pond fishery in the *haor* area mainly has an income-generating feature and less probability of being affected by climate change impacts on culture fishery. The approach should be extended beyond study areas and be adopted as a key strategy for development of *haor* fisheries resources in Bangladesh.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Annexure 1. The taxonomic group used in the catch analysis of the pond fishery & taxa contributed to each group (Native cultured fish, Exotic cultured fish & natural non-cultured fish) by % to the catches.

Group	Scientific name	Local name	Common name	Percentage composition of the total					
				Netrakona	Sunamganj	Kishoreganj	Habiganj	B.Baria	Overall %
Native cultured Fish	*Labeo rohita*	Rui	Roholabeo	15.5	7.88	12.95	9.67	11.56	10.82
	Chrrhinus cirrhosus	Mrigal	Mrigal carp	5.95	3.48	3.42	8.33	7.56	5.29
	Catlacatla	Catla	Catla	5.31	0.91	2.67	3.33	5.81	3.23
	Amblypharyngodon mola	Mola	Indian carplet	1.53	2.88	0.48	2.78	0.21	1.66
	Labeocalbasu	Kaliboush	Orangefinlabeo	-	-	0.62	-	0.71	0.27
	Mystussp.	Tengra	Striped catfish	0.4	-	-	-	0.53	0.19
	Ompokpabda	Pabda	Pabdah catfish	1.06	-	-	-	-	0.15
Exotic cultured Fish	*Oreochromismossambicus*	Tilapia	Mozambique tilapia	1.62	28.18	4.52	43.33	12.62	18.49
	Oreochromis niloticus	Mono-sex tilapia	Nile tilapia	40.41	4.09	40.57	-	12.83	16.59
	Hypophthalmichthys molitrix	Silver carp	Silver carp	9.68	7.88	10.47	6.11	14.26	9.9
	Cyprinus carpio	Common carp	Common carp	4.02	13.64	4.74	2.22	6.07	7.94
	Barbonymus gonionotus	Thai sarputi	Thai sarputi	4.74	11.82	2.88	12.78	1.99	7.15
	Ctenopharyngodonidella	Grass carp	Grass carp	2.24	10.3	2.97	4.78	2.88	5.68
	Pangasianodonhypohthalmus	Thai pangus	Thai pangus	-	3.18	0.38	-	1.68	1.62
Natural non-cultured fish	*Puntius sp.*	Puti	Barb	2.88		2.72		4.28	1.86
	Channa striata/C. marulius	Shol/Gozar	Striped/ Great snakehead	0.87	2.27	1.82		1.37	1.56
	Heteropneustesfossilis	Shing	Stinging catfish	1.08		1.6			1.07

	Clariasbatrachus	Magur	Magur	0.47		1.2			0.37
	Channapunctata	Taki	Spotted snakehead	2.13		0.61			0.63
	Anabas testudineus	Koi	Climbing perch	0.08		0.67			0.59
	Mastacembelus sp.	Baim	Eel	-		-		0.11	0.03
	Wallago attu	Boal	Wallago	-		-		0.08	0.02
	Palaemonsp.	Prawn	Prawn	0.05		0.41			0.07
		Local small fish	Loach, small catfish, eel, garfish	-		0.46		-	0.07
		Others	small barb, catfish, flying barb,	-	2.88	3.85	6.67	10.02	4.72