IMPACT OF A SUBMERSIBLE EMBANKMENT PROJECT ON HAOR BASED LIVELIHOOD

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IMPACT OF A SUBMERSIBLE EMBANKMENT PROJECT ON HAOR BASED LIVELIHOOD

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It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree.

…………………

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Session: April 2005

Dedicated to my

BELOVED MOTHER AND HEAVENLY FATHER

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BCR	Benefit-Cost Ratio
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CARE	International Humanitarian Organization
CNRS	Centre for Natural Resource Study
DTW	Deep Tube-Well
EIP	Early Implementation Project
EGIS	Environmental and Geographic Information Services
FAP	Flood Action Plan
FCD	Flood Control and Drainage
FRRAS	Flood Risk Reduction Activities in Sunamganj
HFL	Highest Flood Level
HH	House Hold
HDI	Human Development Index
HHDI	House Hold Development Index
HYV	High Yielding Variety
GDP	Gross Domestic Product
GIS	Geographic Information System
IBRD	International Bank for Reconstruction and Development

IDA	International Development Agency
IFAD	International Fund for Agricultural Development
IWFM	Institute of Water and Flood Management
LGED	Local Government Engineering Department
LLP	Low Lift Pump
mha	million hectare
mmt	million metric ton
MPO	Master Plan Organization
O&M	Operation and Maintenance
SEP	Submersible Embankment Project
SDC	Swiss Agency for Development and Cooperation
SIDA	Swedish International Development Agency
SPSS	Statistical Package for the Social Sciences
UNDP	United Nations Development Programme
WARPO	Water Resources Planning Organization

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ABSTRACT

Haor in the Northeast Region of Bangladesh is a very unique type of wetland and is characterized by the presence of numerous large, deeply flooded depressions, between the rivers. Premonsoon flash flood from the neighboring hilly region of India is a common phenomenon, which damages the only possible *Boro* crop of the region. A number of submersible embankment projects (SEPs) have been constructed by Bangladesh Water Development Board (BWDB) to give protection against premonsoon flashflood. From the review of past studies, it has been ascertained that SEPs have had positive impact on *Boro* production. But, the impact of the SEPs on the people's standard of living and contribution of the project to the development goal as per National Water Policy has not been assessed. In this study, the impact of a SEP on the Haor based livelihoods has been assessed. Sonamoral SEP that was implemented in 1991 in Sunamganj district in the northeast region has been selected as the study area.

An index called Household Development Index (*HHDI)* based on the concept of the UNDP for assessment of human development is used to quantify livelihood development of the study area. *HHDI* is constructed using the important livelihood development indicators considering the context of the study area e.g. income, length of working opportunity in the main and other occupations, food security, protein intake and access to natural resources. Participatory rural appraisal (PRA) method has been applied to collect the information of pre and post project condition based on the indicators. Four Haor based livelihood groups, viz. agricultural, fisherman, boatman and aquatic plant harvester have been identified in the study. They are fully dependent on the Haor and its natural resources. A total of 500 households survey, five focus group discussions and five village level general meetings have been conducted for this study.

The present study shows that, the Sonamoral SEP has successfully contributed in increasing the *Boro* production through reducing damage and increasing coverage of HYV *Boro*. But, the value of *HHDI* has declined from pre project (before 1991) condition to post project (after 1991) condition in agriculture from 0.54 to 0.43, fisherman from 0.52 to 0.42, boatman from 0.45 to 0.36 and in aquatic plant depended group from 0.51 to 0.47. The average of *HHDI* has declined from 0.53 to 0.43. Agriculture landowners who are holding the large portion of the cultivable land are mostly benefited from the project while the other livelihood groups are deprived. Negative impact on hydrological system and ecological resources is also observed in the study area.

CHAPTER ONE

Introduction

1.1 Background and justification of the study

Haor is a unique type of wetland in the universe. Haors are back swamps that are bowl shape depressions adjacent to rivers. There are 411 Haors comprising an area of about 8000 km^2 dispersed in the districts of Sunamgonj, Sylhet, Moulvibazar, Hobigonj, Netrokona & Kishoreganj in the northeast region (Fig.1-1) of Bangladesh (BWDB, 2005). The Haors are flooded during monsoon. During the dry season, the floodwater drains out, leaving one or more shallow beels. Then the rich alluvial soils are exposed around the peripheral region of the Haor, and these are cultivated for *Boro* rice, which is the principle crop of this region. But premonsoon flash flood from the very steep uplands adjacent to the region in Asam and Meghalaya Hills range in India is a common phenomenon, causing immense damage to the standing *Boro* crops before harvesting. To protect the crops in the Haor areas, Bangladesh Water Development Board (BWDB) has constructed submersible embankments, which protect the crops from premonsoon flashfloods but go under water during monsoon. Since 1966, BWDB has constructed 46 submersible embankment projects in the Haor region. A total of approximately 0.29 million hectare cultivable land has been protected from flash flood by implementing 1826 km of submersible embankment (BWDB, 2005).

A study by Saleh and Mondal (2007) shows that *Boro* rice production has increased due to implementation of Submersible Embankment Projects in the Haor region. Though the rice production has increased, the Haor region still remains in the high poverty zone as per the data of Bangladesh Bureau of Statistic (BBS, 2004). This contrast has encouraged to take this study of assessing the impact of submersible embankment project on livelihoods in the Haor region. As per the National Water Policy (Ministry of Water Resources, 1999), achieving decent standard of living for the people is among the development goals of water management projects. An important question is, how much the submersible embankment projects contribute to this goal and the proposed study is intended to address this issue. The Sonamoral Haor submersible embankment project of Dharmopasa Upzilla of Sunamganj district (Fig. 1-1) is selected for this study. This project was completed in 1991 and it is one of the latest completed submersible embankment projects in the district. Considering availability of data, accessibility to study area and availability of support from local organization for conducting the survey work Sonamoral Haor is selected for the study.

1.2 Study Objectives

The main objective of the study is the assessment of impacts of a submersible embankment project on human development in the Haor area, and the method developed in the study is expected to be useful for the assessment of the contribution of water management projects to national development goals.

The specific objectives of the proposed research are:

i. to identify livelihood activities of households in a selected Haor;
ii. to characterize livelihoods in the Haor by constructing appropriate household development indicators; and
iii. to analyze impacts of the submersible embankment project on livelihoods in the selected Haor.

1.3 Limitations of the Study

Very few studies have been conducted in Haor region. The secondary information, which is available, is mostly divisional, district and limited Upazilla basis. Collection of socio-economic information of the study area for pre project condition was a difficult task for the study. For the information of pre project condition, consultation with local communities and social survey at household level are mostly used. Considering the resource limitation, time constrain and difficult communication, survey conduction was not possible in another Haor without submersible embankment condition.

1.4 Organization of the thesis

The thesis is divided into eight chapters. The first chapter covers background and objective of the study and the second chapter covers Haor system and submersible embankment projects. Chapter three and four cover the information on the study Haor and its submersible embankment project (SEP) respectively. Chapter five and six discuss the construction of Haor based livelihood indicators and the process of social survey respectively. Chapter seven presents the impact of SEP as evaluated through the indicators and chapter eight presents' conclusions and recommendations.

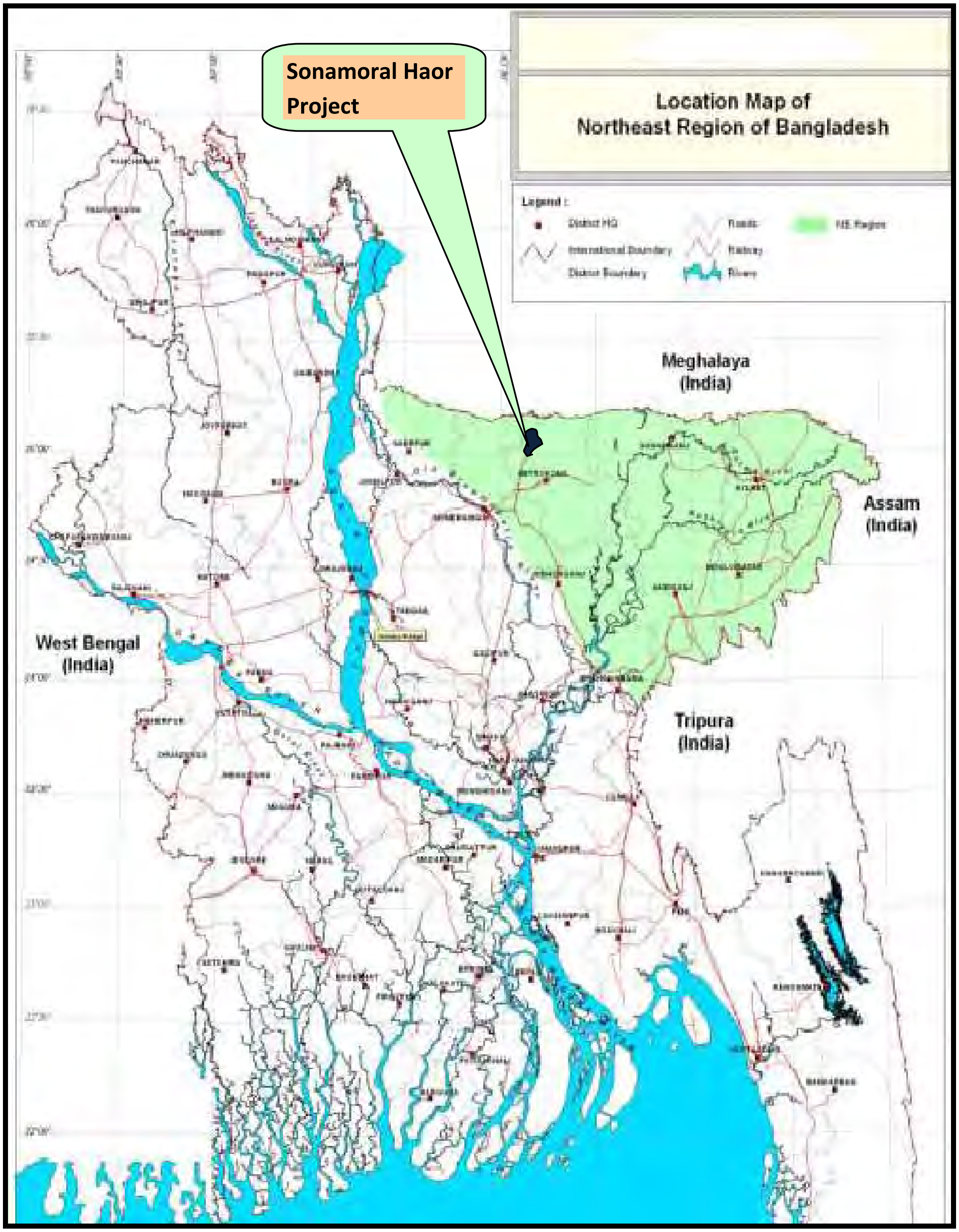


Figure 1-1: Study area location

CHAPTER TWO

Haor System and Submersible Embankment Project

2. 1 Description of Haor system

Haors are located in the Northeast Region of Bangladesh that covers an area of approximately 24,500 sq km, bounded by the international border with India to the north and east (Fig.1-1). The greater part of this region is taken up by the Haor basin, which comprises the floodplains of the Meghna tributaries, and is characterized by the presence of numerous large, deeply flooded depressions, known as Haors, between the rivers. A vast alluvial plain possesses some 6,000 permanent shallow water bodies known as beels (usually in the lowest parts of the Haors or in abandoned river channels), surrounded by large areas of seasonally flooded plains. The basin is bounded to the north by the hill ranges of Meghalaya, to the south by the hills of Tripura and Mizoram, and to the east by highlands of Manipur. The numerous rivers rising in these hills cause extensive flooding during the monsoon season (Fig. 2-1), with much of the region being flooded to a depth of up to six meters. The drainage is towards southwest via the Surma, Kushiyara, Baulai, and Kalni rivers into the Meghna River and ultimately to the Bay of Bengal. Almost all land above the maximum flood level is under permanent cultivation and human

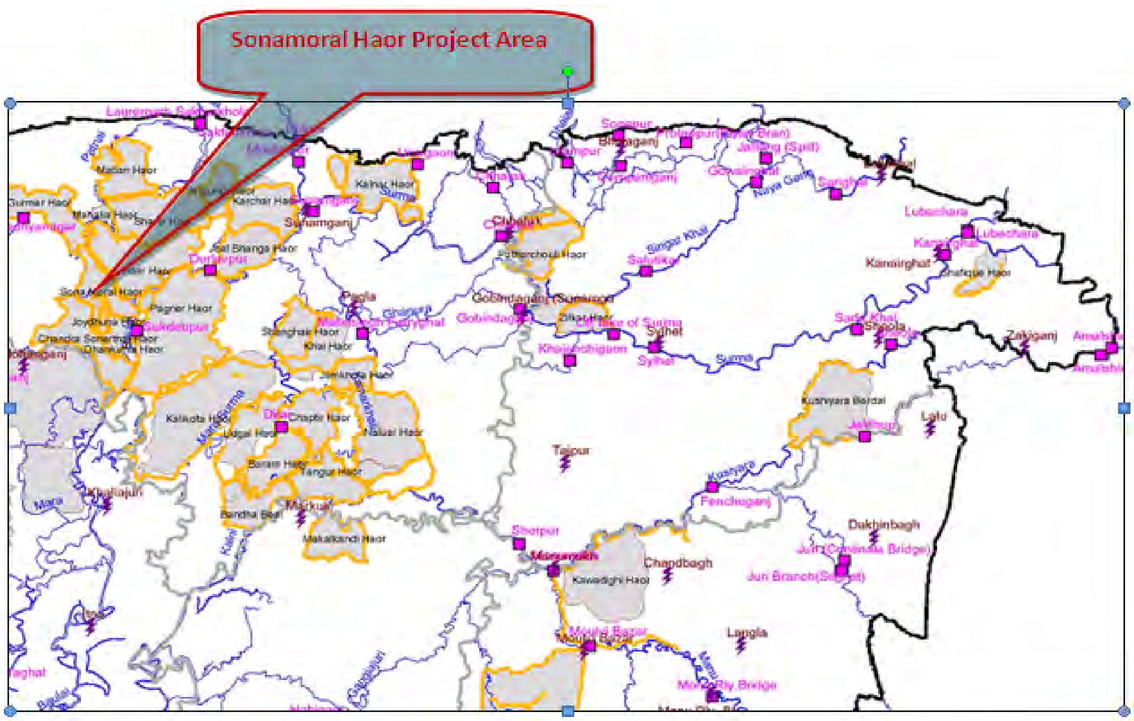


Figure 2-1: Rivers and Haors in Northeast region

settlement.

The Haors are back swamps or bowl-shaped depressions between the natural levees of rivers. Haors get flooded to a depth of as much as six meters during the rainy season and in many cases two or more neighboring Haors link up to form much larger water bodies. During the dry season, most of the water drains out, leaving one or more shallow lakes (beels). These are especially numerous along the lower courses of the Baulai and Kalni Rivers. Many of these become overgrown with aquatic vegetation, and some dry out completely by the end of the dry season. As the monsoon floodwaters recede during the dry season, rich alluvial soils are exposed around the margins of the beels, and these are extensively cultivated for *Boro* rice.

Figure 2-2: Typical picture of Haor in monsoon

2.2 Physical configuration of Haor

The topography of the Haor area is essentially a valley and is extremely flat, the Surma is the main river flowing through the Haor areas of Sylhet Division. It feeds the lowlands with floodwater during monsoon and drains them in winter (Fig.2-2). The ground elevation has a natural slope towards the Haors in Sunamganj, which has surrounding elevation about 3m average above the mean sea level. The Surma River has catchments in the Garo, Khashi and Jaintia Hills. The premonsoon floods in the Haors arrive in April, after heavy downpour in the Barak or Surma valley. According to the wetland resources special study by northeast regional water management project (Shawinigan Lavalin Inc. and Others, 1992), the principal systems are as follows:

- The Haor basin contains about 47 major Haors and some 6,300 *beels* of which about 3,500 are permanent and 2,800 are seasonal. These wetlands vary in size from as little as a few hectares to many thousands of hectares. Baram, Banka, Habibpur, Maka, and Makalkandi Haors, which unite to form a single large water body during the rainy season; the Ghulduba Haors; and Ranga and Baudha beels. Located in the eastern and lowest part of the basin in Mymensingh.
- Tangua, Shanir, and Matian Haors in the deep northern basin at the foot of the Meghalaya Hills. These form a single water body during the rainy season.
- Dekhar Haor, Pathar Chanli Haor, and Jhilkar and Jhinkar Haors, to the east of the Tangua system.
- Sonamoral, Halir, Joydhona and Dhankunia Haors are in the north side of the Tangua Haor.
- The Jamaikata, Mahai, Nalua, and Parua Haor system, on the eastern rim of the basin.
- Hakaluki, Chatal Bar, Haila, Kawadighi, Pagla and many smaller Haors, in the central Sylhet lowlands.
- Hail Haor, between the Tarap and Banugach hill ranges in the southeast.
- Dingapota, Ganesher, Tolar, Anganer, Bara, and Humaipur Haors, in the south of the basin.
- Etna and Sania Haors, Kishorganj district and Khaliaghuri Haor at east Mymensingh.

During the monsoon the individual identification of a particular Haor is not possible. Basically, in monsoon, the Haors turns into an inland sea. People stay in mounds locally called “Ati” which are formed with dumping soils and are situated in middle or the periphery of Haors.

2.3 Hydrology of Haor Region

The region’s climate is governed by monsoon, which is seasonally persistent wind system of low to moderate intensity. The southwest monsoon begins in May and continues until late September. Following a brief period of instability, it is replaced by the northeast monsoon, which begins in November and continues until mid-March. Another period of instability occurs during March and April. The southwest monsoon is laden with moisture and brings abundant rainfall to the area. The northeast monsoon, however, is dry and brings practically no rainfall. Although the annual rainfall in the region ranges from 2500 to 4000 mm/year and it is higher than the average rainfall from the rest part of the country and is added to by the amount of water that enters through the Surma-Kushiyara river system. The Surma river is a major river in Bangladesh, part of the Surma-Meghna river System. It starts where the Barak river from northeast India divides at the Bangladesh border into the Surma and the Kushiyara rivers. The Surma is fed by tributaries from the Meghalaya Hills to the north, and is also known as the Baulai river after the south-flowing Someswari river joins it. The Kushiyara receives tributaries from the Sylhet Hills and Tripura Hills to the south, the principal one from the Tripura Hills being the Manu. The Kushiyara is also known as the Kalni River after it is joined by major distributaries from the Surma. It ends in Kishoreganj District, above Bhairab Bazar, where the two rivers rejoin to form the Meghna River. The waters from the river ultimately flow into the Bay of Bengal.

Most part of Sylhet - in particular Sunamganj and Habiganj - is relatively flat. Large parts become inundated during the monsoon, and stay that way until long after the monsoon is over.

Because of the topography, the water level rises fast upon commencement of the rains. The regular occurrences of extremely sudden and heavy rainfall in hills add to this (the Khasi and Jainthia Hills have some of the highest rainfall recorded on earth), producing flash floods.

2.4 Characteristics of Premonsoon Flashflood:

Flash flood occurs in areas where the upstream basin topography is relatively steep and the concentration time of the basin is relatively short. In Bangladesh flash floods generally occurs in the northeast, southeast and Chittagong regions (Fig 1-1). But two flash floods are completely different in considering the time frame. In southeast and Chittagong region flash flood occurs in the full monsoon (June-Sep) whereas the flash flood in northeast region occurs in premonsoon season March-April. This is why the flash flood in the northeast region is called premonsoon flashflood. The extent and the devastating effect of premonsoon flashflood are quite substantial and a recurrent phenomenon for the northeast region of Bangladesh. In the Haor area, flash flood comes from the very steep uplands adjacent to the region in Asam and Meghalaya hills range in India causing immense sudden flow of water in northeast region of Bangladesh.

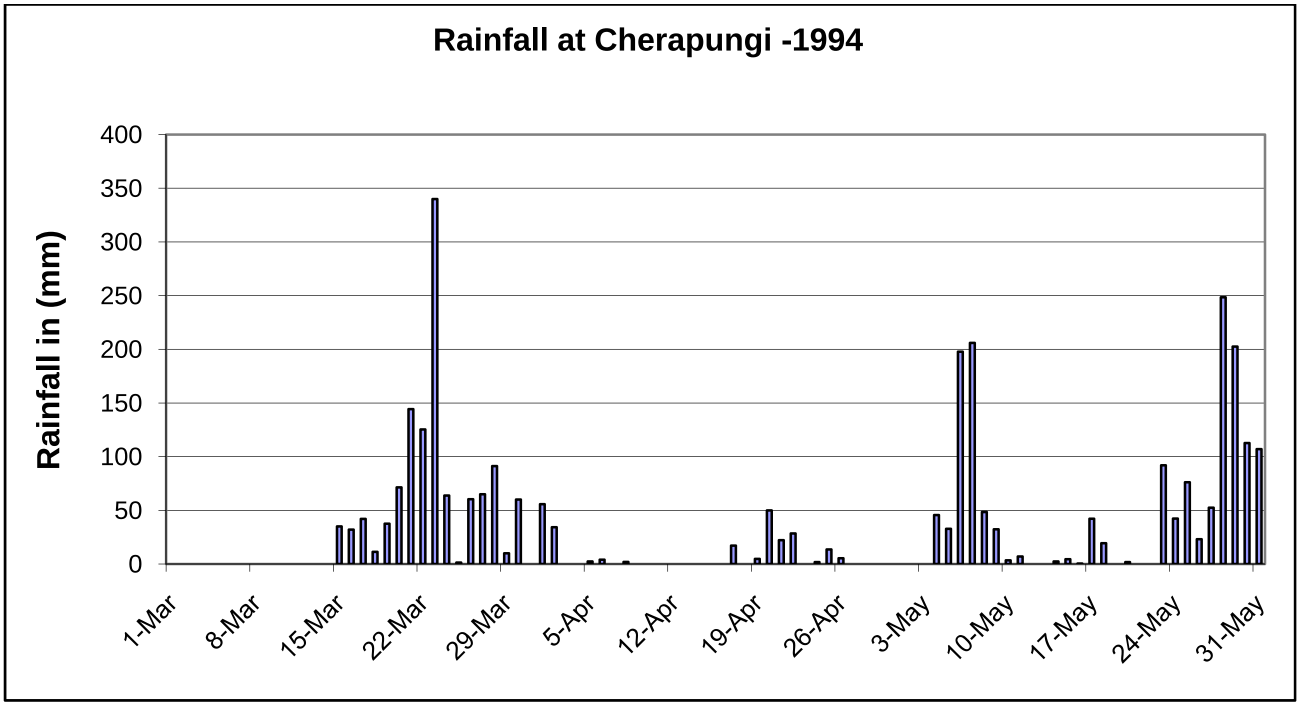


Figure 2-3: Rainfall data in nearby boarder station Chrapungi of India

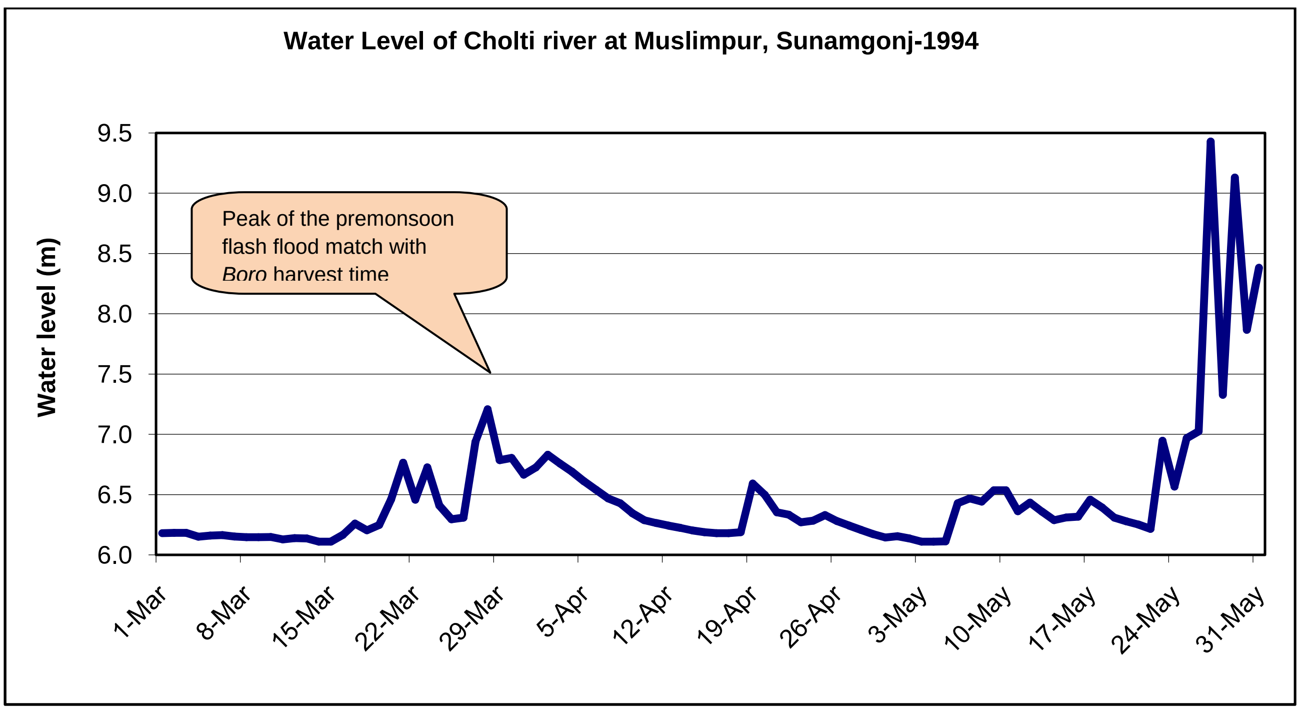


Figure 2-4: Hydrograph of Chalti River at boarder area in Bangladesh

Fig. 2-3. shows the rainfall in India and Fig. 2-4. shows the corresponding river hydrograph in Bangladesh boarder area and the timing of premonsoon flash flood. Most of the rivers in these areas are originated from nearby hilly area of India. These rivers are extremely flashy that is characterized by sudden and wide variation in flow as a result of excessive rainfall. When heavy rainfall occurs in the hilly region of India, water quickly moves towards the Haor area of Bangladesh through a number of rivers and Khals. This floodwater not only carries the water but also a huge amount of sediment originated mainly from the hills. The timing of the premonsoon flashflood coincides with the harvesting time of *Boro* causing enormous damage to the standing paddy.

2.5 Ecological resources

The Haor ecosystem is composed of a number of different, diverse and interacting sub-ecosystems, including forest, terrestrial and aquatic sub-ecosystems. Of special interest in the case of the aquatic sub-ecosystem are the wide ranges of aquatic species, in particular fish. The Haor has one of the richest inland fisheries resources. The ecological characteristics are such that a wide range of aquatic life has developed, and the fish biodiversity is rich and diverse. In its original form, the basin has consisted of a rich mosaic of permanent and seasonal lakes and ponds with abundant aquatic vegetation, surrounded by vast areas of swampy ground with tall reeds and seasonally flooded grasslands. Swamp forest, dominated by *Barringtonia*, *Pongamia*, and other flood-tolerant tree species, have covered the river levees, and provided a secure refuge for terrestrial wildlife during the monsoon floods. On higher ground, these have given way to scrub jungle and dense stands of bamboo.

In the past, Haor was rich in Wildlife. Marsh Crocodiles and Otters were common in every lake and swamp. One-horned Rhinoceroses, Wild Buffalo, and Swamp Deer grazed in the marshes, and Asian Elephants, Gaur, Sambar Deer, Hog Deer, and Wild Boar roamed the forests and tall grasslands. Tigers and Leopards were also common, along with many smaller predators such as Wolves, Jackals, and several species of wildcat. And everywhere, there were birds teeming flocks of migrant ducks and shorebirds from Siberia mingling in winter with the resident flocks of cormorants, pelicans, herons, egrets, storks, ibises, whistling-ducks, comb ducks, pygmy geese and many more species. During the breeding season, there were huge mixed colonies of cormorants, herons and storks in the patches of forest, while the marshes were rung with the bugling calls of Sarus Cranes.

There has been significant reduction of the native flora and fauna of the Haor basin of Northeastern Bangladesh. Now, although most of the permanent water bodies have survived, all other ecosystems have almost completely disappeared. Vast areas of the seasonally flooded plains have been converted to rice monoculture, while areas less suitable for rice are now heavily grazed by domestic livestock or cultivated for wheat and other crops. The swamp forests have been reduced to a few small patches, often no more than ten or twenty widely scattered and now very old trees, while virtually all land above the level of the monsoon floods has been utilized for permanent settlement, homestead forests, and public infrastructure. The swamp forests, scrub jungle, bamboo thickets and dense stands of reeds have disappeared almost without trace.

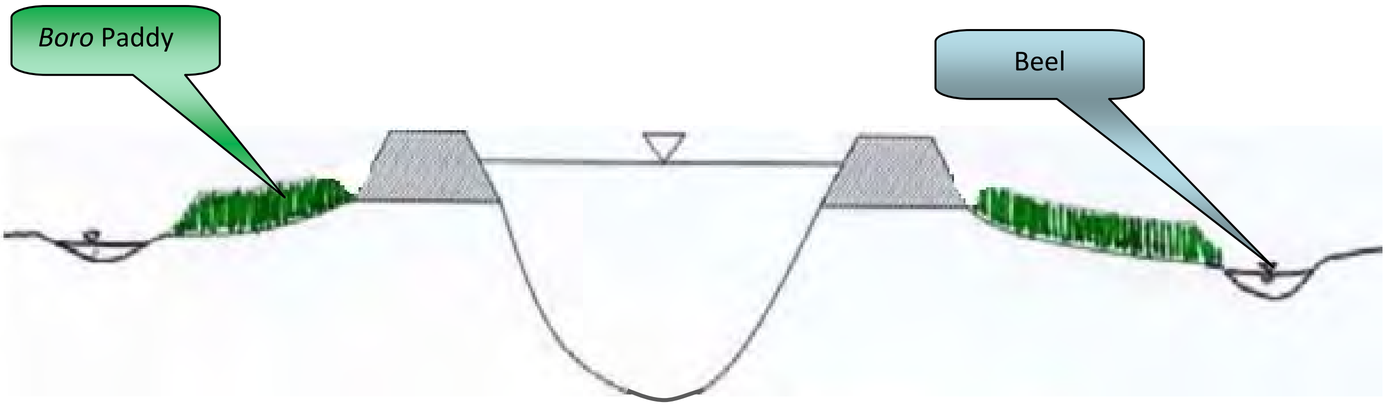
2.6 Description of Submersible embankment project (SEP)

The hydrological regime in the Haor basin is conducive to growing only *Boro* rice, which is vulnerable to premonsoon flash floods. The concept of protecting *Boro* rice from premonsoon flashflood in Haor basin through constructing submersible embankment was originally initiated by *Zamindars* (landlords) in the 1920s. The Bangladesh Water Development Board (BWDB) added the scientific dimension to this concept in 1960s. It constructed a total of 1826 km of submersible embankments in 46-project area under six districts (Sunamganj, Sylhet, Moulvi Bazar, Hobiganj, Netrokona and Kishoregonj) in the northeast region to protect 289,911 hectares of *Boro* rice crop from premonsoon flashflood.

2.6.1 Concept of Submersible Embankment Project (SEP):

Submersible embankment project is a special type of project designed to protect agricultural crops, usually *Boro* rice, grown in the winter season and harvested during the premonsoon Submersible embankment is constructed along the bank of the rivers and cannels to restrict the entrance of premonsoon flash floodwater into the Haor for a certain period of time (Fig. 2-5) so that farmers can have the safe harvest of their only crop *Boro.*

Embankment preventing premonsoon flashflood



Embankment submersed during monsoon

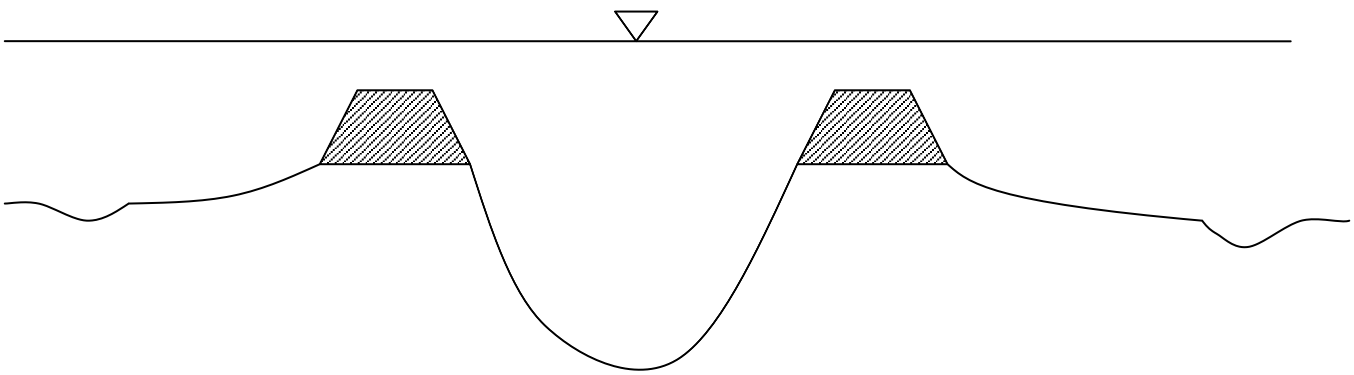


Figure 2-5: Embankment position during premonsoon flash flood and during monsoon flood

Submersible embankment allows overtopping of monsoon floodwater into Haor after the harvesting time and gradually the area is inundated. During full monsoon, it remains submersed and the monsoon floods pass over it. At the end of the monsoon, water from the basin drains back to the river system through cross drainage structures and embankment cut at different locations.

2.6.2 Design criteria of submersible embankment project:

The submersible embankments in the Haor areas are designed to restrict the 1 in 10 year premonsoon floodwater from entering the project until 31 May (BWDB, 1996). The embankments are provided with a freeboard of 0.3 m to account for possible increase in premonsoon flood levels due to confinement effect. The embankments have a crest width of at least 2.5 m with side slopes of 1V: 3H.

Flushing/drainage regulators are provided in the embankments to facilitate (1) filling of the project with water after the *Boro* harvest is complete, so as to reduce the damage of embankments during overtopping, and (2) drainage in the post-monsoon period. Structure size is determined by premonsoon flushing requirements. The capacity of the structures is sufficient to allow the basin to fill in up to 0.3 m below the embankment crest by the time the embankments are overtopped that limits damage to the embankment during overtopping, and post-monsoon drainage requirements. The head difference across the structure is designed not to exceed 0.3 m, to discourage farmers from cutting the embankments to accelerate drainage. The regulators also allow flushing to the internal canals and retain the water for lift irrigation during winter and have provisions for fish passage or allow fish migration.

Although as per the BWDB design manual the submersible embankments are designed to prevent floodwater from entering the project till 31 May, review of past studies and feasibility reports shows that the implemented projects have actually been designed to prevent flood water from entering the projects till 15 May (SSISP, 1990).

2.6.3 Operation and Maintenance

Bangladesh Water Development Board (BWDB) is shouldering the responsibility of regular operation and maintenance of the submersible embankments and controlling structures. Local government is also facilitates the operation and maintenance on ground.

The regulator gate operation is mainly done by the local people in association with BWDB. The gate of regulator is started to open from May 16 and the opening is completed by 24 May. There is always conflict among farmer, fisherman and boatman in opening and closing the regulator gate depending on their different water demand.

The earthen submersible embankments, which are submersed every year in monsoon and experienced severe wave actions, require regular repair and maintenance. Again, embankments are cut at different locations for drain out water by farmers and fishermen, which also need to close every year.

CHAPTER THREE

Description of the Study Area

3.1 Submersible Embankment Project location

The Sonamoral Haor sub-project that has been selected for the study is situated about 8.5 km southwest of Jamalganj Upazila and about 9.5 km North-East of Dhannapasha upazila headquarter in Sunamganj district.

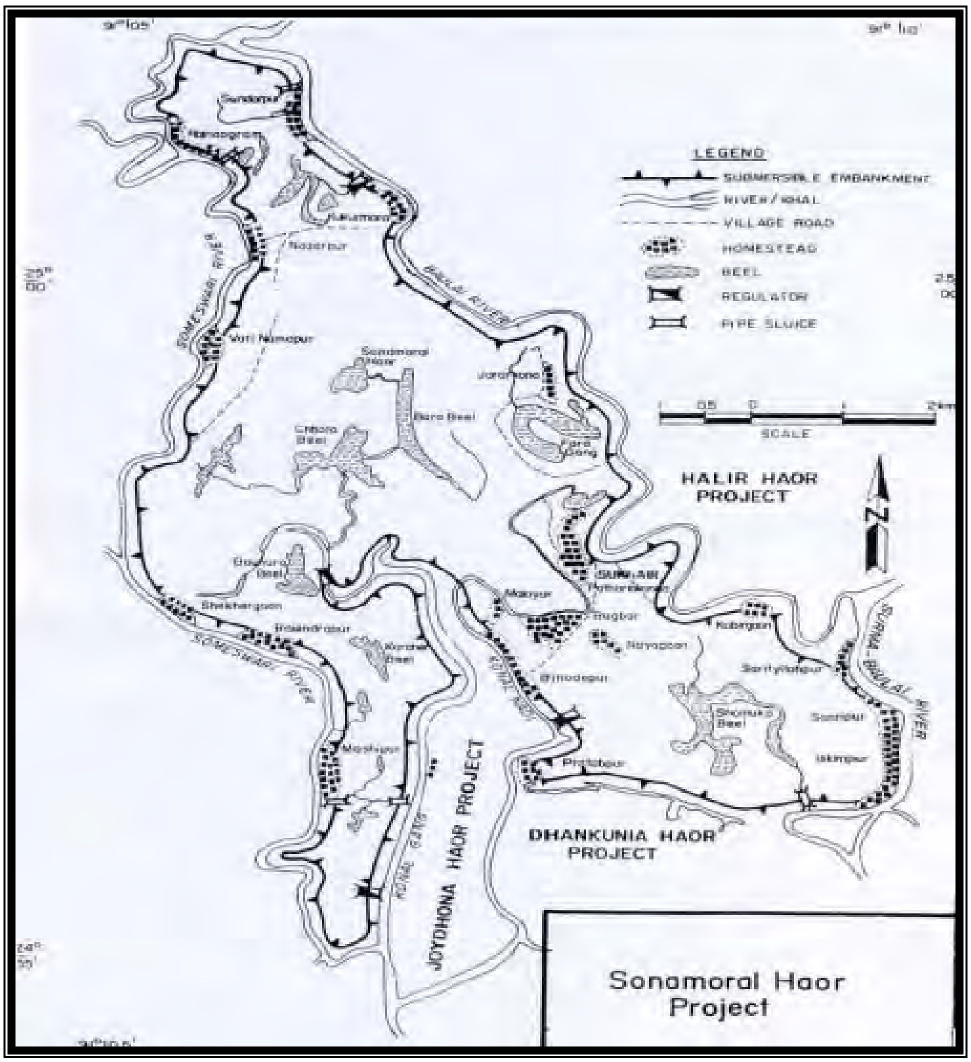


Figure 3-1: Sonamoral Haor Project area Source: (SSISP, 1990)

There are two unions in the study Haor area: Uttar Sukhair- Rajapur and Joysree.

Most of the portion of the Sonamoral Haor is located in Jamalganj Upazila and the remaining western part is located in the Dharmapasha upazila under Sunamganj district. There are several Haor projects such as Curmar and Halir Haor in the North, Pagner Haor in the East and Joydhonona, Dhnkunia and Chandra Sunarhat Haor in the south (Fig. 3-1).

Topographically the northwestern corner of the Sonamoral Haor is relatively highly elevated and the southern part is relatively low. The topographical variation inside the sub-project area ranges from 0.42 m to 5.16 m with a major depression in the southeastern side of the project. The total sub-project area is 3,275 ha and the net benefited area is 3,160 ha. (SSISP, 1990). The project was identified by BWDB in 1981. Feasibility study was subsequently carried out and project was recommended for inclusion in the SSIP program. Construction works started in 1986-87 and the project was completed in 1990-91.

3.2 Description of the study Haor

3.2.1 Water resources system

Water resources system of the Sonamoral Haor sub-project is composed of rivers, khals, Haor and beels located in and around the project area. The sub-project is bounded by Bauli river on the North-East, Sormeswari river on the West, Konai river on the south and Surma river on the East side (Fig.3-1) Within the Sonamoral project area, there are a number of beels, which are connected to the bounding rivers of Bauli, Dorchari and Surma through various khals, of which the most important are the Juddail and kharashjan Khals and important beels are Chata beel, katailjan beel, chaittainya beel, Baro beel, Bausi beel, Fera gang (ox-bow lake) beel, Filainya beel, Baon bora beel and IShasanka beel (Fig. 3-1).

There are four main khals in Haor area: a) Juddail; b) kharashjan Khal c) Daulatpur khal and d) Jordar khal. There are some sub-khal a) Patharkandi-Bagbari khal; b) Harjalhali- Shukhair Bazar and c) Protappur-Verirpar (Fig. 3-1).

3.2.2 Flooding condition

The location of Sunamganj and its topography made it extremely prone to be effected by early rain in bordering Indian hilly State that fetches heavy downpour of rainwater. This project area faces premonsoon flashflood almost every year due to huge volume of water coming in from the Surma River through different connected rivers surrounding the project area. In the early monsoon, when excessive floodwater accumulates in the Surma River, it creates backwater on the Baulai river, Someswari river and Konai river. This backwater as well as the water coming from upstream jointly raises the water level above the embankment resulting in overtopping and breaching of the embankment at several locations through which water easily enters into the Haor. Flood water normally entered into the Haor area within the time range from 15th April to 20th April (SSISP, 1991)

Water starts overtopping the submersed embankment into this Haor area from the northern part of the project area when flash flood occurs. Local rainfall also creates flood in the Haor, but it does not exceed one fourth of the total area. The entire Haor inundates within few days when heavy rainfall occurred in the neighboring hilly area. The rivers, which are responsible for the flash flood and their distribution, are Baulai River (controls 40%) and Someswari River (controls 60%). During the monsoon, Sonamoral Haor is flooded to depth ranging from 1.5 to 6.0 meters (Shawinigan Lavalin Inc., 1992).

3.2.3 Drainage condition

Drainage network of the study area comprises of a number of khals, beels and river in and around the project area. Land level slopes down from north to south, which favors drainage towards Someswari and konai rivers. Water from low-lying beels is mainly drained out by Juddail and Kharashjan Khal through regulators constructed on the respective khals. Both the regulators are now working properly. In addition to the above-mentioned regulators, water also drains out through a number of locations where embankment is cut by the public and breached by floodwater.

In the lowest part and the beels of the study area, water normally drains out within the first week of December. But the there is a tendency of delay in water drain out due to drainage congestion. If the Haor drain out with in first week of December then it will be good for farmers to transplant Boro in the field. About 25% area of Haor suffer drainage congestion problem.

The rivers those controls drainage are: Baulai River; Kalapani River; Somesswari River, Surma River and all internal and external canals are already silted up to a extent. Water logging is becoming a challenging issue of the study area.

3.2.4 Irrigation

At present most of the cultivable land is under irrigation facilities. Surface water is the only source of irrigation in the project area and like other Haor area groundwater is not used at all due to high cost. Mostly LLPs are used to withdraw surface water from rivers and beels for irrigation purposes. In some cases indigenous technology Kun is used for irrigation purpose from beel areas. Local people reported that over the years the water storage capacity of the beels area had decreased due to silting up of bed level of beels. They also suggested that irrigation facilities from beel area could be improved if the re-excavation of beels is done.

3.2.5 Land Resources

The Sonamoral Haor falls under Agro ecological region of Sylhet basin. The landform of the project comprises very lowland. The periphery of the project is moderately to deeply flood. The area comprises two major soils: Fagu and Sulla. The Fagu soils occur on the upper part of the basin. They are gray mottled brown, firm, clays. The Sulla soils occupy the basin bottoms. These soils are greenish gray, sticky clays. The soil reactions of these soils are highly acidic to neutral and average organic matter content is 3.5%. Most of the soil nutrients are high to medium except phosphorus and boron. The land is inundated periodically by premonsoon flash flood and monsoon flood. According to the (Shawinigan Lavalin Inc. and Others, 1992) study it is found that around 90% of the total area is agriculture land (Table 3-1)

Table- 3-1: Land use distribution of Sonamoral Haor project area

Sl. #	Type of land use	% Of total land	Remarks
1	Settlement	2%	
2	Homestead garden	1%	
3	Vegetable garden/ seed bed	2%	
4	Cattle grazing	1%	Fallow land
5	Road/ infrastructure	1%	
6	Agriculture	90%	
7	Water body	3%	River, Beel and cannel area
Total		**100%**	

(Source, FAP 6)

3.3 Structural components of Sonamoral SEP:

The project was implemented during the period 1990-'91 under the financial support of Asian Development Bank (ADB). The major physical elements of the SEP include submersible embankment, compartmental embankment, regulator, pipe sluice and closures.

Table 3-2: Embankment cross section parameters

Parameter	Dimension
Crest Width	3.0 m
River Side Slope	1:3
Country Side Slope	1:3
Free Board	0.3 m
Crest elevation	7.01 m (PWD)

(SSISP, 1991)

The cross sectional parameters of the submersible embankment are shown in Table 3-2. The height of the embankments is designed for 1:10-year premonsoon flood expected to occur before May 15. Since the embankment is designed to be overtopped, the freeboard is provided mainly to accommodate the expected rise in premonsoon water levels after the project implementation (SSISP, 1990). The present operation status of the interventions is given in Table 3-3.

The total length of embankment is 41 km. The big portion of embankment is located on the west side of Kalni River. With respect to design level, the height of embankment is low at Markuli, which is closer to Jalalpur village. About 2.5 km. length of embankment is very much vulnerable from Badalia four-vent regulator to Dholer Khal ghat. Lots of breaches and ditches are along this length (Fig. 3-1).

The 2nd part of the embankment is located on the bank of river Kamerkhali. The height of embankment is low with respect to design level within the reach from Jalalpur to Terapasha Bazar due to poor operation and maintenance work over the years. The 3rd part of the embankment is located at Terapash bazer to Halikona Launchghat on the east bank of Kemerkhal River. The height of embankment is low due to long absence of maintenance work. Eight major breaches are located at Jalian nadier mukh (300 feet); east side broken area of Ghagatia khal (1000 feet); Ghoramer khal bhanga (I00 feet); middle portion of Nachni Bazar Bhanga (60feet); south side of Nachni bazer Bhanga (300 feet); Shaldigha village Bhanga (70 feet); Kurer khal Bhanga (100 feet), and Acrier khal Bhanga (150 feet**).** The last part of the embankment is located at Holykona Launch Ghat to Markuli closer. There major breaches exist at Surier Parer Dala (2000 feet); Tetoyer Dhala (I00 feet); Islampurer Dhala (40 feet).

There is a small portion of compartmental embankment of length 0.54 km for the purpose of retaining monsoon water to irrigate *Boro* field. The height of embankment is low which is currently not suitable for storing irrigation water. The embankment is generally in good condition although annual routine maintenance work is required. BWDB reported that suitable materials for embankment construction are not available locally and that imported materials are used. There are breaches and public cuts. Local farmer reported that generally the breaches in the embankment occur in May as the embankment is being overtopped. The public cuts are made to drain the Haor. During the study, local people raised concerns for additional drainage structures. Local people also stated that the sediment deposition is occurring along Baulai River and that this impedes drainage.

Table: 3-3: Status of the structures of Sonamoral Haor project and present O&M

Sl. No.	Structure	Condition of the structure	Local mitigation measure
1	Submersible embankment from Bhadgonabade mouza to Islampur mouza (Southern side of Sonamorol Haor beside the Konai river locally called "Kalagang"	• 5/6 breaches are located near the following villages: a) Jardhar b) DoaArar, c) Islampur, d) Binadpur. • The height of this section of the submersible embankment is low. • Flash flood enters into this Haor from the Dhankunia Haor due to this low height of the submersible embankment	• Local farmers try to comprehend the initial onslaught of the flash flood for few days to complete their boro harvesting. These sporadic attempts remain largely unsuccessful when the flood increases • BWDB carries out limited rehabilitation work on an annual basis
2.	Submersible embankment from Islampur mouza to Sundarpur mouza.(Eastern side of Sonamoral Haor beside the Boulari river and partly beside the Shurma river).	• 4/5 major breaches are located near the following villages: a) Shukhair Nij, b) Noagoan, c) Jarakona, d) Sundarpur (Locally known as Koyra). • The height of this section of the submersible embankment is low. • Flash flood enters from the Boulai river both through the breaches mentioned above and also through overtopping several sections of the submersible embankments. This is also caused by the siltation on the Boulari river. • Wave erosion cause damages to this section of the submersible embankment as well	• Local farmers try to comprehend the initial threat of flood intrusion for few days to complete their harvesting. Often these efforts remain unsuccessful • BWDB carries out limited rehabilitation work on an annual basis

3	Submersible embankment from Sundarpur mouza to Bhadgaonbadc mouza (Western side of Sonamorol Haor)	• 4/5 major breaches are located near the following villages: a) Najarpur, b) Haripur, c) Jaysree, d) Bhadgaon bade. • The height of overall submersible embankment along with the specified locations remained low. • Flood waters entrance from Shomeshori river. • Wave erosion cause damages to this section of the submersible embankment as well.	• Local farmers triad to fill up some breached • BWDB carries out limited rehabilitation work on an annual basis
4	Daulatpur Regulator (2-vent)	• Physical condition of the regulator is good and functional • Link canal has been silted up.	• Local people do not carry out any major initiative to rehabilitative the regulator
5	Jurdhar Regulator (3-vent)	• Physical condition of the regulator is poor and non functional. • Link canal has been silted up. • Attached embankment has a breach near the regulator. • Some components (e.g. key, handle etc) of the regulator have been stolen.	• Local people and UP representatives close the gate with sand bag for protection of floodwater. • BWDB has not carried out any O&M work for a long time
6	Doarar Regulator (2- vent)	• Physical condition of the regulator is poor and non functional. • Linked canal has been silted up. • Attached embankment has a breach in the southern side of the regulator.	• Local people and UP representative trained to close the gate with sand bags in the last *Boro* season
7	Kukurmara Regulator (2- vent)	• This regulator is functioning with a poor physical condition. • Linked canal has been silted up	• Local people and UP representatives close the gate with sand bag for protection of floodwater.

Source: (CEGIS, 2002)

3.4 Agriculture practice

This Haor is deeply to moderately flooded during the monsoon season. The soils are clayey and less porous and less permeable. About 85 percent of the total project area is used for agricultural crops. *Boro* is the only crop grown in these areas. Both HYV and local variety are grown in this Haor (Table 3-4).

Table 3-4: Cropping pattern of Sonamoral Haor

Land type	Crop	Area (ha)	Percent of NCA
Low land	*Boro* (HYV)	1264	40
Very low land	*Boro* (local)	1896	60
	Total	**3160**	**100**

HYV Boro includes BR-28, Br-29, Br-26 and Br-16. Shail is the most local variety practices in these places. HYV *Boro* remains more in the vulnerable condition against flash flood, as it is harvested one month later than the local variety. The farmers go for HYV with the expectation of more food grains to accommodate his increasing number of family members. But the crops grown in these areas are frequently damaged by flash flood in the month of April and May.

Table 3-5: Annual paddy production in devastating flood year (2003- 2004) in Sonamoral Haor

Name of crop	Damage free area		Damaged area by flood		Total production (ton)	Production lost by flood (ton)
	Area (ha)	Yield rate (ton/ha)	Area (ha)	Yield rate (ton/ha)		
Boro (HYV)	126	3.8	1138	Nil	479	4324
Boro (Local)	190	2.1	1706	Nil	399	3583
Total					**878**	**7907**

The river Baulai in the east and Shomeshwari in the west are mainly responsible for damaging the corps due to inadequate height of submersible embankment to prevent early flashflood water. In the devastating flood of 2004, about 90% of the crops areas were damaged. The farmers received only 878 tons of paddy where in average years, about 6968 tons of paddy are produced annually (Table 3-5).

3.5 Fisheries and other ecological resources

Sonamoral Haor is moderately rich in fisheries resources. The Haor is situated farm from the thana headquarters and they have weak communication facility for fish marketing. This Haor is under various threats due to population pressure and indiscriminate resource use. According to the local people, the main causes of degradation are over-harvesting, siltation, conversion of wetlands into rice fields, unwise felling of aquatic trees, erection of embankment and other anthropogenic interventions. According to the local fishery office, the average current fish production is around 1877 metric ton from the 4739 acre of the study area, which is almost 20% less from the pre-project condition. Major fisheries issues so far identified by the local people are as follows –

- Fish production is decreasing due to habitat loss, change of existing aquatic ecological condition and poor fisheries management.
- Fisheries biodiversity is declining due to indiscriminate fishing e.g. use of harmful fishing gears, catching of post larva and brood fish, completely dewatering of leased water bodies for fishing, etc.
- Loss of fish habitats (both area and depth of perennial beels, khals and adjacent rivers) due to rapid siltation and illegal encroachment.

Net fish habitat area is about 370 ha. The major beels are Chato beel, Boro beel, Feragang beel, Saska beel, kataijlan beel, Chaittainya beel, etc. Beside these, a number of Khals namely Pathrakandin to Bagbari khal, Harjakhali to Sukhai bazaar khal, Protappur to Varirpur khal, etc. are connecting these beels with the surrounding rivers. The Haor is surrounded by Someswari River, Baulai River, Surma River and Konai River. Fish habitat area expands up to 70% of the Haor during monsoon. Average depth of the beels is 1.2-l .5 meters. Most of the fish habitats i.e. khals, beels and adjacent rivers are silting up gradually.

There has been mass extinction of the native flora and fauna of the Haor basin of Northeastern Bangladesh. In its original form, the basin would have consisted of a rich mosaic of permanent and seasonal lakes and ponds with abundant aquatic vegetation, surrounded by vast areas of swampy ground with tall reeds and seasonally flooded grasslands. Swamp forest, dominated by *Barringtonia*, *Pongamia*, and other flood-tolerant tree species, would have covered the river levees, and provided a secure refuge for terrestrial wildlife during the monsoon floods. On higher ground, this would have given way to scrub jungle and dense stands of bamboo.

3.6 Socio-economic condition

Population of this Haor is about 33,000 and the household's number is 2,799 Table ... In this Haor area 95% of households have cattle, 15% of household have goat and lamb and 95% of household have chicken and duck. There are more than thirty mouzas in the Sonamoral Haor sub-project area. There is no connected road in the area. But approximately 20 km khacha road was observed in this Sonamoral Haor area, which remains submerged in monsoon period. The length of river surrounding the Haor area is approximate 40 km and the internal canal is approximately 5-6 km. In the project area there are 23 villages in two Upazillas where 3 villages (Ronogram, Sundarpur and Kukurmara) are fully washout by wave erosion (Table 3-6).

Table 3-6: Distribution of HH of study area

SL	Name of Union	Name of Village	Number of HH
1	Sukhair Razapur (N)	Islam Pur	148
2		Shantipur	130
3		Shariatullah Pur	148
4		Kazirgaon	117
5		Hazipur	68
6		Kanchanpur	65
7		Sukhir Village	497
8		Jararkona	283
9		Jararkona Noagaon	82
10		Patharia Kanda	72
11		Noagaon	100
12		Bagbari	80
13		Protappur	111
14		Digjan	167
15		Binodpur	60
		Sub-Total	**2128**
16	Joysree Union	Nazarpur	160
17		Bhati Nazapur	67
18		Shekhergaon	158
19		Rajendrapur	106
20		Moheshpur	180
		Sub-Total	**671**
		Total	**2799**

Because of the geographic location, topography, hydrological systems, natural disaster vulnerability, environmental and ecological condition the challenges and opportunities of Haor base household are quite unique and different from the rest of the country.

Lack of demand for agricultural labour in the monsoon season, combined with extremely limited access to land and to markets severely limits employment and income generating opportunities. Male members migrate to urban areas for temporary work, which makes the life and livelihood of the poor women in the Haor region vulnerable. Women have limited mobility and traditionally not been engaged in commercial or trading activities. Alternative livelihood opportunities are constrained by lack of education or skills, knowledge of appropriate activities, and lack of confidence. Due to the remote location and difficult physical conditions, public services are quite limited. A list of public service institute is shown in Table: 3-7.

Table 3-7: Public service institutes in study area

SL	Name of Union	Name of institute	# Of institute	Remarks
1	Joysree	Primery school	20	1 community school
		Madrasa	1	
		High school	1	
		Bazer	2	
		Post Office	1	
		Health complex	1	
		UP Land Office	1	
2	Sukair Rajapur	Primery school	14	Govt-10, registered- 4
		High school	1	
		Bazer	2	
		Sub Post office	2	
		Krisi Bank	1	
		Health center	1	

The impact of all of these factors is experienced by the poorest people, and those who are marginalized within households and in society – women, the old and infirm, very young children, and those who have some form of disability.

In recent years, poor people have increasingly lost their fishing rights in the Haors or rivers, which had been their major source for livelihoods and food-security for decades. These water bodies have now been taken over by powerful people with political connections. They control the majority of water bodies and only allow poor people to fish for a payment of daily fees and a percentage of sales proceed for a certain period.

The distribution of land ownership is also imbalanced with a wide range. A significant proportion of land is holding by absentee owners. There is few percentage of Haor residents who is holding quite a large amount of land. Nearly, half of the Haor residents are landless and the remaining half are holding small to medium range of land ownership.

CHAPTER FOUR

Construction of Haor Based Livelihood Indicator

4.1 Considerations for assessing human development

Defining human development

According to UNDP (1990), human development is a process of enlarging people's choices. In principle, this choice can be infinite and change over time. But at all levels of development, the three essential ones are for people to lead a long and healthy life, to acquire knowledge and to have access to resources needed for a decent standard of living. If these essential choices are not available, many other opportunities remain inaccessible. But human development does not end there. Additional choices, highly valued by many people, range from political, economic and social freedom to opportunities for being creative and productive, and enjoying personal self-respect and guaranteed human rights.

Human development has two sides: the formation of human capabilities such as improved health, knowledge and skills - and the use of their acquired capabilities - for leisure, productive purposes or being active in cultural, social and political affairs. If the scales of human development do not finely balance the two sides, considerable human frustration may result. According to this concept of human development, income is clearly only one option that people would like to have, albeit an important one. But it is not the sum total of their lives. Development must, therefore, be more than just the expansion of income and wealth. Its focus must be people.

Considerations for measuring human development:

The measurement of human development should for the time being focus on the three essential elements of human life -longevity, knowledge and decent living standards.

For the first component-longevity life expectancy at birth is an indicator. The importance of life expectancy lies in the common belief that a long life is valuable in itself and in the fact that various indirect benefits (such as adequate nutrition and good health) are closely associated with higher life expectancy. This association makes life expectancy an important indicator of human development, especially in view of the present lack of comprehensive information about people's health and nutritional status.

For the second key component knowledge - literacy figures are only a crude reflection of access to education, particularly to the good quality education so necessary for productive life in modern society. But literacy is a person's first step in learning and knowledge building, so literacy figures are essential in any measurement of human development. In a more varied set of indicators, importance would also have to be attached to the outputs of higher levels of education. But for basic human development, literacy deserves the clearest emphasis.

The third key component of human development - command over resources needed for a decent living - is perhaps the most difficult to measure simply. It requires data on access to land, credit, income and other resources. Income indicator is used in absence of the data on many of these variables, for the time being, making the best use of an income indicator. The most readily available income indicator - per capita income – has wide national coverage. But the presence of non-tradable goods and services and the distortions from exchange rate anomalies, tariffs and taxes make per capita income data in nominal prices not very useful for international comparisons. Such data can, however, be improved by using purchasing power- adjusted real GDP per capita figures, which provide better approximations of the relative power to buy commodities and to gain command over resources for a decent living standard.

The Human Development Index

People do not isolate the different aspects of their lives. Instead, they have an overall sense of well-being. Considering the various aspect of life it is difficult to construct a composite index of human development. Past efforts to devise such an index have not come up with a fully satisfactory measure. They have focused either on income or on social indicators, without bringing them together in a composite index. Since human beings are both the means and the end of development, a composite index must capture both these aspects. The Human development index (HDI) by UNDP (1990) captures the three essential components of human life -longevity, knowledge and basic income for a decent living standard. Longevity and knowledge refer to the formation of human capabilities, and income is a proxy measure for the choices people has in putting their capabilities to use.

The HDI is an indicator of the average achievements in the field of basic human capabilities (human development). One has to take into account its deficiencies as well, such as the incapacity to reflect the distributive effects of the development (the inequality) and to measure the deprivations aspects of the development. Moreover, according to Amartya Sen (Sen, 2000: 17-24) it is important to distinguish between the use of HDI as an index and the overall concept of human development. Namely, we should be clear about the fact that there are many relevant variables of the human development that are not included in the HDI.

Human development index is based on three components (the life expectancy, the achieved education and the living standard) and is not exclusively focused on the economic wealth - as the case may be with the GNP (Jahan, 2002).

The HDI is constructed as per UNDP (1990) in three steps. The *first* step is to define a measure of deprivation that a country suffers in each of the three basic variables -life expectancy (*X1*), literacy *(X2),* and real GDP per capita *(X3).* A maximum and a minimum value is determined for each of the three variables given the actual values. The deprivation measure then places a country in the range of zero to one as defined by the difference between the maximum and the minimum.

Thus I_{ij} is the deprivation indicator for the *j*-th country with respect to the *i-th* variable and it is defined as:

$$I_{ij} = \frac{(maxX_{ij} - X_{ij})}{(\max X_{ij} - \min X_{ij})} \dots \dots \dots \dots \dots \dots \dots \dots \dots (4.1)$$

Where, X_{ij} is the actual value of the *i-th* variable for the *j-th* country *and* $\min X_{ij}$ and $\max X_{ij}$ are the corresponding minimum and maximum values of the variables of that country.

The *second* step is to define an average deprivation indicator(I_j). This is done by taking a simple average of the indicators:

$$I_j = \sum_{i=1}^{n} I_{ij}/n \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (4.2)$$

Where, I_j is the value of average deprivation index of the *j th* country and n is the number of variables.

The *third* step is to measure the human development index (HDI)as one minus the average deprivation index:

$$(HDI)_j = \left(1 - I_j\right) \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots (4.3)$$

Where, $(HDI)_j$ is the value of Human Development Index (HDI) of the *j th* country

Dixon & Easter (1986) define integrated watershed management as a process of formulating and implementing a course of actions involving natural and human resources in a watershed, taking into account the social, political, economic and institutional factors operating within the watershed and surrounding rive basin and other relevant regions to achieve social objectives. They emphasized that watershed management activities bring in many biophysical changes into the system. According to the water resources management report of World Bank (2003), watershed activities are intended to provide livelihood opportunity to the local community in developing countries. The success or failure of watershed management programmes is usually measured in terms of change in irrigated area, agriculture production, livestock etc. and the benefit of such programmes are only reaped by the bigger landlords, whilst the poor and landless are left behind. This situation compels us to have a proper quantitative mechanism in place for assessment of the contribution of such water management projects on livelihood taking relevant factors into account and eliminating the drawbacks of qualitative assessment.

The Human Development Report of UNDP (1990) uses three basic indicators, mainly income, health and literacy for measuring human development at national level. Lodha & Gosain (2005) proposed the use of two additional indicators of cattle holding and land holding along with the three HDI indicators, keeping in view the importance of these two factors in rural livelihood. They have used the technique to assess the impacts of development base programmes in the Dudhi micro-watershed, which is located in the Raisen district of Madhya Pradesh in India.

4.2 Formulation of Household development indicators and index:

An approach similar to the UNDP's for capturing human development has been used to quantify the livelihood of the study Haor. A set of equation was formulated to measure the development of various livelihood groups.

According to Lodha & Gosain (2005) House Hold Development Index (*HHDI*) represents the position of a particular household within a given population.

Calculation of HHDI involves four steps. In the first step Eq. (4.4) is used to measure development indicator D_{ij}. as given below.

$$D_{ij} = \frac{(X_{ij} - \min X_{ij})}{(\max X_{ij} - \min X_{ij})} \dots\dots\dots\dots\dots\dots\dots\dots\dots (4.4)$$

Eq. (4.4) is obtained by putting Eq. (4.1) in Eq. (4.3). D_{ij} *is* the value of development indicator for the *j th* household with respect to the *i th* indicator and X_{ij} is the individual value of the *i-th* indicator for the *j-th* household and $\min X_{ij}$ and $\max X_{ij}$ are the corresponding minimum and maximum values of the indicator of corresponding livelihood group.

The maximum and minimum values are used for the indicators over the Haor of interest (the project area) are indentified for each indicator. The development measure then places a household in the range of zero to one, as defined by the difference between the maximum and minimum.

In the second step Eq. (4.5) is used to measure the Household Development Index $(HHDI)_j$ for *j-th* household by taking a simple average of all the development indicator values of all livelihood development indicators

$$(HHDI)_j = \sum_{i=1}^{n} D_{ij} / n \text{ ....}(4.5)$$

Where, n is the number of indicators

In the third step Eq. (4.6) is used to measure the Household Development Index $(HHDI)_k$ of *k-th* livelihood group by taking average of the value of $HHDI$ for each household of that group.

$$(HHDI)_k = \sum_{j=1}^{m} (HHDI)_j \ /m \text{.................... } (4.6)$$

Where, m is the number of households of *k-th* livelihood group.

In final step, Eq. (4.7) is used to measure the Household Development Index of the project area $(HHDI)_p$ by taking average of the value of $HHDI$ of all livelihood groups as shown in Eq. (4.3).

$$(HHDI)_p = \sum_{k=1}^{l} (HHDI)_k \ /l \text{.................... } (4.7)$$

Where, l is the number of livelihood groups of the project area.

4.3 Selection of indicators for Haor based household livelihood development:

Measurement of the household development of Haor based livelihood should not be based in terms of increase in production of crops or fish catch rather it is important to consider their increase in income, food security, opportunity to work, protein intake and access to natural resources. The indicators have been selected considering the major Haor based livelihood factors, which reflect the development of the households. Community opinion has also been taken into consideration in selection of indicators.

Measurement of the household development of Haor based livelihood, six indicators have been selected, which are as follows:

i) Income
ii) Food security
iii) Employment opportunity in main occupation
iv) Employment opportunity in other occupation
v) Protein intake
vi) Access to ecological resources

The indicators are discussed below:

Income: The annual income in terms of taka per year is an important indicator for assessing HH development. Here the annual input cost for the livelihood options is deducted to get net income. This indicator reflects the economic outcome from the effort of the livelihood options. Income of individual households also indicate the well being status and resiliency to unwanted shocks.

Food security: Food security is measured in terms of duration (months of a year) when a household have the ability to procure required food for their healthy life. It is observed that, even after bumper production farmer has storage of food just for few months after the harvest or limited ability to procure food beyond few months. So, availability of food in number of months in a year is a reflector of the food security of a particular livelihood group.

Employment opportunity in main occupation: Employment opportunity for particular livelihood option in Haor area is dependent on seasonality. For example, farmers have their employment opportunity only in the dry season while fisherman has the employment opportunity in the wet season only. Rest of the period they are engaged in other occupations. For example, farmers catch fish during the wet season and fisherman work in harvesting rice during the dry season. The HH development is strongly dependent on the length of employment opportunity in their main and other occupation. Here the total number of months of employment in a year is used as the indicator of the opportunity of employment. This employment opportunity reflects the HH development of a particular livelihood group.

Employment opportunity in other occupation: Employment opportunity other than main occupation in terms of month in year reflect the opportunity for income in lean period, practically when there is no opportunity to work in main occupation. At the same time, it also reflects the tendency of change in main livelihood option, for which the households have the inherent skills and expertise.

Protein intake: In the Haor area fish is the main source of protein for HH because other protein source is quite scarce in the area. People in the Haor area meet their protein need through consuming fish. This protein intake is also related to the health status of the HH. The fish access and availability of fish is a good measurement of HH livelihood development. Protein intake is measured as a number of days in a week where HH have fish in their food menu.

Access and availability to ecological resources: Households in the Haor area are dependent on ecological resources in many ways especially on aquatic resources. Due to different unplanned development initiatives and gradual encroachment of land for cultivation these abundant resources are in stress. The access and availability to the ecological resources is becoming challenging for the bottom portion of the community. This indicator measures the availability and access for using aquatic plant as fire wood source, supplementary food, and medicine.

CHAPTER FIVE

Social Survey on Livelihood Activities

5.1 Survey methodology

To assess the impact of Sonamoral Haor Submersible Embankment Project, a social survey has been conducted to collect the information on social, economical and ecological for pre and post project conditions. In conducting this survey the household interview and Participatory Rural Appraisal (PRA) method have been used.

5.2 Procedure of data collection

The following PRA tools have been used to collect the information:

- Transact walk
- Focus group discussion
- Individual and key informant interview
- Large group discussion.

To completion the total process two major steps is taken

i) Preparatory activities

ii) Field data collection

Transact walk a tool of PRA has been conducted in Sukhain Razapur and Joysree union of the study area for getting the general understanding on the geographic context, livelihood opportunity, seasonal variability, socio-economic condition and environmental status. Key informant interview has been conducted in both unions for exploring the information regarding the different livelihood options and their variation over time with major hydrological and environmental concerns about the study area

i) **Preparatory activities:** Before starting the field survey several preparatory activities have been taken like site selection, team formation, team orientation, questionnaire development and field test of questionnaire.

a) Site selection

The number of total households of the Sonamoral Haor SEP command area is 2799 in 20 villages. Total 20 villages divided into 5 clusters. Each cluster consists of 4 villages. One central village from each cluster is selected for conducting sensitization and general meeting where households from all villages participated and represented all types of livelihood groups.

b) Sample size selection:

The number of total household of Sonamoral submersible embankment project is 2799. The simple size equation of Sufian (1998) is used to select the number of household for conducting individual household survey:

$$\boldsymbol{n = \frac{z^2\, pqN}{e^2(N-1) +\, z^2pq}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{5.1})$$

Where,

N is the size of population

p is the sample proportion (.5)

q is the (1-p) sample non proportion (.5)

e is the Precision rate or acceptable error (5%)

On 95% confidence level based on the normal distribution, z value is 1.96

Using the above formula, the sample size is **338** households. For capturing a good number of HH of all different livelihood groups in study area survey has been conducted by increasing the sample size from 338 to **500** households.

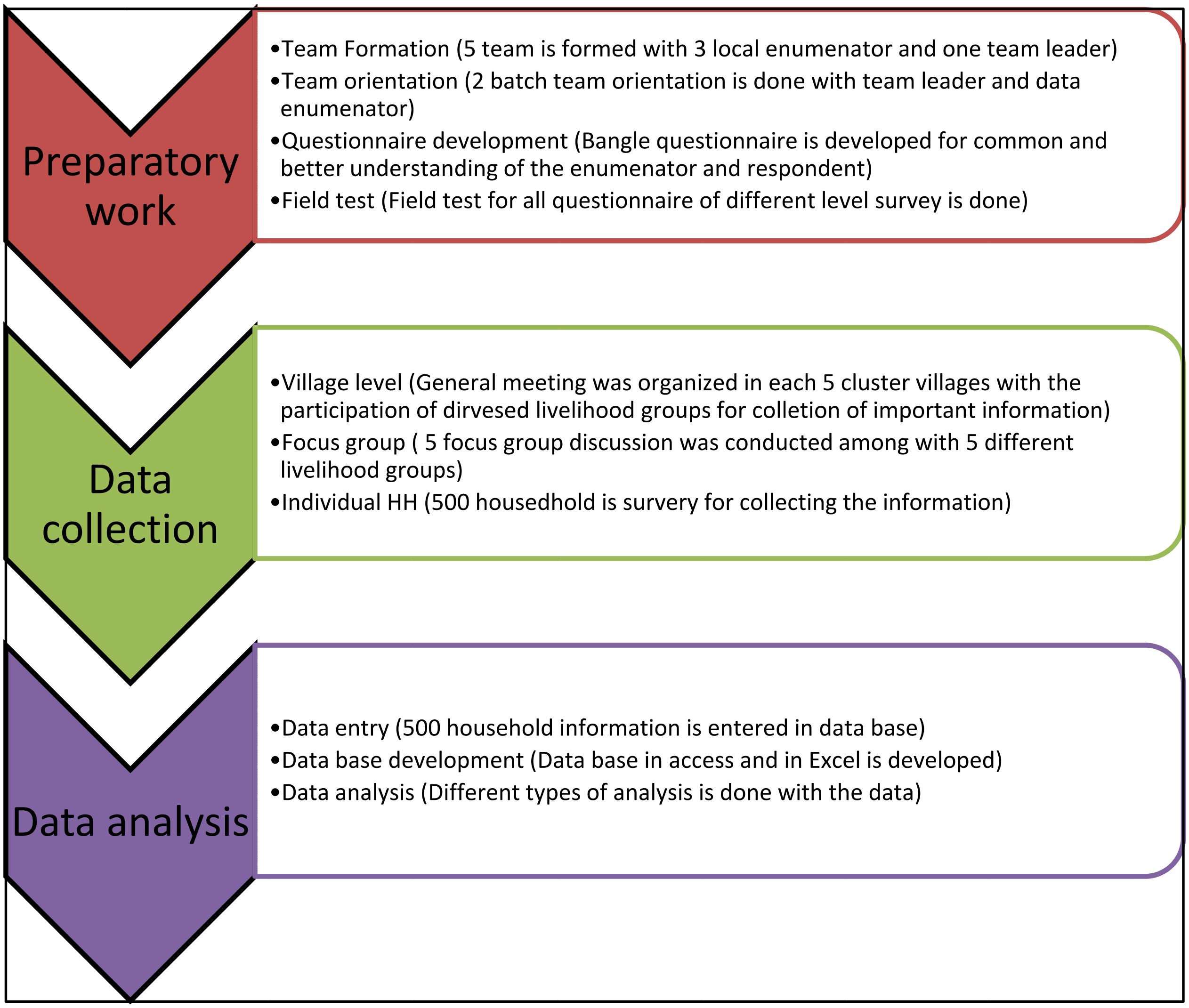


Figure 5-1: Flow diagram of survey process

c) Team organization:

A team was formed with 20 members to conduct and facilitate the total survey. Fifteen data collectors were selected from the local community on the basis of their educational status, experience and understanding the context of the survey. A local NGO, CNRS has provided their support in contracting with them. A management team leading by me was formed with five experienced staff from CARE, FRRAS project to lead the survey and facilitate the data collectors for conducting the survey.

d) Questionnaire development: A draft questionnaire was developed first in considering the requirement of the study and shared with the team. A consultative workshop was organized with CARE, FRRAS staff for finalizing the questionnaire. The objective of the workshop was to orient the staff that will lead the survey team and gather their concerns and feedback for making the questionnaire convenient for the data collector and respondent. Taking into consideration the concerns from all and after conducting the field test, the questionnaire for the survey has been finalized which is attached in Appendix-2.

e) Team Orientation

A full day workshop with the team leaders and data collectors was conducted for detail clarification on the questionnaire and purpose of the study. The facilitation style and approach for conducting survey was discussed in detail in the workshop. The responsibility of team leader and data collectors were defined in the workshop. A survey plan was developed in the workshop.

ii) Field data collection

a) Village level data collection:

Data was collected from village level, focus group and individual household survey shown in Figure 5-2. In each cluster centre a stakeholder workshop was organized to explain the objective and importance of the study. Basic information regarding the Haor based livelihood, socio-economic condition and overall impact of the submersible embankment was discussed among them. With their consensus a suitable date is fixed for conducting a village level meeting with the participation of representatives of all types of livelihood groups from the cluster villages.

b) Focus group discussion:

Focus group discussion among the different livelihoods groups has been conducted for understanding the impact on their livelihood due to construction of submersible embankment and the changes in their socio-economic condition. Individual interview has been conducted for collecting the household level informations. Large group discussions among different cross-section of people of the study area have also been conducted for validation of collected information. Total process of the social survey is shown in Figure 5-1.

From the information of the sensitization meeting the livelihood group was identified. A focus group discussion was conducted for each Haor based livelihood group. Separate questionnaire format has been used to collect the information from the focus group discussion.

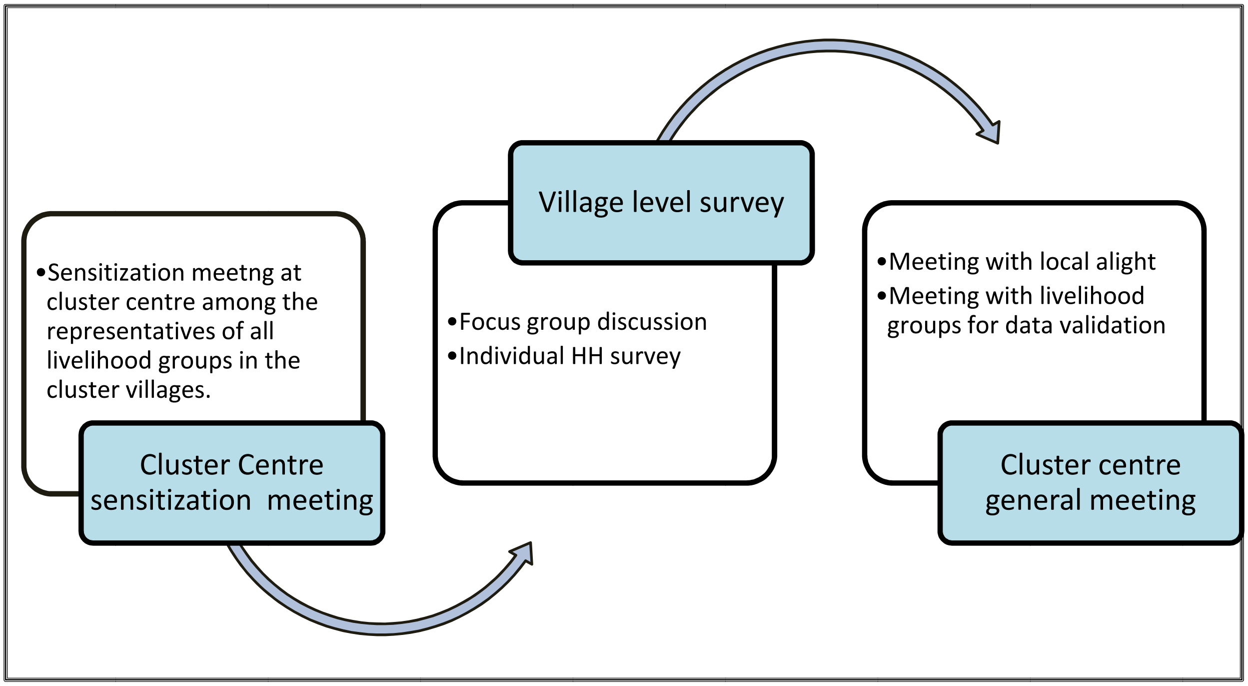


Figure 5-2: Flow chart of data collection

c) Individual interview:

In each village of the clusters, a simple random survey was conducted in a proportionate way so that the information from every village is represented. In some cases, the presence of informative respondents was given the priority in selecting the respondent HHs. Emphasis was also given to the livelihood groups whose number were relatively less like, boatman and aquatic plant base livelihood groups. Adequate time and required facilitation was provided to help the respondents for understanding the questionnaire and providing accurate information.

d) Village level general meeting and data validation:

In each cluster center village another meeting is conducted with the participation of local elites, representatives of all livelihood groups in the cluster villages for sharing the collected information and validate the data. Additional information regarding the environmental impact, ecological impact and other social impact due to the construction of submersible embankment has been collected from the meeting. Sample size and survey details are shown in Table 5-1.

Table 5-1: Village wise survey information

SL	Name of Union	Name of Village	Total HH	Number of HH surveyed	Date of survey		
					HH survey	Focus group	Village meeting
1	Sukhair Razapur (N)	Islam Pur	148	23	22.11.09 to 28.11.09		
2		Shantipur	130	27	DO		
3		Shariatullah Pur	148	15	DO	21.11.09	
4		Kazirgaon	117	30	DO		
5		Hazipur	68	3	DO		
6		Kanchanpur	65	2	DO		
7		Sukhir Village	497	55	DO		26.12.09
8		Jararkona	283	38	DO	22.11.09	22.10.09
9		Jararkona Noagaon	82	-			
10		Patharia Kanda	72	19	DO	21.11.09	
11		Noagaon	100	33	DO		
12		Bagbari	80	15	DO		
13		Protappur	111	26	DO		22.11.09
14		Digjan	167	24	DO		
15		Binodpur	60	30	DO		
		Sub-Total	**2128**	**340**			
16	Joysree Union	Nazarpur	160	34	DO		25.11.09
17		Bhati Nazapur	67	21	DO		
18		Shekhergaon	158	25	DO		28.10.09
19		Rajendrapur	106	25	DO	21.11.09	
20		Moheshpur	180	55	DO	21.11.09	
		Sub-Total	**671**	**160**			
		Total	**2799**	**500**			

5.3 Identification of Haor based livelihood activities in the study area

The total number of household in the Sonamoral Haor is 2799. The social survey has been carried out based on for 500 HH which is larger than the requirement of 338 HH for the study area as per Eq. (8). of the study area. Around 84% livelihood groups are Haor based livelihood. They are fully dependent on Haor and its natural resources. Livelihood groups and their distribution are shown in Table 5-2. Within the 84% of the Haor based livelihood groups, 73% are depended on agriculture. In the agricultural group it is found that different type of engagement like agriculture landowner, sharecropper and contractual labor for agriculture. Sixty five percent of this agricultural group has very small to medium range of land.

Fisherman group is 21% of the total the Haor based livelihood. They are engaged in fish catching, fish selling and dry fish processing. 65% of this livelihood group hold small amount of land.

Table: 5-2 Livelihood distributions in study area

Sl #	Livelihood group	Number of HH	Percentage of total livelihood
1	Agricultural	304	61
2	Fisherman	88	18
3	Boatman	15	3
4	Aquatic plant base livelihood	11	2
5	Others	82	16

The ownership of land in the Haor area is seasonal. In the wet season, landowners have no right to their land for fishing, which goes to the Govt. distributed fish leaseholders. From the wide level consultative discussion, it found that the fisherman community is squeezing gradually due to reducing availability of fish in the Haor and restriction to fishing.

Community people of the Sonamoral Haor told that in previous times, each HH maintained an individual boat for their communication. But after the engine boat was introduced and internal communication becomes restricted for certain time due to construction of submersible embankment, a good number of commercial boat emerged and some HH took it as livelihood option. Three percent HH found as among the total surveyed HH are found as boatman livelihood group. 23% among the boatman community have small homestead.

Two of the total Haor based livelihood communities are found who are dependent on Haor aquatic plant. They collect some vegetable plants, medicinal plants and plants that are used as fire source from the Haor and sell those in the market. it is found that, in previous times the size of the aquatic plant based livelihood group was much larger than the current group. Due to encroachment by agriculture, habitats for these plants are diminishing, leading to decreased availabilities. This livelihood group is adapting to changes by choosing to out migrate or work as labors in other occupations.

CHAPTER SIX

Assessment of Impact on Hydro-ecology and Livelihood

6.1 Impact assessment basis

The impact of the SEP has been assessed on *Boro* production, hydrology, ecology, livelihood and water management. The impact assessment has been done by comparing the pre and post project conditions. Questionnaire survey has been conducted in such a way to capture information for both pre and post project conditions. Secondary available data (CEGIS, 2006; SSISP, 1991) has also been collected to compare the pre and post project condition.

The production of *Boro* is assessed for pre and post project conditions including crop variety, agricultural land coverage and input cost. For hydrological analysis, focus group discussion, key informant interview and village level meeting along with physical observation have been done. In ecological impact assessment pre and post condition data on fish and aquatic plant availability has analyzed. Impact of livelihood has been assessed using the household development index. HHDI is developed based on Haor based development indicators discussed in section 4-3.

6.2 Hydrological impact:

Sonamoral Haor is surrounding by Bauli, Sormeswari and kalapani rivers and also linked with Surma through branch. Measured water level data of these rives is not available, except for Sumra river gage near Sumanganj district town which is quite far away from the study Haor. Due to non-availability of measured water level data, questionnaire survey, key informant interview and focus group discussions are conducted to collect information for hydrological impact analysis. Pre monsoon flashflood water trends to overtop the submersible embankments 10-15 days earlier in post project condition than pre project condition. The pick of the pre monsoon flashflood is also noticed 1-1.5 feet higher in post project condition than pre project condition.

Regarding the development potential of more submersible embankments in the region, (FAP 6) studies expressed concerns about the possible increased water level in the regional rivers (confinement effect) and changed sediment deposition pattern due to more such projects. For a holistic understanding of the confinement effect of the SEPs on pre-monsoon HFL, a thorough and rigorous analysis (with the help of remote sensing and GIS) considering all the relevant parameters is necessary (Saleh and Mondal, 2007).

From the discussion at various levels, the following hydrological impacts as experienced by the local project community came out.

Reduction of beel area:

In the questionnaire survey it is mentioned by the project beneficiary that the beels area has significantly reduced in the post project condition. The bottom of the beels has risen due to siltation and depth of water has reduced. Scarcity of surface irrigation for the HYV *Boro* in the dry season is gradually becoming concerns to the local community. Demands for re-excavation of beels are raised by them. Few have reported that they are planning for DTW for irrigation in the coming years.

Disruption of hydraulic linkage:

Submersible embankment disrupted the linkage of numerous khals with the beels of the study Haor. Drainage of water from the Haor is delayed due to this reason. Lack of adequate water regulator structures, people have to cut the embankment at different locations for drainage and again have to re-build then before the next pre-monsoon flash flood. In both occasions conflict arises among fishermen and the farmers with the timing of opening and closing of embankment gates. Moreover, soil availability for re-building the embankment is gradually becoming a big concern.

A tenancy of delay in water drain-out is observed by the local community. Due to this reason, the transplant of *Boro* paddy is delayed and the vulnerability to damage is getting higher. The local community also reported that the Baulai, Kalapani and Somesswari Rivers and the internal and external canals of the study Haor are silted up to such an extent that it is creating the problem of water logging. Currently, about 25% area of the Haor is suffering from drainage congestion problem.

6.3 Ecological impact:

From the study of Kafi (April, 2008), it is clear that migration of fish is affected in Haor due to construction of submersible embankment. SEP prevents onset of migration of species Boal, Rui and Catla and causes delay to it. Thus the river, floodplain and beel breeders has been prevented from breeding and consequently ripen eggs in their ovaries has reserved through autolysis. Submersible embankment thus reduces the brood stocks of major carps (Rui and Catla) by preventing early migration. An earlier study by Ali (1990) had similar observation. In Table 6-1, the list of fish species in the study Haor is given.

Table 6-1: List of fish species availability in the Study Haor water system

Guild	Fish Scientific Name	Local Name	Habitat type		
			River	Khal	Beel
Eel	*Macroganthas aculeatus*	Tara Baim	A	A	P
Eel	*Macroganthas pancalus*	Guchi Baim	A	A	P
Large catfish	*Wallagu attu*	Boal	P	A	A
Small catfish	*Mystus vitatus*	Tengra	P	P	P
Carp	*Labeo ruhita*	Ruhu	P	A	P
Gobies	*Glossogobius giurus*	Baila	P	P	P
Leaf fish	*Nadus nudus*	Meni	P	P	P
Loach	*Lepidocephalus guntea*	Gutum	A	P	P
Carplet	*Amblypharyngodon mola*	Mola	P	A	A
Carp	*Leboe kalbaus*	Kal baus	P	A	
Catfish	*Mystus punctatus*	Ghagor	P	A	P
Glass fish	*Parmabasis baculis*	Chanda	P	P	P
Catfish	*Hetaropneustes fissils*	Sing	A	P	P
Snakehead	*Channa sriatus*	Shol	A	P	P
Snakehead	*Channa Marulius*	Gizar	A	P	P
Barb	*Puntius ticto*	Titputi	P	P	P
Barb	*Putius chola*	Puti	P	P	P
Snakehead	*Channa puntatus*	Taki	A	P	P
Prawn	*Prawn sp.*	Chingri	P	P	P
Note: A= Absent and P=Present					

Wallago attu (boal) makes limited longitudinal migrations in the rivers and lateral movements on to the floodplain (ODA, 1994). The species Catla and Rui tend to migrate from floodplain to rivers. As reported by previous studies (Khan and Jhingran, 1975; Jhingran and Khan, 1979), these species may make full migration to the rivers or may end up remaining in the khals or beels and breed there if migration is obstructed.

The aquatic species would require sufficient depth of water for breeding and regeneration. As it is noticed by the project beneficiaries that the depth of the river, khal and bills in Sonamoral Haor is gradually decreasing and its impact reduced the variety and quantity of the local aquatic species.

Due to enhancing the *Boro* production through increasing safe harvest for flash flood protection by submersible embankment, the gradual encroachment by agricultural activity is found in the study area, which destroying the habitat for weeds and bushy trees. These weeds and bushy trees are suitable place for breeding of aquatic species and they also serve as supplementary food for fish. This is more significant for Boal. This species has a predatory nature and when the species do not get sufficient food they eat own juveniles. This will affect the species of Boal regeneration and dispersion.

It is a growing concern that water management interventions have reduced stocks by reducing habitat area for a particular time, restricted in and off migration and depleted the source of food for fish by encroaching land. During the *Boro* season drying up the beel water for irrigation also damag the habitat of fish. After the monsoon period the fish try to migrate off the floodplain and beels to the rivers, during the period of flow (i.e. October and November). The closer of regulator/sluices to store water for later use in irrigation for the *Boro* crop causes a hindrance to the migration of fish. So, it is likely that SEP has reduced the reverine and floodplain spawning stocks and prevented the return of fish fry to the floodplain and river. In Table 6-2 the list of fish species which are in critical status in the study Haor is shown.

Table 6-2: List of fish species that are in critical status in Sonamoral Haor

Fish Scientific Name	Local Name	Availability	
Chirhinus Chirhosus	Mrigal	Rare	
Catl Anabus restidineus	Koi	Rare	
Catla Catla	Catla	Rare	
M. rosenbergii	Hingri Bora C		Unavailable
Puntius sarana	Sharputi		Unavailable
Labeo nandina	Nanid		Unavailable

6.4 Impact on *Boro* production:

An analysis of the impact of submersible embankment projects on agriculture was carried out in the FAP 6 studies (Shawinigan Lavalin et. al., 1992). Of the 21 completed projects till then, 15 were reported to have positive impacts. Negative impacts related to the construction of the partial flood protection embankments included alteration of sedimentation pattern, deficient drainage and increasing water levels in river systems. Apart from studying the impacts of individual projects, a review of the impact of submersible embankments of Sunamganj on the district's agricultural production was also made. Submersible embankments constructed in the district have protected about 37% of the net cultivable area.

As a part of the evaluation of BWDB's System Rehabilitation Project, EGIS (1998) studied the impact of Chaptir Haor on agriculture and asserted that the project would increase the HYV acreage by 10% and reduce the crop damage by 40%. While analyzing the impacts of two decades of EIP, Datta (1999) studied the impacts of Zilkar Haor on agriculture and affirmed that the project increased the rice production by 28%, mainly due to increased cultivation of HYV rice and reduced crop damages by the flash floods. A study by Saleh and Mondal (2007) shows that *Boro* rice production has increased due to implementation of Submersible Embankment Projects in the Haor region.

From the above review of previous analyses it is evident that considering individually, the submersible embankment projects have had positive impact on *Boro* production. But taken together in a regional context, these projects may have failed to increase the overall *Boro* production (Shawinigan Lavalin Inc. and Others, (1992). A similar study on the district-wise FCD coverage in Bangladesh and the increase in Aman production during 1964-93 period showed little correlation (Rahman and Chowdhury, 1999).

Table 6-3 indicates that the coverage of the HYV has increased while the traditional Boro cultivation has decreased in the study area. The gross agricultural coverage has also increased by around 2%.

Table 6-3: Contribution of Sonamoral SEP on Boro production

Crop	Cropping area (ha)			Production (ton)		
	Pre-project	Post-project	Change in %	Pre-project	Post-project	Change in %
Boro (HYV)	1011	1264	25	3539	5056	43
Boro (local)	2086	1896	-9	4172	3982	-5
Total	**3097**	**3160**	**2**	**7711**	**9038**	**17**

The crop saved from the premonsoon flashflood is more than 40% according to the local community. Considering the increase in production and protection from the damage of premonsoon flashflood, it can be inferred that the submersible embankment project increased the production.

At the same time the input requirement has also increased significantly for the HYV. The study found that around 85% farmers are getting involved in deep indebtness for managing the input cost and surviving the longer lean period.

Benefited Group:

A critical question is where the benefit of increased production goes. The land ownership distribution in Sonamoral Haor showed that the percentage of land-less or small landowners is much higher than medium to large landowners, as shown in Table 6-4. According to the survey, it is found that around 77% land is owned by the large and medium farmers and only 23% is held by landless and small land owners (Fig. 6-1).

Table 6-4: Land ownership pattern of Study area

Owner type	% of total population	% of total land
Land less (0-0.2ha)	40.73	0.55
Small land owner (0.2-1ha)	33.44	21.89
Medium land owner (1-2ha)	14.24	25.17
Large land owner (>2ha)	11.59	52.39
Total	100	100

But the proportion of the large and medium farmer is only 26% of the total household. The land less (0-.2 ha) and small landowners (0.2-1 ha) are around 74% of the total household. Medium landowners (1-2 ha) are around 14% and large landowners (2 ha+) are around 11%. It is clear that, the large landowner group, which is 12% of the total household are holding more than half of the total land of the study area and enjoying the maximum benefit of the submersible embankment project.

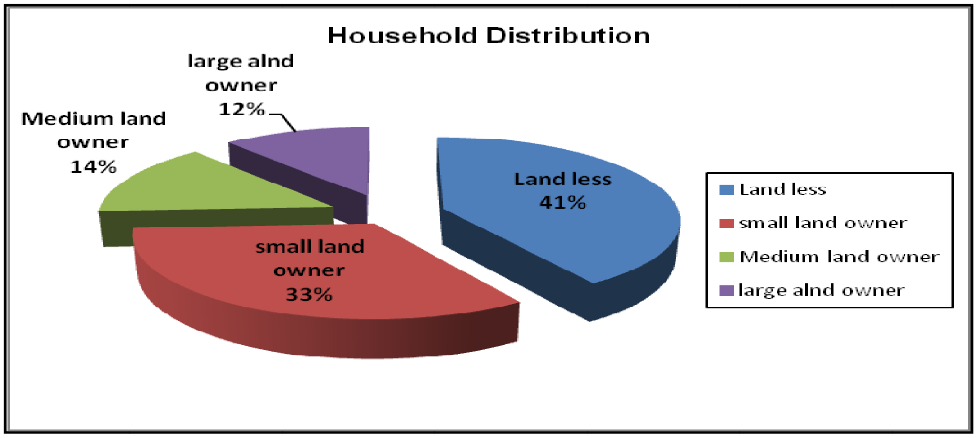


Figure 6-1: Distribution of land ownership pattern

6.5 Impact on livelihood:

The main objective of the study is to assess impact of SEP on the Haor based livelihood by comparing between the pre project condition (before 1991) and post project condition (after 1991). The impact assessment has been carried out by following the methodology discussed in section 4.3. Calculation of *HHDI* requires maximum and minimum values of the indicators as Eq. (4) in section **5.4** shows, and the values are given in Table 6-2. In Table 6-3, indicates that in most cases the household livelihood development index shows lower value in post project condition than the value for pre project condition. Among all Haor based livelihood groups the decline of HHDI is observed for agriculture and fisherman groups, which is 78% of the total livelihood group. The values of HHDI in rest two groups the boatman and aquatic plant based are also lower from pre to post project condition. The lowering of HHDI value of livelihood groups suggests that the livelihood condition of majority households has not improved rather declined.

There are other factors that also might be contributed for the declination of household livelihood development index in addition to impact of submersible embankment. Other factors, like

Table 6-5: Maximum and Minimum values of indicators for each livelihood groups

Livelihood group	Indicator	Value of Indicator			
		Pre project		Post project	
		Max	Min	Max	Min
Agricultural	Income (TK per year)	250000.00	1000.00	300000.00	2000.00
	Food security (months per year)	12	0	12	0
	Working opportunity in main occupation (months per year)	6	3	6	1
	Working opportunity in other occupation (months per year)	6	0	5	0
	Protein intake (days in week)	7	1	7	1
	Access to natural resources (%)	100.00	50.00	100	0
Fisherman	Income (TK per year)	200000.00	2000.00	250000.00	5000.00
	Food security (months per year)	12	0	12	0
	Working opportunity in main occupation (months per year)	9	3	6	2
	Working opportunity in other occupation (months per year)	6	2	8	2
	Protein intake (days in week)	7	4	7	1
	Access to natural resources (%)	100.00	60.00	100	0
Boatman	Income (TK per year)	50000.00	5000.00	100000.00	18000.00
	Food security (months per year)	12	0	12	0
	Working opportunity in main occupation (months per year)	12	6	12	7
	Working opportunity in other occupation (months per year)	6	0	2	0
	Protein intake (days in week)	7	2	5	1
	Access to natural resources (%)	100.00	60.00	100	10
Aquatic plant dependent	Income (TK per year)	30000.00	5000.00	60000.00	10000.00

	Food security (months per year)	12	1	8	2
	Working opportunity in main occupation (months per year)	12	2	12	0
	Working opportunity in other occupation (months per year)	6	0	11	2
	Protein intake (days in week)	7	4	4	1
	Access to natural resources (%)	100.00	70.00	90	10

population growth, basic services condition, inflation, national and global economic conditions might have some influences.

Indicator and livelihood group wise results:

Income:

The amount (Table 6-3) of income in all livelihood groups has decreased from pre project condition to post project condition. It is found that the most deviation (0.09) of income is the boatman livelihood group. It can be explained that, the introduction of engine boat instead of traditional boat promoted wide variance in income increment for this livelihood group. Delineation of income in agricultural and aquatic plant based groups is same (0.03) while fisherman group has the lowest among all groups (0.01).

Working opportunity in main occupation:

The value (Table 6-3) of working opportunity in main occupation of agricultural livelihood group has increased but declined in all other livelihood groups. The increase in agricultural group is because of the increase in the coverage of HYV of *Boro*, which is more labour intensive than the local variety. The decline in other groups is due to reduction of ecological resources and introduction of new technology.

Working opportunity in other occupation:

In post project condition, the HHDI values of working opportunity in other occupations have increased in all livelihood groups except the agricultural group. It is because of the increased coverage of *Boro* production promoted the increase opportunity in main occupation of agricultural group. Accordingly, the increase in other livelihood group can be due to the decrease in the main occupation.

Food security:

Like income indicator food security value of all livelihood groups have declined from pre project to post project condition. In boatman livelihood group the value (Table 6-3) has declined most (0.07). Due to the safe harvesting the food availability has increased but does not reflect the increase food security. As food availability is only one part of food security but other part food access and food utilization has not achieved.

Protein intake:

The value of this indicator has declined most among all indicators in all livelihood groups. This is because of the gradual decrease of fish resources in the study Haor. In pre project condition most of the household used to take fish almost 7 days in a week but in post project condition it has reduced to almost half whereas fish is the main source of protein in the locality.

Survey result shows that 75% of the HH of all livelihood groups do not have three times meal in a day almost half of the year. The percentage of loan taking is significantly raised among all livelihood groups. On average 85% of HH are in the cycle of loan.

Access to natural resources:

Like Protein intake, the value (Table 6-3) of access to natural resources indicator has declined in all livelihood groups because of the environmental and ecological degradation due to reduced natural bushes and increased use of fertilizers, pesticides etc for increased coverage of HYV of rice.

Table 6-6: HHDI value of different livelihood groups

Livelihood group	Indicator	Value of Indicator	
		Pre project	Post project
Agricultural	Income	0.19	0.16
	Food security	0.53	0.51
	Working opportunity in main occupation	0.62	0.70
	Working opportunity in other occupation	0.20	0.18
	Protein intake	0.82	0.52
	Access to natural resources	0.89	0.50
	HHDI	**0.54**	**0.43**
Fisherman	Income	0.15	0.14
	Food security	0.41	0.36
	Working opportunity in main occupation	0.74	0.71
	Working opportunity in other occupation	0.14	0.16
	Protein intake	0.76	0.57
	Access to natural resources	0.94	0.59
	HHDI	**0.52**	**0.42**
Boatman	Income	0.33	0.24
	Food security	0.41	0.34
	Working opportunity in main occupation	0.44	0.40
	Working opportunity in other occupation	0.08	0.15
	Protein intake	0.66	0.54
	Access to natural resources	0.81	0.47
	HHDI	**0.45**	**0.36**
Aquatic plant dependent	Income	0.44	0.41
	Food security	0.44	0.47
	Working opportunity in main occupation	0.68	0.60
	Working opportunity in other occupation	0.26	0.41
	Protein intake	0.70	0.50
	Access to natural resources	0.56	0.52
	HHDI	**0.51**	**0.47**

Agricultural:

Fig. 6-2 shows that for the agricultural livelihood group the pre-project values of all indicators of HHDI are lower except the working opportunity in main occupation. The reason for the decrease of value in income is that the majority of the Agriculture group is land less or small landowner and they are mainly share cropper who invest for the production and taking the risk.

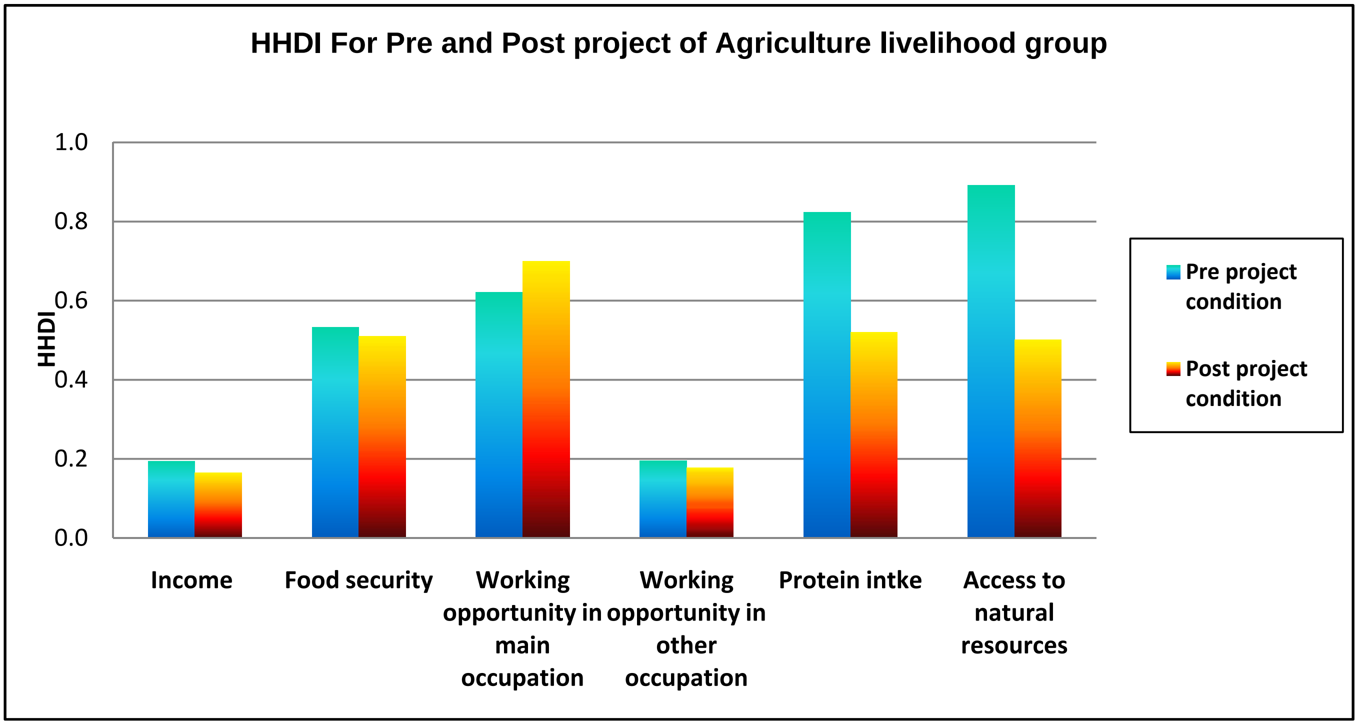


Figure 6-2: HHDI of agricultural livelihood group for pre and post project condition

These majority marginal farmer are straggling with the higher input cost for production. Basically, 11% large landowner grabs the significant portion of the benefit of additional crop production from protection of crop by SEP. It is evident that Agriculture landowner group is the most benefited group. Reasons for declining HHDI value is discussed in section 6.4.

Fisherman:

Diminishing trend of fish availability has impacted fisherman livelihood group. This diminishing trend is due to reduction of fish habitat and obstruction of migration route. The SEP project promotes the interest of the leaseholder of water bodies through creating distinct boundary of water bodies by the demarcation by submersible embankment when water starts falling and beginning of fishing season. Leaseholders are mainly political and influential persons in the area. Leased areas are mainly beel which they have taken lease from the DC's office.

Fishermen are not able to fish in Haor area as previous. Now they have to pay at particular leaseholder for fishing in the Haor. All Indicators value of HHDI for the fisherman livelihood group (Fig. 6-3) of post project condition is less than pre project condition except the value of working opportunity in other occupation. This is because fishermen are moving to the other occupation leaving their main one. Reasons for reducing fish recourses is discussed in section 6.5.

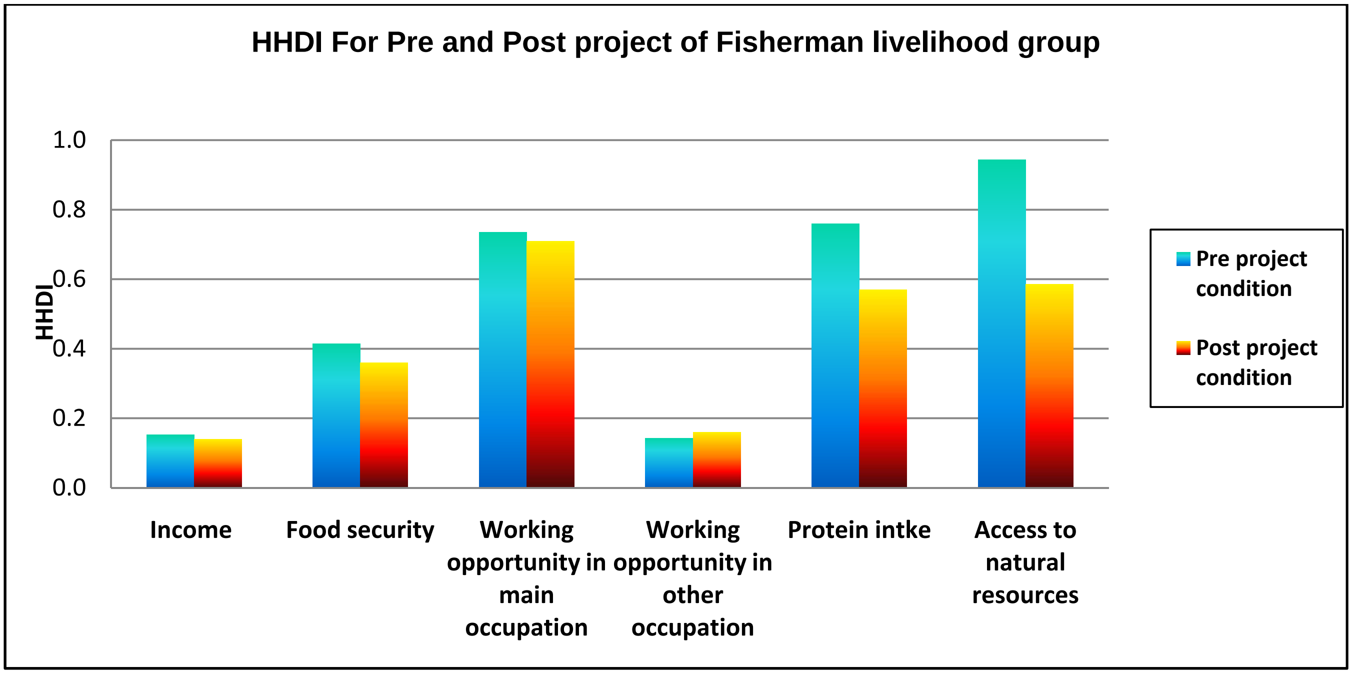


Figure 6-3: HHDI of fisherman livelihood group for pre and post project condition

Boatman:

After introduction of engine boat, the boatman livelihood group has started changing their livelihood pattern and adapting different livelihood options. Eventually after the construction of the embankment internal communication particularly transportation of harvested paddy has suffered and it is an adverse effect on the boatman livelihood. For regular communication use of boat is reduced also due to the absence of required structures for boat pass. Like the fisherman livelihood group, all indicators value of HHDI (Fig. 6-4) are shown less for the post project condition than the pre project condition except the working opportunity in other occupation. Decrease in income and food security is due to the reducing working opportunity in the main occupation.

Aquatic plant dependent:

Aquatic plant based livelihood group is quite few and they are in stage of distinction. At previous time lots of opportunity was available to collect different types of vegetable plant, medicinal plant and plant for erosion protection and firewood from Haor. But gradually, the encroachment by agriculture land, use of pesticide and fertilizer are reducing the availability of those plants.

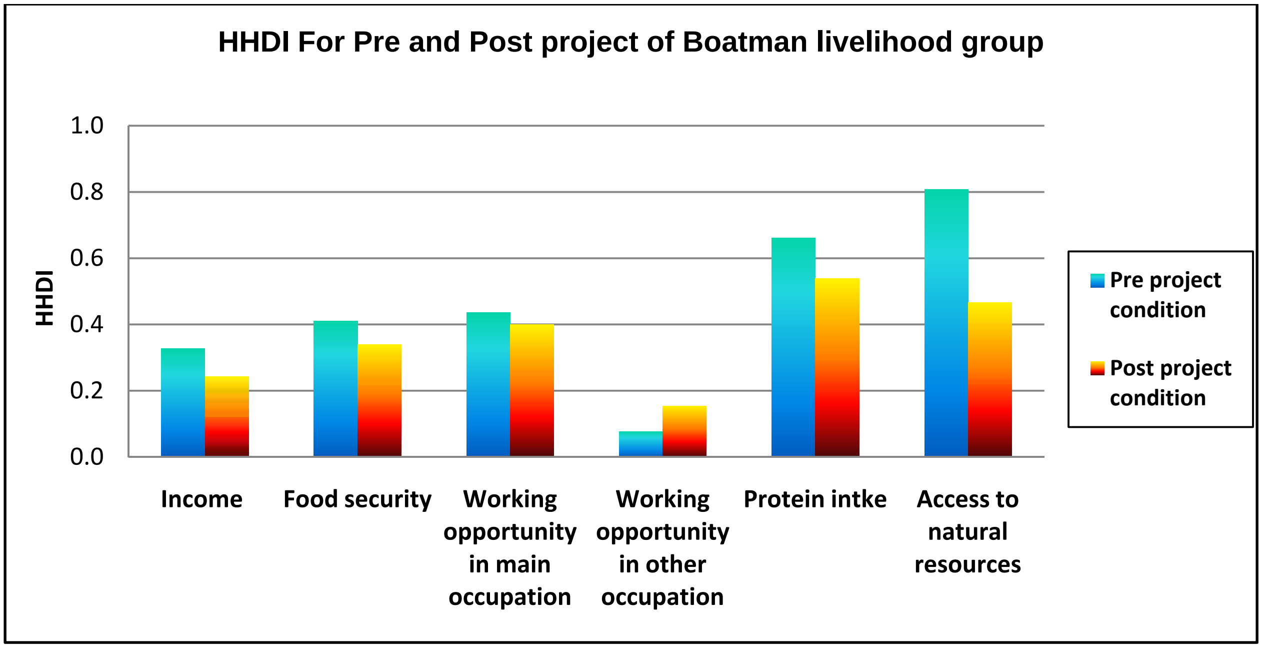


Figure 6-4: HHDI of boatman livelihood group for pre and post project condition

Like boatman and fisherman livelihood groups the indicator value of HHDI of aquatic plant based livelihood group (Fig. 6-5) shows declining trend and the rising tendency of working opportunity in other occupation. This is because the group is changing their livelihood pattern. Reasons for declining HHDI value discussed in the section 6.5.

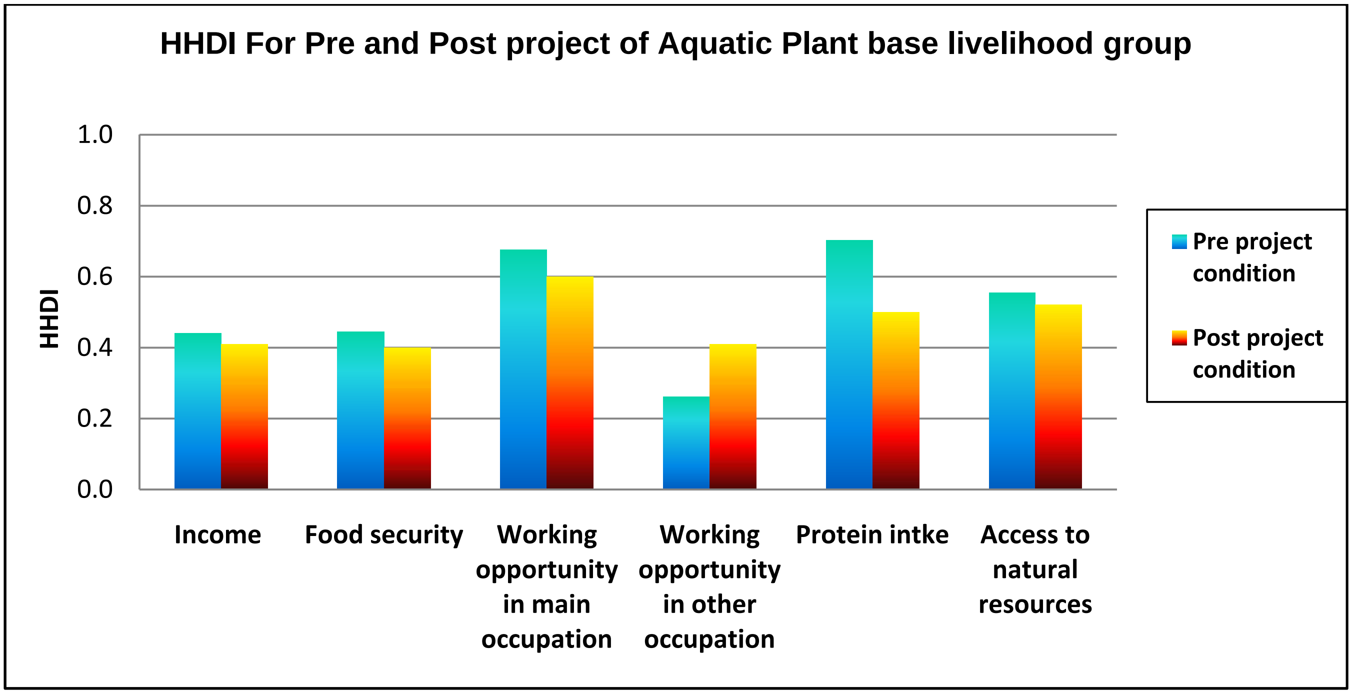


Figure 6-5: HHDI of aquatic plant based livelihood group for pre and post project condition

Overall HHDI:

The overall value of household development index for the study area has calculated with taking weighted average of HHDI of four Haor based livelihood groups. The number of households of livelihood groups -agriculture, fisherman, boatman and aquatic plant based is considered to calculate the weighted average of HHDI as shown by Table 5-2. The overall value has declined from 0.54 in pre project condition (before 1991) to 0.43 in post project condition (after 1991) shown in Table 6-7. This indicates that the benefit from the submersible embankment project has not been equitably distributed among the community. Most of the benefit goes to Agri landowner and majority of the poor households are deprived from the benefit of the project.

Table 6-7: Overall Household livelihood development Index in the study area

Livelihood group	Weight age factor	Pre project HHDI	Post project HHDI
Agriculture	0.73	0.54	0.43
Fisherman	0.21	0.52	0.42
Boatman	0.04	0.45	0.36
Aquatic plant dependent	0.03	0.51	0.47
Weighted Average HHDI	**1.00**	**0.54**	**0.43**

Above findings are consistent with the results of a study by the Bangladesh Institute of Development Studies (2005). The study shows that the average Human Poverty Index has declined in Bangladesh from 47.2% in 1993-94 to 34.8% in 1998-2000. But, 17 out of 64 districts in Bangladesh have Human Poverty Index higher than 45% and Sunamganj district is one of those 17 districts with high poverty.

CHAPTER SEVEN

Conclusion and Recommendation

7.1 Conclusion:

The social survey shows that there are four Haor based livelihood groups in the study area and they are agricultural, fisherman, boatman and aquatic plant dependent. They are fully depended on Haor water regime and its ecological resources.

Assessment of impact of submersible embankment project in Sonamoral Haor indicates that the project has been successful in raising *Boro* production. But standard of living of Haor based livelihood groups has not improved though *Boro* rice production has increased. Assessment of *HHDI* based on the indicators income, food security, working opportunity in main occupation, protein intake and access to natural resources shows that *HHDI* has declined from pre project (before 1991) condition to post project (after 1991) condition in agriculture from 0.54 to 0.43, fisherman from 0.52 to 0.42, boatman from 0.45 to 0.36 and in aquatic plant depended group from 0.51 to 0.47. The average of *HHDI* has declined from 0.53 to 0.43. Agriculture landowners are the main beneficiaries. The negative impacts of the project like reducing ecological resources (fish, aquatic plants), conflict between water users, restricting boat communication and controlling access to the natural resources has affected majority of the target households.

7.2 Recommendation:

The outcome of the study indicates that submersible embankment project to prevent premonsoon flash flood in the Haor region should not be planned for single purpose of protecting Boro rice crop only. Project planning should also give attention to the improvement of standard of living of the community as emphasized in National Water Policy. A study can be under taken to investigate how to integrate food security, ecological and livelihood criteria in the planning of the flood management project in the Haor region. Livelihood assessment in another Haor without submersible embankment condition can be conducted for widening the understanding of SEP impact on Haor based livelihood.

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Appendix-1: Some photographs of the study

Figure 1: Haor in monsoon

Figure 4: Homestead area of Haor

Figure 2: Embankment in starting of dry season

Figure 5: Double vent sluice gate of Sonamoral SEP

Figure 3: Submersible embankment protecting *Boro* paddy

Figure 6: Start for field survey from Dharmopasha Upazilla

Appendix-1: Some photograph of the study

Figure 7: Workshop with CARE, FRRAS staff on survey plan

Figure 10: Data collection from focus group discussion

Figure 8: Sensitization meeting at cluster centre village

Figure 11: Individual HH level data collection

Figure 9: Village level meeting for data validation

Figure 12: Focus group discussion with boatman livelihood group


Figure 13: Discussion with project beneficiary


Figure 14: Boatman livelihood group


Figure 15: Observing fish catch from local community


Figure 16: Discussion with local alights with other livelihood groups


Figure 17: Aquatic plant base livelihood group


Figure 18: Discussion with the Agriculture farmer

Appendix- 2: Formats used for conducting survey

Mvg chv‡q Av‡jvPbv (wf‡jR Mæc wWmKvkb)

Mv‡gi bvg t

BDwbqb t

Lvbvi msL¨v t

‡jvK msL¨v t

Dcw¯'Z †jv‡Ki msL¨v t

1| Kwl Ges AKwl †ckvRxwe Qvov Ab¨ †ckvq wb‡qvwRZt

n¯Í wkí cwiev‡ii msL¨v

grm¨ Rxwe cwiev‡ii msL¨v

cvKwZK m¤ú` wbfikxj cwiev‡ii msL¨v

‡bŠ cwienb wbfikxj cwiev‡ii msL¨v

Ab¨vb¨ (wK ai‡bi) †hgb- PvKix Rxwe

2| Avcbv‡`i Mv‡g †Kvb †ckvRxwe †kYx (15-20 ermi) c‡e wQj wKš eZgv‡b bvB?

2.1 n¯Íwkí cwiev‡ii msL¨v

2.2 grm¨Rxwe cwiev‡ii msL¨v

2.3 cvKwZK m¤ú` wbfikxj cwiev‡ii msL¨v

2.4 ‡bŠ cwienb wbfikxj cwiev‡ii msL¨v

2.5 Ab¨vb¨ (wK ai‡bi) †hgb- PvKix Rxwe

3| MZ 15-20 eQ‡i AvMvg eb¨vi cwieZb we‡klbt

K) c‡e (15-20 eQi) ‡Kvb gv‡m eb¨v AvmZt

L) H mg‡q AvMvg eb¨vq cwbi D”PZv †Kgb _vKZ, eZgv‡bi †P‡q †ewk ☐ Kg ☐

4| Weš Í eva wbgv‡bi Av‡M (15-20 eQi c‡e) GjvKvi kZKiv KZfvM Rwg‡Z avb Pvl Kiv n‡Zv?

=-----------%

5.1 nvl ‡oi Rwg‡Z avb Pv‡li cwigvb (kZKiv)

eZgv‡b : ---------% 15-20 ermi c‡e: ---------- %

5.2 D”Pdjbkxj avb Pv‡li cwigvb (kZKiv)

eZgv‡b ----------% c‡e -------------%

6| †ev‡iv Aeev‡`i cwigvb (kZKiv)

eZgv‡b -----------% 15-20 ermi c‡e -----------%

7| Weš Í ev‡ai d‡j Rjve× mgm¨v RwbZ Rwgi cwigvb (kZKiv)

eZgv‡b ---------- % c‡e -----------%

8| †mP mgm¨v RwbZ Rwgi cwigvb

eZgv‡b ----------% c‡e ---------- %

9| eva nIqvi d‡j ‡bŠ cwienb ¶wZM¯ n‡”Q wKbv ? ✓ w`b

K) n¨v L) bv

10| 15-20 eQi Av‡Mi Zjbvq eZgv‡b ‡Kvb †Kvb gv‡Qi cRwZi cwßKg?

K) L) M) N) O)

11| Rxe‰ewP‡Îi cwieZ‡bi d‡j wK wK RxeRšÍ ev cvbx nwi‡q †M‡Q?

12| 15-20 ermi Av‡Mi Zjbvq wK wK Dw™` K‡g‡Q? ✓ w`b

K) †fIR   L) Lv`¨ mieivnKvix   M) A_Kix

13| KlK KLb eva KvU‡Z Pvq?

K) eb¨vi Av‡M ‡Kvb gv‡m-

L) eb¨vi c‡i †Kvb gv‡m-

14| †R‡j KLb eva KvU‡Z Pvq ?

K) eb¨vi Av‡M ‡Kvb gv‡m-

L) eb¨vi c‡i †Kvb gv‡m-

15| Avdv‡ji d‡j ewo Ni fv½vi cwigvb 15-20 ermi c‡ei †P‡q eZgv‡b

K) †e‡o‡Q □ L) K‡g‡Q □

16| KlK, †R‡j, AKwl kwgK, n¯Íwkí I cvKwZK m¤ú‡`i Dci wbfikxj †jvK‡`i Rxe‡bi

P¨v‡jbR ¸wj wK wK?

17| 15-20 eQi c‡e cwiewiK Rxeb hvÎvi gvb eZgv‡bi †P‡q - ✓ w`b

K) Lv`¨ wbivcËv fvj □ Lvivc □

L) wPwKrmv †mev fvj □ Lvivc □

M) wk¶v c×wZ fvj □ Lvivc □

nvDR‡nvì mv‡f (Lvbv chv‡q Z_¨ msMn)

Z_¨ c`vbKvixi bvg t

(eq¯‹‡jvK n‡j fvj nq)

eqmt

wcZvi bvgt

cwiev‡ii m`m¨ msL¨vt DcvRbKvix KZ Rbt

wk¶vMZ †hvM¨Zv (Z_¨ c`vbKvixi)t

Mvgt BDwbqbt

Z_¨ c`vbKvixi †ckv t

Kwl kwgK	A-Kwl kwgK	grm¨ Rxwe	cvKwZK m¤ú` wbfikxj	n¯Íwkí	‡bŠ cwienb

Ab¨vb¨

1.1 gj ‡ckvi wee ibt

1.2 Av‡qi cwigvb (Drcv`b LiP ev‡`)

K) weMZ eQi t--------------------UvKv L) c‡e (15-20 eQi) t -------------------- UvKv

1.3 Lv`¨ wbivc` gv‡mi msL¨vt

K) weMZ eQit -----------------gvm L) c‡e (15-20 eQi) t---------------------gvm

1.4 eQ‡i KZ gvm Kv‡Ri m‡hvM?

K) weMZ eQit--------------------gvm L) c‡e (15-20 eQi)-----------------------gvm

1.5 Ab¨Î Kv‡Ri gv‡mi msL¨v (kZ - Ab¨ †ckv Ab¨ Dc‡Rjv)

K) weMZ eQit ------------------ gvm L) c‡e (15-20 eQi) -----------------------gvm c‡hvR¨ b‡n

1.6 c‡e Ab¨‡Kvb †ckv wQj wKbv? ✓ w`b

K) n¨v L) bv

_vK‡j wK †ckv?

1.7 Ab¨ †ckvq Kv‡Ri m‡hvM

K) weMZ eQi---------------------gvm L) c‡e (15-20eQi) ------------------------gvm

1.8 weMZ ermi F‡bi cwigvb (b‡f¤i, 2008-wW‡m¤i, 2009)

ÑÑÑÑÑÑÑÑÑÑÑÑÑÑÑÑUvKv

K) F‡bi Drmt gnvRb, GbwRI, e¨vsK, Ab¨vb¨ ✓ w`b

L) 15-20 ermi c‡e FY M¯ wQ‡jb wKbv? ✓ w`b

n¨v ☐ bv ☐

1.9 weMZ 15-20 eQ‡i Avcbvi m¤ú‡`i nvm/ e„× Ae¯v

ÑÑÑÑÑÑÑÑÑÑÑÑÑÑÑÑÑ UvKv nvm / e„×

1.10 Rxeb hvÎvi gvb eZgv‡bi ‡P‡q c‡ei (15-20 eQi) wK Ae¯v wQj?

K) Lvev‡i ZiKvixi msL¨v eZgv‡b ☐ c‡e ☐

L) wPwKrmv †mevi Rb¨ wbfikxj Wv³vi/wbR ☐ Ab¨vb¨ ☐

M) cwiev‡ii wkw¶Z †jv‡Ki msL¨v eZgv‡b ☐ c‡e ☐

1.11 nvIo wbfi Rvjwbi cvc¨Zv (kZKiv)|

K) eZgv‡b ☐ % L) c‡e ☐ %

1.12 Rvjwbi aib

K) eZgv‡b -------------------------------- L) c‡e---------------------

1.13 Rvjwbi cvc¨Zv | ✓ w`b

eZgv‡b ☐ µq ☐ wbR msMn

c‡e ☐ µq ☐ wbR

1.14 cwiewiK gvQ cwßi cwigvb dvêb-ˆPÎ (ïKbvi mgq msMn)|

K) mßv‡n gvQ cwßi cwigvb

eZgv‡b ☐ w`b c‡e ☐ w`b|

1.15 Avfš—ixb †bŠ cwienb Ae¯'v| ✓ w`b

eZgv‡b c‡ei †P‡q fvj ☐ Lvivc ☐

Z_¨ msMnKvixi ¯^vÿi

bvgt

<u>`jxq Av‡jvPbv (†dvKvm Mæc wWmKvkb)</u>

1. Avcbvi Mv‡g KZ cwievi GKB ai‡bi †ckvq wb‡qwRZ (msL¨vq)?

2. MZ (15-20) eQi c‡e GB †kYxi †ckvq cwievi msL¨v KZ wQj?

3. MZ (15-20) eQi c‡e GB †kYxi †ckvi ^`wbK gRix KZ wQj? eZgv‡b KZ?

4. hw` msL¨v cwieZb (ev‡o/ K‡g) nq, Zvn‡j Zvi Kvib wK?

5. GB †ckvq, eQ‡i M‡o KZgvm KvR nq?

K) eZgv‡bt L) AZx‡Z (15-20 eQi c‡e)t

6. GB ‡ckvq, eQ‡i M‡o KZ Avq nq?

K) eZgv‡bt L) AZx‡Z (15-20 eQi c‡e)t

7. eZgv‡b GB †ckvi mgm¨v ¸wj wK wK?

8. eZgv‡b KZ cwievi GB †ckv cwieZ‡bi cwiKíbv Ki‡Q? †Kb Ab¨ ‡ckvq †h‡Z Pvq?

9. †Kvb ‡ckvq cwieZb Ki‡Z Pvq?

10. GB †ckv Dbq‡b Zv‡`i †Kvb mwbw`ó c¯Ívebv wK?

Z_¨ msMnKvixi ¯v¶it

bvgt